Iranian Journal of Economic Studies
Vol. 1, No. 2, Fall 2012, 95-106

Welfare Impacts of Imposing a Tariff on Rice in Iran vs an Export Tax in Thailand: A Game Theoretic Approach

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Abstract

In this study, the social welfare impacts of the interaction of Iranian rice import policies and Thai export policies are analyzed using a game theoretic approach in conjunction with econometric supply and demand models. The joint impacts of increasing the world price of rice, resulting from the export policies in Thailand along with changes in tariff rates in Iran, on social welfare are analyzed in the two countries. Because Iran is a small country in terms of the volume of world rice trade its policies do not influence Thai social welfare. Results of this study show that in order to maximize its own social welfare, the government should impose a modest tariff rate of approximately 3%. This is much less than the actual tariff rate applied in recent years, e.g. 19% in 2007.

Keywords: Game Theory, Social Welfare, Tariff Rate, Rice Imports, Iran and Thailand
JEL Classification: B41, C7, D01, Q11.

Received: 23/5/2012 Accepted: 11/2/2013
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1. Introduction

Rice is the principle food staple in Iran. Population growth and a rising standard of living have stimulated domestic consumption. In 2007 roughly 1500 thousand tons of rice or 35 percent of domestic consumption was imported (FAO[1], 2009). A large share of these imports, come from Thailand where rice is a major crop. Rice uses over half of the cropland area and the agricultural labor force in Thailand and is the main component of Thai exports. Thailand is also one of the world's largest rice exporters. Its rice polices can be expected to affect world rice prices thereby influencing the social welfare of other exporters and importers. Iran is a small country in terms of the volume of rice trade and its policies do not affect world prices. However, the Iranian policy makers can respond to world price changes by adjusting import tariff rates that in turn affect domestic social welfare.

Recent large increases in world cereal and other food prices have led many governments to adopt policies intended to mitigate the adverse domestic impact. From 2000 to mid-2008, the nominal price of rice on world markets roughly doubled. Many countries responded with policies aimed at reducing domestic food prices (International Monetary Fund, 2008). Exporters increased export taxes or imposed export quotas; importing countries reduced import tariffs and other taxes or introduced price controls.

The Iranian government intervenes in the rice market to protect consumers and to prevent the price of rice rising in the country. Various policies can be used to influence the balance between production and consumption, including tariffs, the volume of rice imports, input subsidies, credit programs, guaranteed prices, and the distribution of coupons for purchases at concessional prices (Najafi, 1999; Bakhshoodeh and Thomson, 2006). The import tariff is the main control variable in Iran. Since production costs are higher than in countries such as Thailand, the Iranian government imposes a tariff to support domestic producers.

Between 1995 and 2007 the minimum, maximum and average tariff rates applied to Iranian rice imports were 3%, 22% and 10% respectively with 19% in the last year. In our analysis, we consider tariff rate options of 3%, 10%, 19%, and 22% in addition to setting a zero tariff.

Thailand has a long history of taxing its rice exports and is often cited as an example of this practice (Warr, 2001). The principal control variable in Thailand is the export tax, which is used to regulate the amount of exports to support domestic consumers. Thailand is a large rice exporter country, so reductions in its exports reduces international supply which results in an increase in the export price relative to the world price of rice. The tax generates revenue for the government and changes exporter surplus. We consider changes in the rate of tax (from a base amount) that result in an increase in the export price of 10% or 15%. We also examine a decrease in the world price by 10% and 15% as results of decreasing tax exports. Thus, the strategies open to Thailand are a 10% to 15% increase/decrease in the rice price.

2. Literature Review

An extensive literature has evolved in the past decades using economic theory to determine the impact of policy reform and trade liberalization of agricultural commodities. Wailes et al. (1991/a) provided a comprehensive study of the Japanese rice market prior to the GATT reforms. The Japanese rice economy is described in the context of the 1991 trade liberalization discussions. This study examined the high-cost Japanese rice production structure that is supported by managing the rice surpluses. They also analyzed the implications of trade liberalization for the world rice market in another study (1991/b). The authors used a multi-product quadratic programming model to investigate the impacts on the world market. The study focused on the changes in Japan rice market.

Chen and Ito (1992) estimated the US rice demand and supply models using the implicit revenue function approach. The study also demonstrated the utility of a switching procedure that allows evaluation of supply response behaviors for time periods governed by multiple farm programs in a system of equations. However, they treated rice as a homogeneous crop. A change in farm prices was found to affect significantly producers' net returns and participation rate. Results indicate price impacts on acreage planted are inelastic for program participants but elastic for nonparticipants

Song and Carter (1996) estimated US supply and demand disaggregating types. They analyzed several scenarios according to

the GATT agreement and the impacts of the global rice trade liberalization on the country.

Wailes et al. (2000) constructed a model namely Arkansas Global Rice Model that consists of 22 sub-models and the rest of the world (ROW) to simulate the world rice trade. They disaggregated rice types such as *indica* and *japonica* solving for Thai 5% f.o.b. rice price and California price. They used econometric and partial equilibrium approaches to close the model such that world imports and exports are equal each year.

Lee and Kennedy (2002) in this study attempted to analyze the potential implication of U.S. rice exports to Japan and Korea. For this purpose, the Japanese and Korean rice economies as well as U.S. export demand are analyzed using empirical supply and demand models. This study analyzed various policies, including several reasonable scenarios regarding changes in Japanese and Korean tariff equivalents from 2% to 8% with respect to U.S. export programs, such as credit guarantee and market development programs. The results showed that the best export policy option from the U.S. perspective is obtained at a 4% tariff reduction for Japan and Korea under a combination of U.S. market access program and foreign market development program. The results suggest that the U.S. policy makers might focus more on the U.S. export policy options than the tariff reduction of Japan and Korea.

Nori (2005) studied the positions of support policies including tariff rate, market price support and subsidy inputs in Iranian rice market and showed that tariff policy on imported rice is implemented less than the other policies.

This paper investigates the interaction between Thai and Iranian rice policies and the impacts of world price changes on Iran's social welfare. That social welfare is obtained by summation producer and consumer surplus and government expenditure or revenue. The goal of the analysis is to examine the effects of tax and tariff rate on social welfare in the two countries. In the policy making process, governments consider the effects of their policies on the welfare of various groups, including producers and consumers (Sloof, 1998).

3. Methodology

In this study, empirical supply and demand models and their respected

elasticity estimates in Iranian rice market as well as export demand for Thailand are estimated to illustrate the interaction of the two country policies and its impact on social welfare in Iran. Econometric estimates of relevant supply and demand functions are used into a game theoretic analysis to obtain Nash equilibrium. We consider consumer and producer surpluses for Iran in the base year (2007) assuming that government tariff income equals the cost of distribution of concessional food coupons, such that the government surplus is equal to zero. Thus, the policy scenario for Iran focuses solely on the setting of the tariff level.

Following Lee and Kennedy (2002), we assume that policymakers seek to maximize a political preference function (PPF) consisting of producer surplus, consumer surplus and government expenditure (revenue) by choosing optimal domestic producer and consumer prices (equation 1):

$$Max.\ PPF = PS + CS + GS \tag{1}$$

Where PS, CS and GS denote producers' surplus, consumers' surplus and change in government revenue, respectively, and applying Mathcad software are calculated in different prices resulted from different policies.

Economic surplus is determined by using econometric estimates of the relevant aggregate supply and demand equations for Iran and Thailand. Payoff functions are calculated that include the various surplus levels initially used to obtain the baseline Nash equilibrium. The payoff function for Iran is constructed as follows:

$$V = \int_{P_W}^{P_S} S(P)dp + \int_{P_W}^{P_D} D(P)dp \ . \tag{2}$$

S(P) and D(P) are the domestic supply and demand functions, respectively. Rice producers are assumed to maximize producers' surplus (PS) and consumers maximize consumers' surplus (CS). Also, it is assumed that only price changes and other conditions are constant. So, we calculate consumer and producer surplus when price changes. In this study, the producer and consumer prices, which reflect the results of a combination of price and quantity operation, are regarded as the policy instruments. The domestic supply and demand equations are described as equations (3) and (4):

$$LnS_t = \alpha_0 + \alpha_1 LnP_{st-1} + \alpha_2 LnA_t + \alpha_3 LnP_{wt} + e_{St} \quad (3)$$

$$LnD_t = \beta_0 + \beta_1 LnP_{Dt} + \beta_2 LnP_{wt} + \beta_3 LnI_t + \beta_4 Ln\, D_{t-1} + \beta_5 Lnpop + e_{Dt} \quad (4)$$

The amount of domestic rice supply (S_t) is a function of producer price at time t-1 (P_{st-1}), area harvested at time t (A_t) and the world price (P_w). The demand consumption (D_t) is a function of retail price (consumer price)(P_{Dt}), the price of imported rice (world price) in period t (P_w), income (I_t), lagged consumption (D_{t-1}) and population (pop). Based on essential variables test, the world price enters into both the domestic supply and demand equations to explain fluctuations of their corresponding dependent variables. e_{St} and e_{Dt} represent the error term of supply and demand function, respectively. Also, to examine collinearity between domestic and world price, we used Condition Index method. Amount of this index is less than 10 and therefore, collinearity isn't a serious problem.

The political payoff for Thailand is a function of its export surplus that will change when world price change:

$$V_{PX} = XS_t(P_w). \quad (5)$$

The equation for export demand is:

$$LnX_t = \gamma_0 + \gamma_1 LnP_{Dt} - \gamma_2 LnP_{wt} + \gamma_3 LnPR_t + e_{xt}, \quad (6)$$

Where X_t, P_{Dt}, P_{Wt} *and* PR_t represent export quantity, the domestic price in Thailand, the world price, and Thailand's production.

Finally, we use equation (7) to establish the relationship between the producer price and the retail price in Iran (Nicita, 2009):

$$LnP_{rt} = \delta_0 + \delta_1 LnP_{st} + \delta_2 Ln(1+TE) \quad (7)$$

That TE is equal to:

$$TE = \frac{(P_{wh} - P_w ER)}{P_w ER} \quad (8)$$

Where P_{st} , ER and TE are the producer price, exchange rate and the tariff equivalent respectively, where the tariff equivalent is calculated from equation (8) following Beghin and Bureau (2001). In this method, tariff equivalent is calculated from computing price gap between imported goods price and similarly domestic goods price. This calculated tariff equivalent can enter in the partial and general equilibrium models (for measuring welfare effects) as a variable (Beghin and Bureau, 2001). Also P_{wh} and P_w are the domestic wholesale price and the world price, respectively.

After conducting the necessary tests for stationarity and diagonal dominance, the rice demand and domestic supply equations were estimated using Two-stage Least Squares (2SLS).The export supply equation (6) and equation (7) were estimated through Ordinary Least Squares (OLS). Finally, we computed consumer and producer surpluses for various scenarios for changes in the Thai export price and tariff rates in Iran.

3.1 Data

Time series data for Iran and Thailand for production, consumption, area harvested, income, producer price, export quantity and export value of rice from 1966 to 2007 were assembled from the FAO (FAOSTAT) database. Wholesale and consumer prices were derived from data from the Central Bank of Iran. Because of the large share of Iran's rice imports from Thailand, the price of rice in that country is considered to be the world price (P_w) and is obtained from the database of the International Rice Research Institute (IRRI). This was converted to the real border equivalent price (P_b) using the official exchange rate. The retail price of rice in Thailand was obtained from data supplied by the Food and Agricultural Policy Research Institute (FAPRI). Exchange rates for Thailand and Iran are obtained from the Penn world database. The structural model used in this study is estimated from annual time series data from 1966 to 2007. All of the time series data except for the retail price in Thailand were stationary in level, and we used first differences for the retail price in the equation.

4. Empirical Results

The results of model estimation including domestic supply, consumption and export supply are shown in Table 1. Except for the constant terms, all independent variables in the domestic supply equation have strong statistical significance and expected signs. The price elasticity for domestic production is calculated to be 0.717, revealing that farmers' response to price is inelastic. Moreover, domestic supply of rice is positively related to its world price implying that domestic producers' competition power and thus domestic supply will improve by increasing world price. Rice consumption is negatively related to own price and the demand price elasticity is 0.0705, which is extremely inelastic. It is because rice is an essential good in Iran and there is only limited consumer reaction to price changes. The income elasticity is also computed to be 0.179, which implies that rice is a normal and necessary good in Iranian households' food basket. The coefficient on lagged demand in the consumption equation is 0.693 implying that there are only gradual changes in consumption in response to the independent variables.

Table 1: Empirical results of domestic supply, consumption and export supply functions

Domestic supply equation (Iran)

1) $\ln S_t = 1.37 + 0.717*\ln P_{st-1} + 0.75*\ln P_W + 1.03*\ln A_t$

(0.202) (2.348) (13.004) (2.23)

Adjusted R^2: 0.97 F: 525.7155

Domestic Demand equation (Iran)

2) $\ln D_t = -2.9672 - 0.0705*\ln P_{rt} + 0.693*\ln D_{t-1} + 0.179*\ln I_t$

(-2.48) (-2.62) (6.62) (3.84)

$+0.267*\ln pop$ $+0.0852*\ln P_w$

(1.68) (2.56)

Adjusted R^2: 0.99 F: 855.2792

3) $\ln P_{rt} = 1.651 + 0.994*\ln P_{st} + 0.121*\ln(1+TE)$

(6.96) (37.03) (0.83)

Adjusted R^2: 0.98 F: 1365.765

Export equation (Thailand)

4) $\ln X_t = -27.42 - 0.368*\ln P_{Dt}(-1) + 0.228*\ln P_{wt} + 2.773*\ln PR_t$

(-10.9) (-2.9) (1.7) (13.39)

Adjusted R^2: 0.89 F: 125.9799

Figures in parentheses are standard errors.
Source: Author(s)

Equation 3 implies that if producer price increase by 1%, the retail price will rise by approximately 1%, all other things held constant, and therefore that retail price variation is broadly equivalent to the variation in the producer price.

All of the independent variables are statistically significant at the 5% level in the Thai export supply equation. As the gap between the world price and domestic retail price widens, producers' willingness to export rice tends to increase. The coefficient for the domestic retail price in the export supply equation is negative and equal to -0.368, indicating that when the domestic price increases by 1%, Thai rice exports decrease by approximately 0.37%. But the responsiveness of exports to the world price is positive and computed at 0.228. Therefore, increasing the domestic retail price or the world price will cause exports to decrease and increase, respectively.

The results of policy scenarios analysis with game theory are summarized in Table 2. These are the payoffs for the two countries under Nash equilibrium. The left hand column in the table indicates the changes in the Thai export price from the base level in 2007. The Iranian tariff rates are arrayed along the top of the table. The value combinations under each export price and tariff rate scenario denote the change in welfare in Thailand measured in million baht ($1=31.25 Baht approximately), and that in Iran, measured in million Rials ($1 = 10 000 Rials approximately).

Based on Table 2, the dominant strategy for Thailand is a 15% increase in the export price with the payoff of 55.3 million baht (A strategy is dominant if, regardless of what any other players do, the strategy earns a player a larger payoff than any other). Therefore, Thailand's welfare remains unchanged as Iran moves from a 0% tariff rate towards 22%. If one player has a dominant strategy, he will choose it and the other player's strategy will be his best response to

this. Since Iran will try to protect its import market, it will try to keep its tariff rate as high as possible to restrict imports and support domestic producers. Therefore, when Thailand chooses a strategy of increasing its export price by 15%, Iran has to choose the 3% tariff rate to maximize its payoff. Under this scenario the payoff is equal to 171 641 million Rial (roughly $17.16 million dollars). Our results show that the government should impose a modest tariff on rice. If government chooses a high tariff rate (more than 3%) to support farmers, it has inverse effects and neither supports farmers, nor improves social welfare.

Table 2: The payoff of game theory between Iran and Thailand

			Iran				
			Tariff rate				
			No tariff	3%	10%	19%	22%
Thailand	Export price	10%	25.3; 46,373	25.3; 47,840	25.3; 51,503	25.3; 52,406	25.3; 57,338
		15%	55.3; 101,558	55.3; 171,641	55.3; 112,629	55.3; 117,022	55.3; 124,133
		-10%	-27.6; -28,316	-27.6; -29,218	-27.6; -31,324	-27.6; -37,293	-27.6; -35,633
		-15%	-64.0; -120,162	-64.0; -123,764	-64.0; -132,623	-64.0; -149,293	-64.0; -148,902

Source: Author(s)

5. Conclusion

In this study, the linkage between Iranian rice imports and Thailand rice exports is analyzed using a game theoretic approach. The Iranian rice economy is analyzed using empirical supply and demand models and elasticity estimates. For Thailand, the export supply is estimated using an empirical econometric model. A social welfare approach is applied to measure the payoff matrix for these countries of varying the import tariff in Iran and the export price in Thailand. The welfare levels of producers and consumers of rice change as result of change in the price of rice created by these variables.

In recent years, the Iranian government has tended to increase

tariff rates on rice (the rice tariff was 19 percent in 2006). While domestic rice producers can be harmed if the import price is less than the domestic producer price, our results suggests that a modest tariff rate of approximately 3% will maximize social welfare. This rate is much less than actual tariff rate imposed by the government.

Nevertheless, while social welfare increases; welfare of rice producers is expected to decrease as result of decreasing tariff rate. In this context, the import quota and tariff policies could be regarded as alternative policies to avoid and or to offset the negative effects of tariff policy on producers.

Endnote

1. http://apps.fao.org

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