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MEASURING THE DEGREE OF MARKET POWER EXERTED BY GOVERNMENT TRADE AGENCIES

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Measuring the Degree of Market Power Exerted by Government Trade Agencies

Abstract

This paper sets up hypotheses tests for the exertion of market power by government trade agencies. The principle of profit maximization is used to derive an equilibrium condition for noncompetitive markets and provide explicit parametric tests for the level of market power exerted. This study differs from previous works in that exertion of market power is revealed through econometric techniques as opposed to the prevailing practice of comparing simulation outcomes to actual data. The Japanese role in wheat trade is selected as an application of the method.

Measuring the Degree of Market Power Exerted by Government Trade Agencies

Introduction

Many countries administer agricultural imports and exports through government trade agencies. This has led a number of authors to address the possibility of imperfect competition and the interaction of market participants (e.g., McCalla; Kolstad and Burris; Alaouze, et al.; Karp and McCalla; Carter and Schmitz; and Paarlberg and Abbott). While these studies provide new insight about the political and economic nature of agricultural trade, they do not utilize statistical methods capable of measuring market power which government-sponsored trade agencies may exert on the market. The purpose of this study is to develop parametric test statistics for identifying exertion of power in markets where government trade agencies have a role. The tests are adapted from methodologies used in industrial organization to identify monopoly power (Bresnahan, Appelbaum).

Several statistical hypothesis tests are constructed. One test is for the exertion of monopsony market power by a government agency as a buyer in international markets. Another test is for the existence of monopoly market power in the domestic market through resale of foreign and domestic product by the government agency. Tests are also developed for joint execution of monopoly and monopsony power and for free trade. Japan's participation in the international wheat market is selected for empirical analysis because Japan is a major importer of wheat and relies on a government trade agency for all imports and domestic resale of foreign wheat.

Empirical results demonstrate that Japan is pursuing a more restrictive import policy for wheat than would be indicated by an optimal tariff strategy. However, results also show that the Japanese government does not pursue a monopolistic policy in resale of wheat in the domestic market. The resulting welfare effects of Japanese wheat import policies suggest that they may be pursuing a policy of collecting tariff revenues sufficient to cover the costs of subsidies for domestic producers.

Background

A number of authors have investigated alternative models of market structure in international wheat trade and their results are often contradictory. McCalla constructed a U.S.-Canada duopoly model. Alaouze, Watson and Sturgess consider a U.S.-Canada-Australia triopoly. Carter and Schmitz argue that the European Economic Community (EEC) and Japan behave as a duopsony. In each study, the maintained market structure is found to be consistent with observed trade patterns. Kolstad and Burris compute solutions for several market structures and free trade and conclude that the only simulation inconsistent with actual data is the Japanese-EEC duopsony.

Karp and McCalla investigate several alternative market structures for the world corn market and conclude that actual price and trade data are closest to an EEC monopsony with a competitive fringe model. However, their results indicate that the historical tariff set by the EEC is about three times higher than the socially optimal tariff. Paarlberg and Abbott investigate the possibility that domestic interest group influence and strategic behavior in international markets determine international wheat trade patterns. They use a revealed preference approach to estimate policymakers' conjectures. Results of their study indicate that strategic conjectures of U.S., Japanese, and EEC policymakers are insensitive to other nations' policies and that strategic conjectures of Canadian and Australian policymakers are sensitive to policies in Australia and Canada, respectively. Results from these two papers suggest that any strategic behavior is limited to one or two countries, i.e., the EEC collecting tariffs on corn imports and possible gaming between Canada and Australia in the wheat market.

A common shortcoming of these studies is that their analytical methods do not permit the possibility of forming nested hypotheses to test for market structure. Each study presupposes a market structure, conducts model simulations, and draws conclusions about the appropriateness of a particular market structure from comparisons of simulation results with actual data. While Kolstad and Burris conduct nonnested hypothesis tests, the power of such tests can be quite low (Judge, et al., p. 885), and the inability of their analysis to reject a number of alternative market structures is not surprising.

A further limitation of these studies is that elasticities used in simulations come from earlier econometric studies, most of which estimate models based on perfectly competitive markets. As a result, there is a discrepancy between the maintained hypothesis of the simulation (noncompetitive market structure) and that of the borrowed elasticities used in the model (competitive market structure). If a market is not competitive, then parameter estimates obtained under the assumption of perfect competition are both biased and inconsistent since the model is misspecified. Subsequent use of such parameters in simulations to investigate market structure would result in possibly misleading conclusions. Properly constructed simulation studies must employ elasticities consistent with the market structure in the simulation model.

A final criticism of simulation studies is that they are restricted to testing discrete combinations of exertion of power by market participants. Conclusions about market power are obtained by comparing a number of simulation outcomes with actual data. The simulated market structure which best reproduces observed quantities, prices, etc., is taken to be the "true" model. To test all possibilities, an infinite number of simulations would be necessary. In contrast, specifying a model flexibly, so that market structure is revealed from parameter estimates, avoids the need to specify all potential combinations of market power. For example, Bresnahan constructs a simple model of supply and demand to test for the existence of domestic monopoly power in a closed economy. He proposes a demand function which contains an interaction between own-price and an exogenous substitute price. This specification results in an estimatable parameter indexing the degree of market power exerted. No a priori assumption about market structure is necessary; market power is estimated as an additional structural parameter in a sectoral model allowing hypothesis tests for particular market structures to be constructed using standard econometric techniques.

This paper sets up hypotheses tests for the exertion of market power by building on the models of Bresnahan and of Appelbaum and Kohli, who use mark-up terms to identify price-taking behavior in their estimation of Canadian import demand and export supply. The principle of profit maximization is used to derive an equilibrium condition for noncompetitive markets and provide an explicit parametric test for the level of market power exerted. Hypothesis tests for three possible objectives of the government trade agency are evaluated: collecting government revenues by imposing tariffs (monopsony strategy), enhancing returns to producers by restricting domestic trade (monopoly strategy), and enhancing producer returns and government revenues through joint intervention in domestic and international markets (middleman strategy). The Japanese role in wheat trade is selected as an application of the method.

<u>Japan's Wheat Policy</u>

The Food Staple Control Act of 1942 gave the Japanese Food Agency (JFA) authority to directly control prices and marketing of wheat, rice and barley (Coyle; Paarlberg and Sharples). Through JFA, the government maintains a two-tier price structure. A producer price is set well above the world level (recently 4.5 times world price) to encourage domestic wheat production and maintain farm incomes at high levels. JFA must buy all wheat offered by farmers at the set producer price (about 90% of domestic production). The consumer (resale) price is also set by JFA; recently, at about 1.6 times world price. To maintain domestic prices above world prices, JFA controls wheat imports through a quota arrangement with licensed importers. The quantity of wheat imported is set to clear the domestic market at the administered resale and producer prices (OECD). All imported wheat has to be sold to JFA, which then resells it, along with wheat purchased from domestic producers, to domestic wholesalers at the administered resale price. Thus, the JFA is in a position to exercise monopsony and monopoly power in the purchase and resale of wheat. About ninety percent of wheat available in Japan is imported and Japan imports about seven percent of wheat sold in the world market.

The Model

Market power is defined as the ability to influence market outcome. In international markets, such power might arise from control of a substantial share of total trade or superior information or control over channels in the marketing system. State trade agencies like JFA, may possess either of these forms of control. While firms use market power to maximize profit, state traders may use market power for a variety of purposes including: price stabilization, enhancement of producer returns and provision of revenues to the government (Just, Schmitz and Zilberman).

JFA has two potential sources for exploiting market power. In its capacity of licensing all imports of wheat into Japan, JFA can exert monopsony buying power in the world wheat market by establishing a wedge (tariff) between domestic and world prices. In its capacity as sole commercial seller of wheat in the domestic market, JFA can exert monopoly power by establishing a differential between the price it pays for imported wheat (including handling charges) and the price it charges domestic consumers. These policies can be executed individually or jointly.

The monopoly solution is well known. The optimal tariff or monopsony solution, was developed by Enke and is used in Carter and Schmitz. Enke demonstrated that the imposition of an optimal tariff may produce net welfare gains for the society imposing the tariff. Joint execution of both monopoly and monopsony policies was first described by Lerner and is characterized as the pure middleman solution. Subsequently, Just, Schmitz and Zilberman and Just, Hueth and Schmitz have examined the pure middleman solution in the context of a state trading agency. They find that state marketing firms exercising both monopoly and monopsony power can generate greater rents than those resulting from either pure monopoly or pure monopsony solutions executed independently. The accompanying deadweight loss to society will also be larger. However, if rent collected is the sole concern, the pure middleman solution will dominate. Such may be the case when a government-sponsored marketing board is working primarily to enhance producer incomes.

In the context of Japanese wheat trade with the rest-of-world, an equilibrium condition which admits the possibility of market power in both the international and domestic markets can be obtained as the solution to the pure middleman's profit maximization problem. The model is initially specified so that monopoly and monopsony powers are incorporated explicitly. These restrictions are later relaxed. The model is specified so that both excess supply and excess demand, expressed in price-dependent form, are functions of Japanese wheat imports, so that Japanese and world prices are sensitive to quantity imported by Japan. It is assumed that individual consumers and individual producers both inside and outside of Japan behave as price takers, and that transportation cost and the exchange rate are exogenous. In addition, it is assumed that governments outside of Japan do not react to government policies set in Japan, so that rest-of-world wheat supply, utilization, and trade can be modeled in aggregate; an assumption supported by both Karp and McCalla and by Paarlberg and Abbott.

Given these assumptions, the profit maximization problem for the Japanese import agency is:

$$\max_{M_J} \Pi = \beta \cdot Prw_J(M_J) \cdot M_J - Pw_{ROW}(M_J) \cdot M_J + \beta \cdot Prw_J(M_J) \cdot S_J(Ppw_J) - \beta \cdot Ppw_J \cdot S_j(Ppw_j) - t \cdot M_J, \tag{1}$$

where β is the exchange rate adjustment factor (US\$/yen); M_J is Japanese wheat imports (million metric tons); Ppw_J is the price paid to domestic wheat producers in Japan (yen/metric ton); $Prw_J(\cdot)$ is excess demand for wheat in Japan expressed in resale price-dependent form (yen/metric ton); $Pw_{ROW}(\cdot)$ is excess supply of wheat from rest-of-world expressed in price-dependent form (US\$/metric ton); $S_J(\cdot)$ is domestic supply of wheat in Japan (million metric tons); and t is transportation cost for wheat to Japan from rest-of-world (US\$/metric ton). The first term in equation (1) represents revenue from resale of imported wheat in Japan by JFA. The second term represents the cost of imports. The third term represents revenue from resale of domestically produced wheat. The fourth term is total cost to JFA of wheat purchased from domestic Japanese producers. The fifth term represents transportation cost of imported wheat. All values are in millions of real U.S. dollars. While there is a small difference between the resale price for domestic wheat and imported wheat, this is due to quality; domestic wheat being somewhat lower in quality compared with imported wheat (OECD). For simplicity, domestic wheat is valued in the profit function at the resale price.

The profit maximizing solution for JFA is given by:

$$\frac{\partial \Pi}{\partial M_J} = \beta \cdot \frac{\partial Prw_J}{\partial M_J} \cdot M_J + \beta \cdot Prw_J - \frac{\partial Pw_{ROW}}{\partial M_J} \cdot M_J - Pw_{ROW} + \beta \cdot \frac{\partial Prw_J}{\partial M_J} \cdot S_J - t = 0, \tag{2}$$

where $\partial Prw_J/\partial M_J$ is the slope of the price-dependent excess demand curve for Japan, and $\partial Pw_{ROW}/\partial M_J$ is the slope of the price-dependent excess supply curve for rest-of-world. Equation (2) can be manipulated into equilibrium condition

$$\beta \cdot Prw_J + \beta \cdot \frac{\partial Prw_J}{\partial M_J} \cdot (M_J + S_J) = Pw_{ROW} + \frac{\partial Pw_{ROW}}{\partial M_J} \cdot M_J + t. \tag{3}$$

Equation (3) states that, at equilibrium, the marginal benefit of imports equals marginal cost of imports. The first left-hand term is the per-unit exchange-rate-adjusted resale price in Japan. The second left-hand term is change in the dollar value of production and imports available in Japan from a change in wheat imports. Taken together, these terms represent marginal revenue from sales (imports) of wheat in the domestic market. The first right-hand-side term is per-unit price in rest-of-world. The second right-hand-side term is change in cost of imports from a change in Japanese wheat imports from rest-of-world. The third term represents per-unit transportation cost for imports. Taken together, these terms represent the marginal outlay incurred by JFA when buying wheat on the world market.

Equilibrium condition (3) can also be expressed as:

$$Pw_{ROW} + t = \beta \cdot Prw_J - \lambda_F \cdot \frac{\partial Pw_{ROW}}{\partial M_J} \cdot M_J + \lambda_D \cdot \beta \cdot \frac{\partial Prw_J}{\partial M_J} \cdot (M_J + S_J), \qquad (4)$$

and

$$\beta \cdot Prw_J - t = Pw_{ROW} + \lambda_F \cdot \frac{\partial Pw_{ROW}}{\partial M_J} \cdot M_J - \lambda_D \cdot \beta \cdot \frac{\partial Prw_J}{\partial M_J} \cdot (M_J + S_J). \qquad (5)$$

The coefficients λ_D and λ_F are added to the equilibrium condition to admit the possibility of alternative market solutions including: pure middleman, monopsony, monopoly and free trade. This specification is an adaptation of Bresnahan's methodology. Parameter λ_D represents Japan's (monopoly) market power in the domestic wheat market. Parameter λ_F represents Japan's (monopsony) market power in the international wheat market. Values of these coefficients can range from 0 to ∞. Values of λ_F and λ_D between zero and one represent less restrictive policies (larger imports) than perfect monopsony, monopoly or pure middleman solutions, but indicate that some market power is being imposed. Values of λ_F and λ_D greater than one represent policies that are more restrictive (lower imports) than perfect monopsony, monopoly or pure middleman solutions. When λ_D and λ_F are both equal to zero, Equations 4 and 5 reduce to the competitive equilibrium solution. When λ_F equals zero and λ_D equals one, equations (4) and (5) return the monopoly solution, and when λ_D equals zero and λ_F equals one, equations (4) and (5) yield the monopsony, or optimal tariff solution. When both λ_D and λ_F are one, equations (4) and (5) are the pure middleman solution.

Estimates for the parameters of market power can be obtained using standard econometric techniques. Before these parameters can be estimated, however, behavioral equations for wheat supply, utilization and excess demand and supply for Japan and for rest-of-world must be specified. Based on standard results from the theory of the firm, wheat supply in Japan (S_J) is specified as a function of producer price of wheat (Ppw_J), producer price of rice (Ppr_J) and cost of production (C_J). Previous wheat production, $S_{J(-1)}$, is included in the Japanese wheat supply equation to represent the partial adjustment process of agricultural supply. In Japan, rice is a substitute for wheat in both production and consumption (Riethmuller and Roe). Japanese supply of wheat is given by:

$$S_J = a_0 + a_1 \cdot (Ppw_J/C_J) + a_2 \cdot (Ppr_J/C_J) + a_3 \cdot S_{J(-1)} + e_{SJ}. \qquad (6)$$

where ϵ_{SJ} is an error term and a_0, a_1, a_2, and a_3 are unknown parameters.

Wheat demand (D_J) in Japan is specified as a function of the resale price of wheat (Prw_J), income (Y_J) and the resale price of rice (Prr_J). An interaction term between the price of wheat and the price of rice ($Prw_J \cdot Prr_J$) is included in the demand function so that the parameter λ_D, JFA's monopoly market power in the domestic market, will be econometrically identified (Bresnahan). Japanese demand for wheat is given by:

$$D_J = b_0 + b_1 \cdot Prw_J + b_2 \cdot Y_J + b_3 \cdot Prr_J + b_4 \cdot (Prw_J \cdot Prr_J) + \varepsilon_{DJ}, \tag{7}$$

where ϵ_{DJ} is an error term and b_0, b_1, b_2, b_3, and b_4 are unknown parameters.

Since changes in ending wheat inventories in Japan are small, excess demand is measured as the difference between domestic demand and supply. In price-dependent form, excess demand in Japan ($ED_J=M_J$) is:

$$\begin{aligned} Prw_J = [1/(b_1 + b_4 \cdot Prr_J)] \cdot [ED_J + a_0 - b_0 + a_1 \cdot (Ppw_J/C_J) \\ + a_2 \cdot (Ppr_J/C_J) + a_3 \cdot S_{J(-1)} - b_2 \cdot Y_J - b_3 \cdot Prr_J] + \varepsilon_{EDJ}, \end{aligned} \tag{8}$$

where ϵ_{EDJ} is an error term.

Excess supply of wheat in rest-of-world is derived similarly. Supply of wheat in rest-of-world (S_{ROW}) is influenced by its own-price (Pw_{ROW}), lagged supply ($S_{ROW(-1)}$), the price of corn as a substitute in wheat production (Pc_{ROW}) and cost of production (C_{ROW}). Supply of wheat in rest-of-world is given by:

$$S_{ROW} = d_0 + d_1 \cdot (Pw_{ROW}/C_{ROW}) + d_2 \cdot S_{ROW(-1)} + d_3 \cdot (Pc_{ROW}/C_{ROW}) + \varepsilon_{SROW}. \tag{9}$$

where ϵ_{SROW} is an error term and d_0, d_1, d_2, and d_3 are unknown parameters.

Demand for wheat (D_{ROW}) is assumed to be influenced by its own-price (Pw_{ROW}), income (Y_{ROW}) and the price of rice (Pr_{ROW}) as a substitute in wheat consumption. An interaction term between price of wheat and price of rice in rest-of-world ($Pw_{ROW} \cdot Pr_{ROW}$) is included in the rest-of-world demand function so that the parameter λ_F, JFA's monopsony market power in the foreign market, will be econometrically identified (Bresnahan). Demand for wheat in rest-of-world is given by:

$$D_{ROW} = e_0 + e_1 \cdot Pw_{ROW} + e_2 \cdot Y_{ROW} + e_3 \cdot Pr_{ROW} + e_4 \cdot (Pw_{ROW} \cdot Pr_{ROW}) + \epsilon_{DROW}. \quad (10)$$

where ϵ_{DROW} is an error term and e_0, e_1, e_2, e_3, and e_4 are unknown parameters.

Stocks of wheat in rest-of-world (ST_{ROW}) fluctuate from year to year, and are specified as a function of wheat price (Pw_{ROW}) and beginning wheat stocks ($ST_{ROW(-1)}$):

$$ST_{ROW} = f_0 + f_1 \cdot Pw_{ROW} + f_2 \cdot ST_{ROW(-1)} + \epsilon_{STROW}, \quad (11)$$

where ϵ_{STROW} is an error terms and f_0, f_1, and f_2, are unknown parameters.

Excess supply from rest-of-world ($ES_{ROW}=M_J$) is calculated from the identity $S_{ROW} + ST_{ROW(-1)} \equiv D_{ROW} + ST_{ROW} + ES_{ROW}$. In price-dependent form, excess supply from rest-of-world is given by:

$$\begin{aligned} Pw_{ROW} = {} & [1/((d_1/C_{ROW}) - e_1 - e_4 \cdot Pr_{ROW} - f_1)] \cdot [ES_{ROW} + e_0 - d_0 \\ & + f_0 + e_2 \cdot Y_{ROW} - d_2 \cdot S_{ROW(-1)} - d_3 \cdot (Pc_{ROW}/C_{ROW}) \\ & + (f_2 - 1) \cdot ST_{ROW(1)} + e_3 \cdot Pr_{ROW}] + \epsilon_{ESROW}, \end{aligned} \quad (12)$$

where ϵ_{ESROW} is an error term.

To facilitate estimation of λ_D and λ_F, the excess demand equation for Japan (8) is substituted into equilibrium condition (4) to obtain an estimable marginal revenue equation. Similarly, the excess supply equation in price-dependent form (12) is substituted into equilibrium condition (5) to obtain an estimable marginal outlay equation. The monopoly and monopsony markup terms, $\frac{\partial Prw_J}{\partial M_J}$ and $\frac{\partial Pw_{ROW}}{\partial M_J}$, are replaced by $[1/(b_1 + b_4 \cdot Prr_J)]$ and

$[1/((d_1/C_{ROW})\ -e_1 - e_4 \cdot Pr_{ROW} - f_1)]$ respectively, from equations (8) and (12). The two resulting equations are then combined with the structural equations for Japan and rest-of-world markets (equations 6, 7, 9, 10, and 11) forming a system of simultaneous equations. This system can be jointly estimated to obtain a full set of parameter estimates including both λ_F and λ_D.

Econometric identification of nonlinear simultaneous equations subject to nonlinear constraints has been investigated by Rothenberg. Identification of structural parameters can be checked numerically by determining the rank of the information matrix augmented with the Jacobian matrix of constraints calculated in a neighborhood of estimated parameters. If the rank of this augmented matrix, equals to the number of unknown parameters, the system is locally identified (Rothenberg). This condition is easily checked using TSP4.1B (Hall, Schnake and Cummins).

Nonlinear three-stage least squares (NL3SLS) developed by Amemiya and implemented in TSP4.1B (Hall, Schnake and Cummins) is used to obtain parameter estimates. Parameters estimated using NL3SLS are generally less efficient than those obtained using full information maximum likelihood (FIML) estimation. However, if the errors are not normally distributed, NL3SLS is more robust than FIML. If errors are nonnormally distributed, NL3SLS estimates are consistent so long as the error terms have zero mean and finite higher moments, while those resulting from FIML estimation may not be consistent (Amemiya).

Lacking any a apriori information about the distribution of the error terms, the NL3SLS estimator is chosen.

Data

Japanese wheat data are mostly obtained from the Statistical Yearbook of the Japan Ministry of Agriculture, Forestry and Fisheries (MAFF). Wheat supply for Japan (S_J) is represented by wheat production. Beginning and ending stocks in Japan are negligible. However, since data for total wheat consumed in Japan are not available, wheat stock data are utilized to calculate quantity of wheat demanded, $D_J = S_J + ED_J + ST_{J(-1)} - ST_J$. Japanese production cost of wheat (C_J) is represented by an index of prices paid by farmers for production requisites from the Food and Agriculture Organization (FAO). Japanese income data (Y_J) come from the United Nations (UN). Government purchasing and resale prices for wheat (Ppw_J, Prw_J) and rice (Ppr_J, Prr_J), cost of production (C_J) and income (Y_J) are deflated by the Japanese consumer price index (CPI_J).

Rest-of-world production (S_{ROW}) and consumption (D_{ROW}) data come from the United States Department of Agriculture and generally are total world wheat production and consumption with Japan removed. Rest-of-world wheat prices (Pw_{ROW}) and cost of transportation (t) are the average wheat export prices from the U.S., Canada and Australia and transportation cost from each exporting country to Japan weighted by each country's wheat exports. The U.S. export price for rice is used to represent rest-of-world rice price (Pr_{ROW}) since the U.S. is the biggest world rice market supplier. Rest-of-world income (Y_{ROW}) is total income in developed and developing countries as reported by the UN. Price of corn (Pc_{ROW}) is an average of export prices of corn in the U.S., Canada and Australia weighted by corn production in each country. Rest-of-world cost of production (C_{ROW}) is an average of indices of prices paid by farmers in the U.S., Canada and Australia, weighted by wheat production in each country. Exchange rate data come from the UN and the United States Bureau of the Census.

Results

The results of NL3SLS estimation using annual data between 1964 and 1985 are reported in Table 1. All parameters are econometrically identified. To ensure global minimization, estimates were obtained using widely different starting values for λ_D and λ_F (0 through 15). All solutions converged to approximately the same parameter estimates in a small number of iterations (ranging from 6 to 14). Details of the convergence criterion are provided in Hall, Schnake and Cummins (p. 76).

Estimated coefficients have the expected signs and most are statistically significant at the 5% level. Coefficients for world wheat and corn prices in the rest-of-world supply function are significant at the 15% level. Parameter estimates for the monopsony and monopoly coefficients are $\lambda_F=10.192$ and $\lambda_D=.001$ respectively.

To validate the model, outcomes from simulation using mean data values were compared to actual data. Simulation with exogenous values set at mean levels results in quantity of wheat traded of 5.24 million tons, resale price in Japan of US$ 328.32 and rest-of-world price of US$ 214.91 per metric ton. The corresponding mean data values are 5.14 million metric tons, US$ 341.21 and US$ 228.31 per metric ton; all close to simulated values and good matches for a nonlinear model. All values are in 1985 U.S. dollars.

Tests for Exertion of Market Power

A major contribution of the econometric approach to analyzing market power is that a number of formal hypothesis tests can be constructed concerning monopoly and monopsony power. Alternative hypotheses to be tested are: i) no market power (free trade) H_o: $\lambda_F=0$ and $\lambda_D=0$, versus H_a: $\lambda_F\neq0$ or $\lambda_D\neq0$,
ii) perfect monopsony solution H_o: $\lambda_F=1$ and $\lambda_D=0$, versus H_a: $\lambda_F\neq1$ or $\lambda_D\neq0$,
iii) perfect monopoly solution H_o: $\lambda_F=0$ and $\lambda_D=1$, versus H_a: $\lambda_F\neq0$ or $\lambda_D\neq1$, and
iv) pure middleman solution H_o: $\lambda_F=1$ and $\lambda_D=1$, versus H_a: $\lambda_F\neq1$ or $\lambda_D\neq1$.

Statistical inference for systems of simultaneous, nonlinear equations estimated using NL3SLS has been developed by Gallant and Jorgenson. They suggest using a quasi-likelihood ratio (QLR) test statistic given by $M=n\cdot(Q_o-Q_a)$, where Q_o is the criterion level obtained from minimizing the system sum of squares under the null hypothesis, Q_a is the criterion level obtained from minimizing the unrestricted system sum of squares, and n is the number of observations. The QLR test statistic is asymptotically distributed Chi-squared with degrees of freedom equal to the number of restrictions under the null hypothesis.

To reject the null for these hypotheses, the value of M must be greater than the tabled Chi-squared value with 2 degrees of freedom (9.91 at the 1% significance level). The value of M for the free trade hypothesis (i) is 63.87; for the perfect monopsony hypothesis (ii) M is 35.92; for the perfect monopoly hypothesis (iii) M is 5123.93; and for the pure middleman hypothesis (iv) M is 5091.46. The rejection of all null hypotheses means that JFA does not operate as if it were a pure middleman, perfect monopolist, perfect monopsonist, or a perfectly competitive firm.

Coefficient estimates from the unrestricted model reveal actual market behavior. The parameter estimate for monopoly selling power of λ_D=.001 and its associated asymptotic t-value of .27 indicate that little or no monopoly selling power is being imposed in the domestic market. On the other hand, the estimated parameter for monopsony market power of λ_F=10.192 and its associated asymptotic t-value of 5.10 suggest that Japan is pursuing a more restrictive import policy than would be indicated by an optimal tariff strategy (corresponding to the values of λ_D=0, λ_F=1). As a result, the price wedge is greater than that which would result from an optimal tariff solution, suggesting that the Japanese government's policy is suboptimal. The reason for this seemingly suboptimal behavior may lie elsewhere in Japan's policy apparatus.

Elasticities

Price elasticities of supply and demand for Japan and rest-of-world calculated at mean values are presented in Table 2. Elasticities in the first row are calculated from the unrestricted parameter estimates in Table 1; no assumption of market power is imposed so these elasticities are econometrically consistent. Rest-of-world excess supply is very elastic (30.0) compared with excess demand for Japan (-.30). This implies that small changes in quantity traded result in small price changes in the rest-of-world market and large price changes in the Japanese market, and reflects the fact that while Japan only imports 7% of all wheat traded in the world market, wheat imports in Japan comprise almost 90% of total wheat consumed. Thus, a small reduction in wheat imports will cause a relatively large price increase in Japan and a relatively small price decrease in rest-of-world.

In order to illustrate bias in elasticity estimates if free trade were incorrectly assumed, the unrestricted model is modified to impose the free trade assumption (Table 3). The free trade model is represented by a system of simultaneous equations including equations (6, 7, 9, 10 and 11). This model specification has been widely used, and is similar to models from which elasticities were borrowed for the simulation studies criticized above. Imposition of free-trade when it is an inappropriate specification results in inconsistent parameter estimates.

Elasticities calculated from the free trade specification and from other studies are listed at the bottom of Table 2. Demand elasticities for Japan employing the incorrect assumption of perfect competition have a very narrow range, from -.12 to -.18. These estimates are all substantially lower than the elasticity from the unrestricted model, implying that the incorrect assumption of free-trade induces systematic downward bias in the absolute value of the demand elasticity. Estimated elasticities of supply in Japan have a wide range, from .68 to 2.72. Interestingly, estimates from the flexible model and the modified (free trade) model vary greatly. The only difference between these models is imposition of a competitive market structure in the modified model; supply and demand specifications, period of estimation and data all remain the same.

Elasticities of supply and demand for rest-of-world are also affected by the imposition of the free trade assumption. The largest differences occur with respect to price elasticities of demand and excess supply. The unrestricted specification results in elasticities nearly three times larger than the free trade specification, again demonstrating the importance of proper model specification to the results.

Political Economy of Japanese Wheat Policy

Among other objectives, the Agricultural Basic Law enacted in 1961 prescribes that agricultural policy in Japan should "enable farmers through increased farm income to enjoy equal standards of living with workers in other industries" (OECD, p. 33). Accordingly, Japanese policy makers have maintained the domestic government purchasing price for wheat well above world and even domestic resale price levels. During the period of estimation, the average government purchase price in Japan was about US$ 700 per metric ton. With average annual production of about 600 thousand tons, the resulting domestic producer subsidy to Japanese wheat farmers amounted to US$ 270 million per year. For the Japanese policy maker, the preeminent policy problem, therefore, is how to provide adequate funding for domestic producer subsidies at least political cost. Results in Table 4 reveal apparent motives for policies actually selected.

Price, quantity and welfare effects for five alternative policy scenarios are presented in Table 4. All calculations are based on estimated parameters appearing in Table 1 and substituting in appropriate values for λ_F and λ_D in the equilibrium condition (equations 4 and 5). Use of parameter values obtained from the unrestricted model is justified for the limited scope of this welfare analysis because they are econometrically consistent estimates of the true parameters. The market solution for quantity imported (M_j^*) is found at the intersection of the marginal outlay curve with the marginal revenue curve, i.e., the solution of equations 4 and 5. The resale price of wheat in Japan is then obtained as the solution of $Prw_J(M_J^*)$ and world price of wheat is obtained as the solution of $Pw_{ROW}(M_J^*)$. Tariff revenue is calculated as $[\beta \cdot Prw_J(M_J^*) - Pw_{ROW}(M_J^*)] \cdot M_J^*$.

Simulation results are consistent with prior expectations. Order of solutions by revenue generation, from largest to smallest is: pure middleman, perfect monopoly, observed trade, perfect monopsony and free trade. Revenues collected from the pure middleman (column 2) and perfect monopoly (column 3) solutions are nearly equal because of relative elasticities of excess supply and excess demand. While tariff revenues generated by the pure middleman and perfect monopoly solutions are high, so are associated deadweight losses. The deadweight cost per dollar of revenue collected amounts to 85 cents, making these options inefficient transfer schemes. The perfect monopsony (optimal tariff, column 4) solution generates tariff revenues of only US$ 45 million, insufficient to cover costs of producer subsidies. Enke argued that the optimal tariff strategy may result in welfare gains for the country imposing the tariff. In this analysis, however, the optimal tariff strategy results in a deadweight loss to Japanese society because producer price in Japan remains fixed, leaving producer surplus constant across alternative market structures. Enke's conclusions assumed that domestic price paid to producers would be the same as consumer price so that producer surplus would be enhanced from the optimal tariff solution.

The observed trade scenario (column 5) provides a relatively efficient transfer mechanism. It produces tariff revenues of US$ 420 million per year, an amount greater than domestic wheat subsidies. The associated deadweight loss of collecting this tariff revenue, (US$ 60 million) amounts to only 14 cents per dollar of tariff revenue collected, only one cent more than the deadweight cost of collecting revenue through an optimal tariff. From a political perspective, the observed trade scenario provides an efficient mechanism for collecting revenues sufficient to cover costs of domestic wheat production subsidies.

Conclusion

The principle of profit maximization is used to derive an equilibrium condition for noncompetitive markets and an explicit parametric test for market structure. The method results in econometrically consistent parameter estimates for the underlying structural equations and elasticities, regardless of the degree of monopoly or monopsony power exerted on the market, and can be especially useful when government trade agencies play a role. This study differs from previous works in that exertion of market power is revealed through econometric techniques, as opposed to the prevailing practice of comparing simulations from alternative market structures to actual data. Studies employing game theory have been limited to discrete choices of possible strategies, in contrast to the flexible, estimable coefficients developed in this paper. Additionally, many earlier works employ elasticity estimates obtained from models that presume free trade. Parameters estimated under such incorrect restrictions are biased and inconsistent, and their subsequent use in simulations to determine market structure yields questionable results. The advantages of the econometric method developed in this paper are demonstrated.

Application of the econometric technique to Japanese wheat trade suggests that Japan pursues a more restrictive wheat import policy than would be indicated by an optimal tariff strategy but does not pursue a restrictive policy for wheat resale in the domestic market. Analysis suggests that the Japanese government may set the tariff level so that sufficient revenues are collected to offset the cost of producer subsidies for wheat. The deadweight loss of collecting this tariff revenue is a relatively low 14 cents per dollar collected. While the deadweight loss to society in rest-of-world resulting from Japanese import tariffs is small, the redistributive effect is sizeable. Producers in rest-of-world lose US$ 183 million in producer surplus, while consumers achieve a similar gain in consumer surplus.

The results of this study suggest at least two areas for future research. The first is to expand and adapt the econometric technique of identifying exertion of market power to accommodate more complex market structures and multiple countries. The second is to combine the econometric approach developed in this paper with game theory, so that both econometrically estimated coefficients and game structure arise from the same maintained null hypothesis. Ultimately, the data might reveal the underlying market structure.

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Table 1. NL3SLS Parameter Estimates for the Flexible Market Structure

	Parameters	Estimates	Asymptotic t-values
Supply in Japan			
constant	a_0	1.4978	8.45
Ppw_J/C_J	a_1	.1873e-4	10.18
Ppr_J/C_J	a_2	-.1676e-4	13.84
$S_{J(-1)}$	a_3	.7125	6.03
Demand in Japan			
constant	b_0	62.3330	9.09
Prw_J	b_1	-.1777e-2	-7.76
Y_J	b_2	.2121e-4	8.31
Prr_J	b_3	-.4721e-3	-8.47
$Prw_J \cdot Prr_J$	b_4	.1445e-7	7.77
Supply in ROW			
constant	d_0	99.5520	2.48
Pw_{ROW}/C_{ROW}	d_1	.3889	1.10
$S_{ROW(-1)}$	d_2	.7992	12.78
Pc_{ROW}/C_{ROW}	d_3	-.7457	1.43
Demand in ROW			
constant	e_0	475.1000	14.37
Pw_{ROW}	e_1	-3.8069	-9.07
Y_{ROW}	e_2	.8427e-4	18.82
Pr_{ROW}	e_3	-28.2180	-8.56
$Pw_{ROW} \cdot Pr_{ROW}$	e_4	.2551	8.78
Stock in ROW			
constant	f_0	38.3750	1.76
Pw_{ROW}	f_1	-.2791	-1.80
$ST_{ROW(-1)}$	f_2	.8215	5.03
Market Power	λ_F	10.1920	5.10
	λ_D	.9923e-3	.27

Table 2. Short-Run Price Elasticities of Supply and Demand for Japan and Rest-of-World

Model	Japan			Rest-of-World		
	Demand	Supply	Excess Demand	Demand	Supply	Excess Supply
Flexible Market Structure (parameters from Table 1) (λ_F=10.992, λ_D=.001) estimation (1964-1985)	-.27	2.45	-.30	-.29	.07	30.10
Flexible Market Structure Modified to Free-Trade (equations 6,7,9,10,11) (parameters from Appendix) (1964-1985)	-.12	.68	-.14	-.06	.09	12.52
Riethmuller and Roe (1960-1981)	-.18	2.72	--	--	--	--
Bale and Greenshields (1966-1975)	-.16	1.61	--	--	--	--
Coyle (1960-1979)	-.18	--	--	--	--	--

Table 3. 3SLS Parameter Estimates from a Free Trade Specification (Equations 6,7,9,10, and 11)

	Parameters	Estimates	Asymptotic t-ratios
Supply in Japan			
constant	a_0	.2982	1.46
Ppw_J/C_J	a_1	.5243e-5	2.10
Ppr_J/C_J	a_2	-.3573e-5	-1.88
$S_{J(-1)}$	a_3	.8148	7.00
Demand in Japan			
constant	b_0	3.6046	.60
Prw_J	b_1	.3826e-4	.20
Y_J	b_2	.1984e-4	7.84
Prr_J	b_3	.1106e-4	.20
Prw_J*Prr_J	b_4	-.4649e-9	-.26
Supply in ROW			
constant	d_0	117.50	2.30
Pw_{ROW}/C_{ROW}	d_1	.4750	.97
$S_{ROW(-1)}$	d_2	.8185	10.70
Pc_{ROW}/C_{ROW}	d_3	-1.2802	-1.48
Demand in ROW			
constant	e_0	503.00	12.44
Pw_{ROW}	e_1	-3.0145	-5.24
Y_{ROW}	e_2	.000077	15.29
Pr_{ROW}	e_3	-39.162	-7.08
$Pw_{ROW}*Pr_{ROW}$	e_4	.3013	7.80
Stock in ROW			
constant	f_0	25.038	1.07
Pw_{ROW}	f_1	-.1258	-.75
$ST_{ROW(-1)}$	f_2	.8470	4.84

Table 4. Model Solutions Under Alternative Policy Scenarios

	(1) Free Trade ($\lambda_F=\lambda_D=0$)	(2) Pure Middleman ($\lambda_F=\lambda_D=1$)	(3) Perfect Monopoly ($\lambda_F=0,\lambda_D=1$)	(4) Perfect Monopsony ($\lambda_F=1,\lambda_D=0$)	(5) Observed Trade ($\lambda_F=10.192$, $\lambda_D=.001$)
Quantity Traded (m. mt)	5.60	2.50	2.50	5.56	5.24
Resale Price in Japan (US$/mt)	248.67	936.12	934.38	256.79	328.32
Price in ROW (US$/mt)	215.39	210.78	210.82	215.33	214.91
Welfare Effects					
Japan					
Tariff Revenue (m. US$)	–	1,730.12	1,725.69	45.46	419.80
Consumer Surplus (US$/mt)	4,253.00	1,056.80	1,063.30	4,201.50	3,773.00
Deadweight Loss (m. US$)	0.00	1,466.01	1,464.08	6.12	60.25
Deadweight Loss/ Tariff Revenue	–	.85	.85	.13	.14
Rest-of-World					
Consumer Surplus (m. US$)	142,840.00	144,545.70	144,533.60	142,863.80	143,018.50
Producer Surplus (m. US$)	79,029.90	77,283.90	77,296.100	79,005.40	78,846.50
Deadweight Loss (m. US$)	–	40.28	40.11	.64	4.90

Note: All prices and values are in 1985 US$ dollars. Transport cost = $33.28/mt.

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