POLICY ANALYSIS OF INTERNATIONAL TRADE IN U.S. BROILERS -A DYNAMIC GAME APPROACH

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The U.S. broiler industry grew rapidly in the last 15 years because of improved efficiency and changing consumer preferences favoring poultry products. The industry experienced export growth without government subsidies or price supports. Although domestic consumption of poultry has expended dramatically in the last fifteen years and is expected to continue rising, higher feed costs and lower real retail price of broilers and higher competition from the red meat industry may tend to reduce profit margins in the poultry industry. Hence, the markets abroad may become more important in the future for the U.S. broiler industry, especially for the southeastern region which is the major production region for broiler meat.

Among the importers of U.S broilers, Japan is the largest one and the market is growing faster than other markets even without the implementation of EEP and TEA programs. Several factors indicate that Japan will continue to be an important market for U.S. broilers. Japanese import demand for broilers is expected to rise due to slower growth of domestic production than consumption. Japanese import tariff of broilers has been decreasing since the early 1980's and is expected to decrease in the future. Economic growth in Japan is stable. The U.S. desires to decrease trade deficit with Japan. Therefore, the Japanese broiler import market is chosen for analysis in the study.

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The focus of this study is to evaluate the potential reactions of the U.S. and Japan to changes in policy related to broilers, find the optimal trade policies for the U.S. and Japan to maximize their separate welfare, and also investigate the impact of policy changes on price of Japanese broilers and welfare of the U.S. and Japan.

The U.S., Thailand, and Brazil are the major foreign suppliers of broilers to the Japanese market. Their shares of the Japanese broilers import market were 41.77% , 39.98% , and 10.63% in 1987 for the U.S., Thailand, and Brazil, respectively. Therefore, each of these countries has sufficient market power to influence price of broilers in Japan and hence the Japanese import market cannot be characterized as perfectly competitive. Moreover, both sides of this market intervene in trade by imposing either import tariffs or export subsidies. Game theory provides a method of analyzing the trading behavior characterized by imperfect competition and intervention. In addition, dynamic game can capture reaction of a country to changes of policy in other countries. Therefore, the concept of a discrete-time infinite dynamic noncooperative game model is applied in the paper. Furthermore, an algorithm developed by F.Kydland (1975) is used to solve this dynamic game problem. The Kydland algorithm is introduced in the following sector.

Methodology and Estimation Procedure

The Kydland algorithm is as follows:

The optimization problem for player i is

$$W^i_t = \max \sum_{t}^{T} (\delta^i_t)^{t-1} (g^{i\prime} * X_t + X'_t * Q^i * X_t) \qquad (1)$$

subject to

$$X_t = AX_{t-1} + BU_t + c; \qquad (2)$$

X_0 is given ;

$0 < \delta^i_t < 1$; and

given decisions of the other players.

The unique equilibrium solution for period t can be computed recursivly as follows:

$$U^*_t = -(H_tB)^{-1} (k_tC + H_t C + H_tAX_{t-1}) \qquad (3)$$

$$\equiv d_t + E_tX_t\text{-}1$$

and the value of the objective function for player i is of the form:

$$W_i^i = v^i_t + r^i_t{}'X_{t-1} + (1/2)X'_{t-1} S^i_tX_{t-1} \qquad (4)$$

where

i= U.S. and Japan;

$W^i_{T+1} \equiv 0$;

$S^i_t = (A + BE_t)' (Q^i + \delta^i S^i_{t+1})(A + BE_t)$;

$r^i_t = (A + BE_t)' [g^i + \delta^i r^i_{t+1} + (Q^i + \delta^i S^i_{t+1})(Bd_t + C)]$;

$v^i_t = \delta^i v^i_{t+1} + [g^i + \delta^i r^i_{t+1} (1/2)(Q^i + \delta^i S^i_{t+1})(Bd_t + C)]'(Bd_t + C)$;

$$H_t = \begin{bmatrix} b^{US}{}'(Q^{US} + \delta^{US} S^{US}_{t+1}) \\ b^{JA}{}'(Q^{JA} + \delta^{JA} S^{JA}_{t+1}) \end{bmatrix};$$

$$k_t = \begin{bmatrix} b^{US'}(g^{US} + \delta^{US} r^{US}_{t+1}) \\ \\ b^{JA'}(g^{JA} + \delta^{JA} r^{JA}_{t+1}) \end{bmatrix}$$

b^{US} and b^{JA} are the columns of B for the respective country. X is state vector and U is control vector of the game. δ is discounted factor. Equation (2) is the state equation of the game and is discussed in later section. Equation (3) is a control rule (reaction function) of the game. It implies that given the market is in state x_{t-1} at time t-1, the best policy to take is the set of policies in the vector, u_t. Government chooses the best policy, u_t, at the beginning of each time period using the most recent information, x_{t-1}. These policies then determine the equilibrium Japanese market price. For a unique soltion to be obtained, $|H_t B| \neq 0$ has to hold for all time periods.

Two active players, the U.S. and Japan, and a passive player, the rest of the countries which export broilers to Japan, are included in the paper. The U.S. and Japan are assumed to maximize their own country's discounted long-run (ten and twenty years are used in this paper) social welfare function which includes consumers', producers', and taxpayers' welfare. This maximization problem is subject to the initial value of price of broiler meat in Japan, policies in both countries and a state equation which describes the relationship between current price of Japanese broiler meat and lagged price of Japanese broiler meat, and current and lagged policies in the U.S. and Japan.

In order to set up this dynamic game model, three simultaneous systems are estimated. The U.S and Japanese demand supply models are estimated to calculate consumers' surplus, producers' and government revenue (taxpayers' welfare) for the welfare function. The U.S. demand and supply model includes four equations which are domestic demand, Japanese demand, other foreign demand, and U.S. supply. Japanese model is composed of three equations representing Japanese demand, domestic supply, and foreign supply. After obtaining the formula of consumers' surplus, producers' surplus, and government revenue, historical data is used to estimate the weights of these three groups in the welfare function. In this step the sum of lagged domestic demand, lagged exports (lagged imports for importing country), and lagged domestic supply is defined as the approximation of welfare values. Alternatively, equal weights for these three groups are also used to solve the dynamic game problem. A model of the Japanese import market is estimated to set up the state equation of the dynamic game. The estimated results of these models are shown in Tables 1 to 3.

The procedure of setting up state equation is represented in the follows: At every time period, Japanese import demand equals total international supply to Japan.

$$USJAQ_t + OTHERJAQ_t = JAIMD_t$$

A difference equation can be obtained from this relationship. This difference equation is called the state equation of the dynamic game. After rearranging the equality, we can obtain a first order linear difference equation:

$$P_t^{JA} = f(P_{t-1}^{JA}, TARIFF_t, TARIFF_{t-1}, USSUB_t, USSUB_{t-1})$$

or

$$P_t^{JA} = \alpha + \beta_1 * P_{t-1}^{JA} + \beta_2 * USSUB_t + \beta_3 * TARIFF_t + \beta_4 * USSUB_{t-1} + \beta_5 * TARIFF_{t-1}$$

Now define a new state, $X_t = (P_t^{JA}, USSUB_t, TARIFF_t, P_{t-1}^{JA}, USSUB_{t-1}, TARIFF_{t-1})'$, and control, $u_t = (USSUB_t, TARIFF_t)'$.

The state equation will be as follows:

$$X_t = AX_{t-1} + BU_t + C$$

or

$$\begin{bmatrix} P^{JA}_{t} \\ USSUB_{t} \\ TARIFF_{t} \\ P^{JA}_{t-1} \\ USSUB_{t-1} \\ TARIFF_{t-1} \end{bmatrix} = \begin{bmatrix} \beta_1 & \beta_4 & \beta_5 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} P^{JA}_{t-1} \\ USSUB_{t-1} \\ TARIFF_{t-1} \\ P^{JA}_{t-2} \\ USSUB_{t-2} \\ TARIFF_{t-2} \end{bmatrix}$$

$$+ \begin{bmatrix} \beta_2 & \beta_3 \\ 1 & 0 \\ 0 & 1 \\ 0 & 0 \\ 0 & 0 \\ 0 & 0 \end{bmatrix} \begin{bmatrix} USSUB_{t} \\ TARIFF_{t} \end{bmatrix} + \begin{bmatrix} \alpha \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

$USSUB_0$ and $TARIFF_0$ both affect the solution (because the coefficients of lagged USSUB and lagged TARIFF are not zero), so it can not be arbitrarily chosen. This type of state equation is reasonable for the games that have a history, such as our model. Therefore, the historical value will be used for the initial value of two policy variables and a price variable. Empirical estimates of the matrices A, B, and C are obtained by substituting the results from the econometric model for the respective coefficients. Because the state vector includes control variables, we can determine how a country's welfare is affected by changes in its own policies of and by changes in policies by an opponent country. This information can be used for future negotiations related to reducing trade barriers.

Japanese prices and gross national product are converter into U.S. dollars.

All price and income variables are deflated by U.S. CPI (1980= 100). Price variables are in the unit of dollars per pound. Income variables are in the unit of billion dollars, and quantity variables are in the unit of billion pounds. Naive expectations are used in the study to prevent some estimation problems such as multicollinearity, inconsistency, and losing degree of freedom caused by other expectation methods.

The econometric results for U.S. supply, U.S. demand, Japanese domestic supply, and Japanese demand are substituted for the quantity variables in the dynamic game to make economic surplus and government revenue compatible to the state equation. Moreover, U.S. broiler meat price and world broiler meat price are substituted by Japanese broiler meat price. Variables other than pirce of broilers in Japan and policy variables are held constant at their means for the study period. After these substitution, both countries' objective functions depend on current and lagged price of Japanese broilers and current and lagged policies of both countries. The total welfare of each country is the discounted sum of single period objective functions.

Two stage least squares procedures are used to estimate three simultaneous systems for the U.S. and Japanese markets and Japanese import market. Ordinary least squares procedures are employed to estimate the welfare equation for both the U.S. and Japan. The relationships between U.S. and Japanese prices of broiler meat and world and Japanese prices of broiler meat are also estimated by ordinary least squares procedures.

Durbin-Watson tests and condition numbers are calculated to check for autocorrelation and multicollinearity.

Data

This paper analyzes international trade in broiler meat among the following countries: the United States, Japan, and the rest of the exporters. The following data are needed for these countries from 1971 to 1987 annually:

1. domestic chicken meat price
2. domestic beef price
3. national income
4. production of broiler meat
5. consumption of broiler meat
6. inventory of broiler meat
7. export subsidy, export tax, or import tariff
8. feed price
9. Comsumer Price Index

In addition to the data stated above, the following data for the U.S. are needed:

10. broilers export quantity to Japan
11. broilers export quantity to countries other than Japan
12. exchange rates to Japanese Yen

Finally, world broiler meat price is also needed.

Japanese imports of broiler meat from different origins (quantity and value) are obtained from Japan Exports & Imports (Japan Tariff Association). From 1971 to 1975, fowls, killed or dressed, fresh, chilled or frozen are used for Japanese imported broiler meat. During 1976 to 1980, fowls, fresh, chilled, or frozen are used. The sum of legs of fowls (with bone-in, fresh, chilled, or frozen) and fowls (fresh, chilled, or frozen) are used for the years after 1980. Retail prices of excellent grade steers are used for beef retail prices and collected from The Meat Statistics in Japan (Livestock Industry Bureau, Ministry of Agriculture, Forestry & Fisheries, Japan). The purchase prices of compound feed for chicken 15-19% rough protein is used to reflect production costs (feed price). This price is from Japan Statistical Year Book (Bureau Statistics, Japan). The Japanese import tariff is obtained from Tariff Schedule of Japan (Japan Tariff Association). Because Japanese inventory of broiler meat is not available and also because the inventory of broiler meat is usually only a small percent of the supply. Japanese supply of broiler meat is set to equal Japanese production of broiler meat. Production and consumption of broiler meat of Japan are collected from Livestock and Poultry Situation and Outlook Report (USDA-ERS),

U.S. disposable personal income is from Agricultural Statistics (USDA). The U.S. beef retail prices are provided by Dr. Lee Christensen, USDA. Whole chickens retail price is used as the appropriate broiler meat retail price and is collected from Poultry and Egg Statistics, 1960-1985 (USDA-ERS) and Dr. Larry Witucki, USDA for recent data. Broiler feed costs are used for the production cost of chicken meat and are collected from Poultry & egg statistics (USDA-ERS) and Dr. Larry Witucki, USDA for recent data. U.S. export of broiler meat to countries other than Japan is the difference between U.S. total exports and the amount exported to Japan. U.S. total broiler meat exports are from Livestock and Poultry Situation and Outlook Report (USDA-ERS) and the amount exported to Japan is from Japanese Exports & Imports (Japan Tariff Association). The U.S. export subsidy under the EPP program is provided by USDA. Production, consumption, and inventory of broiler meat are collected from World Livestock and Poultry (USDA-ERS).

The average world price for poultry meat exports is used to represent the world price and is collected from FAO Trade YearGook (United Nation Food and Agriculture Organization). Exchange rate, U.S. consumer price index, Japanese consumer price index, and Japanese gross national product are obtained from International Financial Statistics (International Monetary Fund).

Previous Work

There are two papers which applied game theory to agricultural commodities. L. Karp and A. McCalla (1983) developed a simple world corn trade model with U.S. being an exporter and EC and Japan being importers and the rest of the world being a competitive fringe. Kydland's algorithm is also applied in their study. However, their welfare function was based on equal weights for three groups-consumers, producers, and taxpayers.

P. Paarlberg and P. Abbott (1986) developed a model of world wheat trade.

Each country maximizes its welfare. Five political interest groups are included in the welfare function, the welfare of each group is represented by either minimizing expenditures or maximizing profits. The relative weights of the five groups are obtained by solving the first order conditions for maximization of welfare subject to a market cleaning constraint and international equilibrium conditions. Although this model includes government intervention, it is a static model. In these two papers, the estimating methods for relative weights of different groups in the welfare function are not based on historical data. In the countries such as the U.S. and Japan agricultural policies should be consistent over time. Therefore, the historical data is used to estimate the relative weights of different groups in this study.

Results and Conclusions

The estimation results of the three systems of simultaneous equations are, in general, consistent with the expected signs and most of the coefficients are statistically significant at least for the 1 percent level. The F-values, adjusted R2s, Durbin-Watson statistics, and condition numbers for the estimated equations indicate that the equations are statistically significant, the independent variables have significant explanation power on the variation of respective dependent variables, and first-order autocorrelation and multicollinearity do not appear to be serious problems.

The estimated weights for U.S. consumers, producers, and taxpayers are 0. 287124, 0.012182, and 6.632291, respectivesly. Producers are ewighted less than consumers, as expected, and government cost has the highest weights. These results reflect that in the U.S. poultry sector consumers have not been taxed to subsidize broiler production and government cost is the most important concern to U.S. policy makers. These results also reflect the fact that the real broiler meat price is declining overtime, the U.S. has never had price support programs for broiler meat, and export subsidy program, which only started in 1985, is programmed to end in 1990. The weights are 0.03913, 0.301254, and 53.49069 for Japanese consumers, producers, and taxpayers, respectively. Producers are weighted heavier than consumers, as expected, and government revenue is the highest weight. Since an import tariff is imposed on broilers in Japan, Japanese consumers pay more for broiler meat and producers benefit from the higher domestic price. There results also reflect the fact that Japanese government tends to protect domestic producers, especially the agricultural producers.

Results of dynamic games are shown in Tables 4 to 7. When the dynamic game problem is solved for 20 years, the results are more stable than when it is solved for 10 years. The optimal policy a country tends to change every year during the first few years and then its policy stabilizes for several years. Toward the end of the planning horizon, the policies begin to change every year to adjust for the ending of the plan. A longer planning period causes the stable number of stable years to increase.

In the optimal solutions with estimated weights, the U.S. imposes an export tax on broiler meat exported to countries other than Japan, and Japan imposes an import tariff on all imported broiler meat. The imposition of an export tax on brolier meat exports to countries other than Japan indicates that the U.S. should encourage exports to Japan because of the higher price in Japan. This kind of policy will direct producers to a more profitable market and also benefit taxpayers by increasing government revenue. When equal weights are used, an export subsidy is chosen as the optimal U.S. policy and the subsidy is much higher than the current one. This type of policy will encourage farmers to export broiler meat to all countries and will increase government costs at the same time. Japan's optimal policy is an import tariff using both estimated weights and equal weights except during the last period when equal weights are used. The average optimal Japanese tariff and price of broilers are higher when the estimated weights are employed. Moreover, the optimal import tariff and Japanese price are higher than current ones no matter which weights are used. Average net price of broiler meat in Japan is about the same as the current level when estimated weights are used and this price is lower than current level when equal weights are used. The results indicated that the Japanese government should tax consumers more to subsidize producers and raise government revenues. The higher Japanese import tariff indicates that Japan would like to encourage more domestic supplly of broliers and reduce imports of broilers. If these policies are used in the future and world price of broilers keeps at the current level, proportion of U.S. exports of broilers to Japan to broiler exports to other countries will increase if the net world price is less than Japanese price after both countries imposing their optimal policies. In addition, the Japanese import demand for broilers will decrease, and Japanese domestic production of broilers will increase due to higher tariff and price.

Estimated values for the welfare of U.S. and Japan are shown in Table 8. The welfare value for Japan is much higher than the welfare value for the U.S. when both estimated and equal weights are employed. Welfare values of the U.S. are all negative. However, the welfare values of the U.S. are more negative when equal weights are used. The negative value can be attributed to the huge export subsidy that induces large government costs when identical weight is used. When the estimated weights are used, the negative value can be attributed to the reduced of producers' surplus due to the taxation on exporting.

The contribution of this study is that the model capture the consistency of policy making in a country, imperfection of the Japanese broiler meat market, allowance of cross-country policy adjustments, and dynamic features of international trade over time. Furthermore, the econometric model estimated in this study is reliable basis for the dynamic game model. However, there are some limitations of this study. First, it is difficult to predict the quantities of future supply, demand, exports, and imports by using the estimated optimal Japanese price and policies in both countries due to the difficulty of predicting all independent variables involved in the U.S. and Japanese demand and supply models. Second, there are a limited number of methods to solve dynamic game models. Only models with quadratic-linear form of the objective function and linear form of the state equation are solvable. Therefore, variables other than state and control variables are difficult to play a significant role in the dynamic game model. Therefore, in this study U.S. and world prices of broilers have to be substituted for by Japanese price of broilers. If

Japanese price of broilers is not a good explanatory variable to U.S. and/or world prices then the overall estimation power of the model will decrease. Third, this study only includes broiler products in the model. Competitive products such as beef and pork are only included in the demand equation for broilers and inputs such as feed are only included in the supply equation of broilers. Separate systems can be included for substitute and complementary products, making the model more complete and the social welfare function more representative.

Further research on the Japanese import market for broilers can include more active exporting countries, such as Thailand and Brazil, to investigate the influence of their policy changes on the U.S and Japan. The model will be more complete if demand and supply systems of other products in the meat group such as beef and some important inputs of growing broilers such as feed are included. The substitution and complementary possibilities will be taken into account if these systems are included. Moreover, the policy for beef and feed can be included in the model to represent a more global society.

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Table 1. Estimation Results of U.S. Model

	D^{US}	USJAQ	USOTHERQ	S^{US}
Intercept	0.003870 (0.024)	0.007486 (2.376)**	0.024814 (1.277)	0.546984 (5.359)*
P^{US}	−0.591083 (−7.543)*			
P^{W}			−0.044077 (−1.825)***	
P^{IA}		−0.00534 (−3.904)*		
$NETP^{W*}$				−0.398133 (−2.052)***
$NETP^{IA*}$				0.151677 (1.572)
I^{US}	0.000744 (14.097)*			
I^{IA}		0.000013 (11.657)**		
P^{US}_{b}	0.032655 (0.797)			
$CHPFDP^{US*}$				0.033086 (2.453)**
T			0.004364 (6.764)*	0.037054 (7.873)*
DUM			−0.036276 (−4.125)*	
F	280.418	71.998	25.363	170.896
$\overline{R}^2$	0.9861	0.8987	0.8204	0.9770
DW	1.880	1.598	1.297	1.225
Condition Number	59.2806	18.1174	26.4961	51.3485

* significant at the 0.1% level

** significant at the 0.5% level

*** significant at the 1% level

Table 2. Estimation Results of Japanese Model

	D^{IA}	JAFS	S^{IA}
Intercept	1.969386	0.129536	0.049216
	(7.436)*	(1.730)	(0.158)
P^{IA}	−0.869029		
	(−8.196)*		
P^{W}		−0.609382	
		(−7.610)*	
$NETP^{IA}$		0.221064	
		(3.615)*	
I^{IA}	0.002262		
	(17.132)*		
TARIFF*			2.585878
			(2.141)**
$CHPFDP^{IA}$*			0.002486
			(0.258)
T			0.145320
			(20.922)*
F	185.514	38.562	368.469
$\overline{R}^2$	0.9635	0.8429	0.9901
DW	1.727	2.213	1.253
Condition Number	17.93	31.33	42.65

* significant at the 0.1% level
** significant at the 0.5% level
*** significant at the 1% level

Table 3. Estimation Results of Japanese Import Market

	JAIMD	USJAQ	OTHERJAQ
Intercept	0.145110	0.006285	−0.001326
	(2.293)	(0.777)	(−0.215)
$NETP^{JA}$		0.010128	0.014099
		(2.971)**	(3.638)*
$NETP^{W}$		−0.010213	
		(−0.682)	
P^{W}			−0.019061
			(−1.919)***
P^{US}		−0.015958	
		(−1.563)	
P^{JA}	−0.116212		
	(−4.231)*		
I^{JA}	0.00292		
	(12.682)*		
$NETP^{JA*}$		0.005911	0.007160
		(1.769)	(1.566)
$NETP^{W*}$		−0.13011	
		(−1.860)***	
P^{W*}			−0.027229
			(−2.524)**
F	85.175	32.234	25.345
$\bar{R}^2$	0.9132	0.9071	0.8589
DW	1.175	2.208	1.329
Condition Number	18.117	96.080	43.836

* significant at the 0.1% level

** significant at the 0.5% level

*** significant at the 1% level

Table 4. Optimal Policies and Price

(Discount factor = 0.92, estimated weights, T = 20)

	Japanese Price	U.S. Subsidy	Japanese Tariff
1	3.63003	0.14475	0.39883
2	3.84586	0.10053	0.40772
3	3.86355	0.09690	0.40840
4	3.86500	0.09660	0.40846
5	3.86512	0.09658	0.40846
6	3.86513	0.09658	0.40846
7	3.86513	0.09658	0.40846
8	3.86513	0.09658	0.40846
9	3.86513	0.09658	0.40846
10	3.86513	0.09658	0.40846
11	3.86513	0.09658	0.40846
12	3.86513	0.09658	0.40846
13	3.86513	0.09658	0.40846
14	3.86513	0.09658	0.40846
15	3.86513	0.09658	0.40846
16	3.86513	0.09658	0.40846
17	3.86512	0.09658	0.40845
18	3.86497	0.09660	0.40826
19	3.86290	0.09692	0.40583
20	3.84178	0.09652	0.38218
average	3.85104	0.09892	0.40648

Table 5. Optimal Policies and Price
(Discount factor = 0.92, estimated weights, T = 10)

	Japanese Price	U.S. Subsidy	Japanese Tariff
1	3.63003	0.14475	0.39883
2	3.84586	0.10053	0.40772
3	3.86355	0.09690	0.40840
4	3.86500	0.09660	0.40846
5	3.86512	0.09658	0.40846
6	3.86513	0.09658	0.40846
6	3.86513	0.09658	0.40846
7	3.86512	0.09658	0.40845
8	3.86497	0.09660	0.40826
9	3.86290	0.09692	0.40583
10	3.84178	0.09052	0.38218
average	3.83695	0.10126	0.40451

Table 6. Optimal Policies and Price
(Discount factor = 0.92, equal weights, T = 20)

	Japanese Price	U.S. Subsidy	Japanese Tariff
1	3.11408	−5.94945	0.44376
2	2.65168	−4.79162	0.35374
3	2.70833	−4.93347	0.36643
4	2.70139	−4.91610	0.36490
5	2.70224	−4.91822	0.36509
6	2.70214	−4.91796	0.36506
7	2.70215	−4.91800	0.36506
8	2.70215	−4.91799	0.36506
9	2.70215	−4.91799	0.36506
10	2.70215	−4.91799	0.36506
11	2.70215	−4.91799	0.36506
12	2.70215	−4.91799	0.36506
13	2.70215	−4.91798	0.36506
14	2.70215	−4.91804	0.36508
15	2.70214	−4.91766	0.36501
16	2.70221	−4.92007	0.36546
17	2.70157	−4.90558	0.36229
18	2.70855	−4.98508	0.38582
19	2.62047	−4.67913	0.18007
20	2.58490	−3.50285	−0.01701
average	2.71085	−4.88406	0.34106

Table 7. Optimal Policies and Price
(Discount factor=0.92, equal weights, T=10)

	Japanese Price	U.S. Subsidy	Japanese Tariff
1	3.11408	−5.94945	0.44376
2	2.65168	−4.79162	0.35374
3	2.70833	−4.93347	0.36642
4	2.70140	−4.91615	0.36491
5	2.70224	−4.91789	0.36502
6	2.70220	−4.92004	0.36546
7	2.70157	−4.90558	0.36229
8	2.70855	−4.98508	0.38582
9	2.62047	−4.67913	0.18007
10	2.58490	−3.50285	−0.01701
average	2.71954	−4.85013	0.31705

Table 8. Values of Weflare of the U.S. and Japan

	Values of U.S. Welfare	Values of Japanese Welfare
Equal Weights		
T=10	−5.22439	92.64961
T=20	−9.46464	85.71209
Estimated Weights		
T=10	−0.61739	184.23271
T=20	−1.66848	252.56656

美國肉雞貿易之政策分析——動態遊戲處理方法

賀惠玲*

摘　　要

養雞事業在美國東南各州是很重要的。在低雞肉價格和高飼料價格下，增加雞肉出口對東南各州顯得格外的重要。美國雞肉最大的國外市場爲日本，目前日本對雞肉進口的需求有增加的趨勢。此外，美國爲減少對日本的貿易逆差亦希望能增加對日本輸出各種產品。因此，本論文將以日本的雞肉進口市場爲討論的重點，尋求美國和日本對雞肉進出口的最適政策並探討這些政策對日本雞肉價格及美日有關雞肉市場的社會福利的影響。

由於日本雞肉進口市場爲寡佔市場且進出口雙方都有政府的干涉，而動態遊戲理論適用於研究一個國家對其他國家政策改變的反應。因此，本論文將以動態的遊戲理論來探討各國的貿易政策及對訂價及社會福利的影響。本文首先以二階段最小平方法估計三個聯立方程式：美國和日本的供給與需求及日本進口市場的供給與需求。用此估計的結果來計算消費者剩餘、生產者剩餘和納稅人福利，並計算動態遊戲理論的state equation。消費者及生產者剩餘和納稅人福利的加權和在本文中代表各國有關雞肉市場的社會福利，其權數則以過去20年的資料來推算。計量模式的估計完成之後，在最初的價格，政策及state equation的限制下，求長期社會福利現值的最大值並進而求得兩國的最適雞肉貿易政策。

研究的結果顯示：美國應對外銷到除日本以外國家的雞肉徵出口稅以鼓勵對日本的出口，而日本則應徵收更高的進口稅以鼓勵國內生產。在此情形下，日本雞肉的消費者將繼續用較高的價格補貼生產者。

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