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ABSTRACT

AN ECONOMIC ANALYSIS OF WELFARE DISTRIBUTION AMONG TRADING COUNTRIES UNDER ALTERNATIVE MARKET INPERFECTIONS

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A model of international trade that permits market imperfections from either exporters or importers is introduced and a quadratic program to find equilibrium solutions under alternative market structures is formulated. A procedure for the welfare analysis of a wheat exporters cartel is outlined.

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I. Introduction

One of the more important elements in modeling agricultural commodities like wheat is the spatial dimension. The distance element is essential in the trade of agricultural commodities because of its bulkiness. Another important element, which is more pervasive in international trade than in intranational trade, is the market imperfection brought about by heavy government involvement.

The spatial dimension of the structure of international markets was a main theme of Schmitz-Bawden work, and an important element in other works (Sarris; Shei and Thompson; Grennes, Thursby and Johnson). Few attempts, however, have been made to incorporate market imperfections in modeling international trade. Abbott suggested a way of incorporating the government sector into the excess demand functions of wheat for individual countries. He stopped short of incorporating those estimated excess demand functions into a global wheat trade model.

The existence of market imperfections is at least a strong possibility of world wheat trade. Some authors argue that incidences of market imperfections can be found on the exporting side (McCalla; Alaouze et al.), while others find evidences of market imperfection created by importing countries (Carter and Schmitz).

This paper is aimed at developing a model of international trade that permits imperfections from either exporting or importing countries and which is applicable to world trade in agricultural commodities. Section II outlines the essence of the model. In section III, a quadratic algorithm, which is designed to incorporate the spatial

dimension and the imperfection dimension, will be introduced. In Section IV, an operational procedure for the welfare impact analysis of a hypothetical wheat exporters cartel will be outlined.

II. General Model of Market Imperfection.

We assume the world commodity market can be divided into four principal market segments: 1) monopolistic exporters, 2) competitive exporters, 3) monopsonistic importers, and 4) competitive importers. Any exporters, who have at least potential monopoly power, are categorized as monopolistic exporters. Similarly, any importers who have at least potential monopsony power, are categorized as monopsonistic importers. The remaining participants are divided into two competitive groups according to their type of participation. The participants with potential market power are not necessarily assumed to behave monopolistically or monopsonistically. When they behave competitively, the model will be equivalent to the standard competitive model. The degree of market imperfection will hinge on the degree to which these holders of potential market power realize this potential. According to the alternative realizations of market power, three different imperfection-embedded market structures are conceivable. Monopolistic imperfection, monopsonistic imperfection and imperfection created by a mixture of monopolistic and monopsonistic powers.

A. Competitive Equilibrium.

When all market segments behave competitively, equilibrium will be obtained at the point at which aggregate global net social payoff is maximized given supply and demand functions for each group of participants.

The competitive equilibrium is shown in Figure 1.

1) D_1, D_2, D_3, D_4 represent the domestic demand schedules of the competitive exporters, monopolistic exporters, monopsonistic importers, and competitive importers respectively.

2) S_1, S_2, S_3, S_4 represent the domestic supply schedules of the competitive exporters, monopolistic exporters, monopsonistic importers, and competitive importers respectively.

3) E_1, E_2, represent the excess supply schedules of the competitive exporters and monopolistic exporters, and E_3, E_4 represent the excess demand schedules of the monopsonistic importers and competitive importers.

The competitive equilibrium will be obtained when the aggregate excess demand, $E_3 + E_4$, is equal to the aggregate excess supply, $E_1 + E_2$. The world market price is $O\text{-}P_f$ and the volume of trade is O-Qt. This equilibrium is optimal in the sense that the aggregate global welfare is maximized at this price-quantity equilibrium.

The aggregate global welfare could be partitioned into two parts; "autarkic social welfare" and "gain from trade." The "autarkic social welfare" for each region is represented by the cross-hatched triangle area enclosed by the vertical axis, and the domestic supply and demand schedules as shown in Figure 1, a, b, c, d. The "gain from trade" for each region is represented by the dotted triangle area enclosed by the horizontal equilibrium price line and the domestic supply and demand schedules as shown in Figure 1, a, b, c, d. This could be equivalently represented by the dotted triangle area enclosed by the vertical axis, the excess demand or supply schedules, and the

horizontal equilibrium price line as shown in Figure 1. e.

Since the "autarkic social welfare" level is invariant to changes in outside world market conditions, the focus of the analysis will be on the "gain from trade" and on how much is this affected by alternative market imperfections.

B. Monopolistic Equilibrium

Assume the imperfection-creatable exporters behave monopolistically and the rest of the world behaves competitively. An equilibrium solution for the monopolistic exporters could be attained when the monopolists maximize their net social payoff through the maximum realization of their potential market power.

This monopolistic equilibrium is shown in Figure 2, where only excess demand and supply schedules are drawn. 1) E1, E2, E3, E4 are defined as before. 2) EE represents the excess demand-supply schedule of the competitive market as a whole, being derived by subtracting E4 from E1. 3) EDR represents the residual excess demand left out to the monopolist when the monopsonist behaves competitively, derived by subtracting EE from E3, and MRE represents the marginal revenue to the residual excess demand schedule, EDR.

The monopolistic exporters maximize their "gain from trade" by equating their excess supply schedule E2 to the marginal revenue schedule MRE. The market is distorted. The world market price is increased from O-Pf to O-Pm, and the trade volume is reduced from k-e to a-c = b-d.

Under this monopolistic equilibrium solution, the monopolistic exporters group will obtain a higher level of "gain from trade", the new "gain from trade" being the trapezoid b-P_m-n-m, which is larger than

the original "gain from trade" under competitive equilibrium (triangle $k\text{-}P_f\text{-}n$). An extra gain also accrues to the competitive exporters (trapezoid $P_m\text{-}d\text{-}e\text{-}P_f$).

However, under this equilibrium, importers would experience a loss in their "gain from trade," the loss being the trapezoid $P_m\text{-}c\text{-}e\text{-}P_f$ for competitive importers and the trapezoid $a\text{-}P_m\text{-}P_f\text{-}k$ for the monopolistic importers behaving competitively.

The aggregate loss of the importers is greater than the aggregate gain of the exporters, the difference being the triangle k-b-m, which is the global welfare loss of the monopolistically distorted market.

C. Monopsonistic Equilibrium

Suppose, now, the potential monopsonists realize their market power against the participants of the rest of the world all of whom behave competitively. With the assumption that the monopsonists maximize their net social payoff, a market equilibrium is shown in Figure 3. 1) E1, E2, E3, E4 and EE are defined as before, 2) ESR represents the residual excess supply left out to the monopsonist when the monopolist behaves competitively, being derived by subtracting EE from E2. 3) MOE represents the marginal outlay schedule to the ESR.

The monopsonistic importers maximize their "gain from trade" by equating their excess demand schedule E3 to the marginal outlay schedule MOE. Again, the market is distorted. The world market price is decreased from $O\text{-}P_f$ to $O\text{-}P_s$, and the trade volume is reduced from b-d to h-f = g-e.

The monopsonistic impact on the distribution of welfare can be analyzed in the same manner as in the case of the monopolistic

equilibrium. Under monopsonistic equilibrium, importers will gain and exporters will lose. The monopsonists will obtain a higher level of "gain from trade" as measured by the trapezoid $k-p_s-g-a$. This area is to be compared with the original "gain from trade" under the competitive equilibrium as measured by $k-p_f-b$. An unexpected gain also accrues to the competitive importers as measured by the trapezoid $p_f-d-c-p_s$. The loss of welfare for the competitively behaving monopolists is given by the trapezoid $b-p_f-p_s-h$, and the loss for the competitive exporters is given by the trapezoid $p_f-d-f-p_s$.

The aggregate loss of exporters is larger than the aggregate gain of the importers, the difference being the triangle a-b-g. This area represents the global welfare loss under the monopsonistic market distortion.

D. Bilateral Collusion Equilibrium

Market imperfection could also be created by a mixture of monopolistic and monopsonistic powers. Theory tells us that market equilibrium is indeterminate when two market powers compete in the same market with the same strength of bargaining power. However, if the two powers arrive at a collusive agreement, then some type of collusive equilibrium could be determined. An interesting fact is that the optimal collusive equilibrium (in the sense of maximizing joint welfare) would be equivalent to the competitive equilibrium with zero market power.

III. Quadratic Programming Formulation

In this section, the general theoretical model described in Section II is restated in quadratic programming form. Takayama and Judge, and

Duloy and Norton have used QP models to analyze monopolistic market equilibriums. But their concept of "monopoly" was that the entire trade flow is completely controlled by a single monopolist, and hence the objective function in their QP model was expressed in terms of maximizing the monopolist's revenue.

A general equilibrium solution for the spatially imperfect market can be obtained by formulating a mathematical problem as follows and by finding the optimum ($\overline{ES}$, $\overline{ED}$, $\overline{EX}$) that maximizes the objective function (1) subject to (2) and (3).

$$(1)\quad WW = F(ES,ED,EX) = \sum_{i=1}^{n} \{Wi(EDi,ESi)\} - \sum_{j=1}^{n} (Tij.EXij)$$

$$(2)\quad \left\{ \begin{array}{l} (i)\quad WM = Fm(ES,ED,EX) = \max \{EDR(\Sigma_j EXmj).\Sigma_j EXmj - Wm(ESm)\} \\ \text{or} \\ (ii)\quad WS = Fs(ES,ED,EX) = \max \{Ws(EDs) - ESR(\Sigma_i EXis).\Sigma_i EXis\} \end{array} \right\}$$

$$(3)\quad \left\{ \begin{array}{l} EDj \leq \Sigma_i EXij \\ ESi \geq \Sigma_j EXij \\ \text{and} \\ ED \geq 0,\ ES \geq 0,\ EX \geq 0 \end{array} \right\}$$

where 1) WW represents the quasi-welfare function for the world, and WM,WS represent the quasi-welfare functions for the monopolist and monopsonist respectively, 2) EDi[=Di(Pi)], ESi[=Si(Pi)] represent the excess demand supply functions for i'th region, the subscripts s and m denoting the

monopsonist and monopolist respectively, 3) Tij represents the unit cost of transporting the product from the i'th region to the j'th region, 4) EDR,ESR represent the residual excess demand and supply functions for the monopolist and monopsonist respectively, 5) EXij is the quantity flow from the i'th to the j'th region, and EDR ($\Sigma_j EXmj$),ESR($\Sigma_i EXis$) would represent the monopolist export price and monopsonist import price at its border.

The functional form of the ED and ES must be preestimated. Once ES and ED are estimated, EDR and ESR can be calculated as indicated in Figure 2 and Figure 3. For the derivation of EDR or ESR in the spatial market with the transportation cost as an important element, a parametric Quadratic Programming can be used. An equilibrium export price for a monopolist, P_m^k, can be found by holding the monopolist's export ($\Sigma_j EXmj$) at some constant level k and solving for the competitive equilibrium. Every other equilibrium price of P_m^k can also be found for each different level of k by parameterizing k in a relevant range, and the trace of these price-quantity equilibriums (P_m^k and k for $k = c_1, \ldots, c_n$) would represent the residual excess demand function for the monopolist in question. The residual excess supply function for the monopsonist can be derived in the same parameterization programming technique.

The monopolistic equilibrium will be obtained by maximizing (1) subject to (2)-(i) and (3), and similarly the monopsonistic equilibrium will be solved by maximizing (1) subject to (2)-(ii) and (3). The purely competitive equilibrium can be solved by maximizing (1) subject to (3) only. The collusive equilibrium can also be solved by prespecifying the collusive agreement into (2)-(i) and (2)-(ii), and then maximizing (1) subject to (2) and (3).

IV. Applicability of the Model - World Wheat Cartel

A variety of extensions of the model outlined above could be made. One such extension would be to incorporate a partial adjustment behavior of the market participants in estimating the ES and ED functions. With this partial adjustment hypothesis, the impacts of market imperfection on welfare distribution would be analyzed over several time periods through a recursive system. Another extension could be to incorporate any substitute products into the system and solve for the multiproduct equilibrium. In this multiproduct world, imperfections could be created by a certain region and/or by a certain product group. Either case can easily be analyzed by utilizing a suitable modification of the above basic model.

One application of the model can be to analyze the world wheat market. The welfare impacts of a recent policy issue - a wheat exporters cartel - can be analyzed through the direct application of the monopolistic equilibrium model outlined in Sections II and III. Only a brief operational procedure is given here because of space limitations.

First, either regional supply and demand functions as used in the Schmitz-Bawden model or regional excess demand functions as used in the Abbott-Sarris model could be incorporated into the standard spatial and equilibrium model with appropriate constraints reflecting the reality of trade policies.

Second, residual excess demand schedules for alternative coalitions of the wheat cartel could be derived. Wheat cartel may be comprised of only the United States and Canada or may include all four major wheat exporting countries. Once the cartel coalition is determined, total

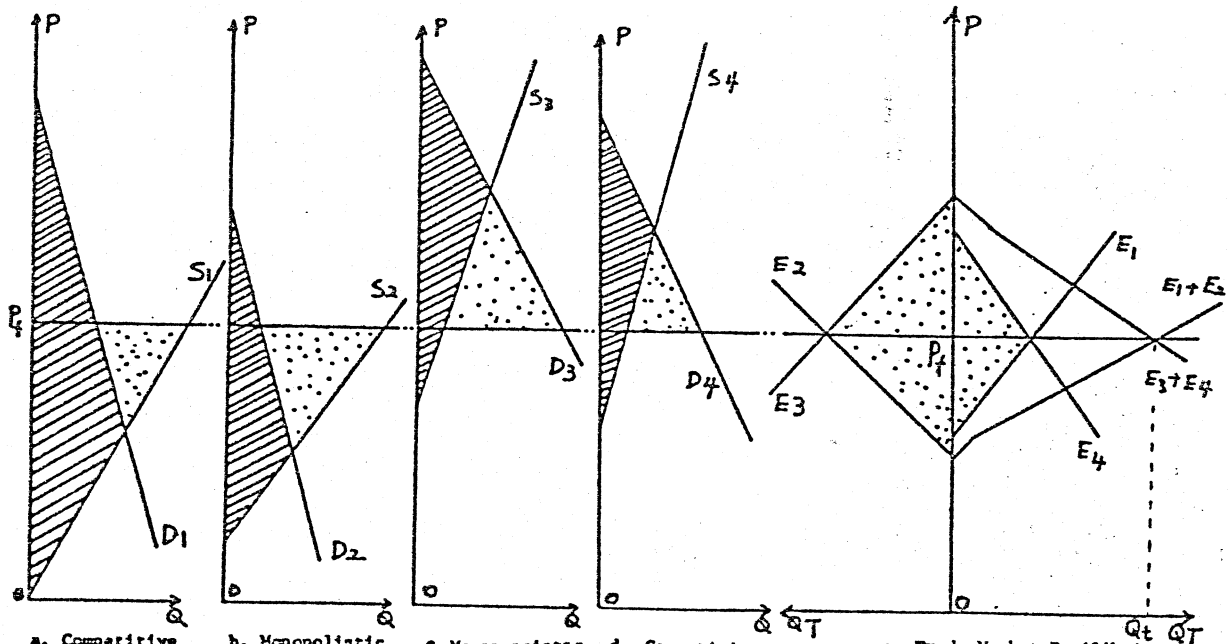
quantity of export for the cartel could be parameterized in the relevant range to trace the residual excess demand schedule for the cartel in the space, which could be linear or nonlinear. The optimum price-quantity combination for the cartel could be detected given the residual excess demand schedule.

Third, this price-quantity optimum for the cartel is plugged into the general model as a constraint in order to determine the cartelistic equilibrium solutions for other regions. Welfare distributions under the cartelistic market structure can be calculated and the estimated welfare gains or losses can be compared with the welfare distribution under competitive equilibrium.

V. Concluding Remarks

In this paper market imperfection is the general form used to characterize markets in international trade. Competitive equilibrium then is considered to be a special case of market imperfection (i.e., imperfection of zero degree).

The basic model of market imperfection introduced in this paper can easily be generalized for any type of the market as pointed out at the start of Section IV. It is hoped that the methodology presented here will be useful in the assessment and/or prescription of present, past, or future commodity trade policy.



a. Competitive Exportars
b. Monopolistic Exporters Behaving Competitively
c. Monopsonistic Importers Behaving Competitively
d. Competitive Importars
e. Trade Market Equilibrium with Excess Demand and Excess Supply Schedules

Figure 1. Competitive Market Equilibrium with Monopolistic Exportars and Monopsonistic Importers All Behaving Competitively.

note. Trade market equilibrium is drawn so that E2 and E3, and E1 and E4 intersect at the market clearing price to simplyfy presentation . This does not affect the conclusion.

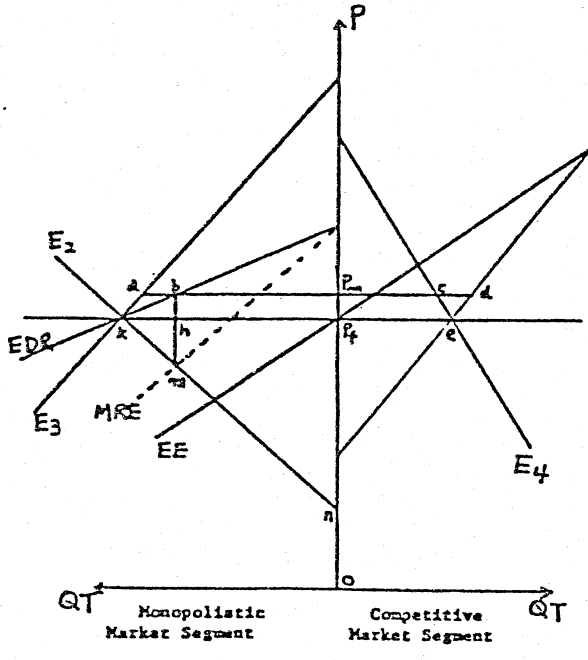


Figure 2. Monopolistic Market Equilibrium with Potential Monopsonist Behaving Competitively.

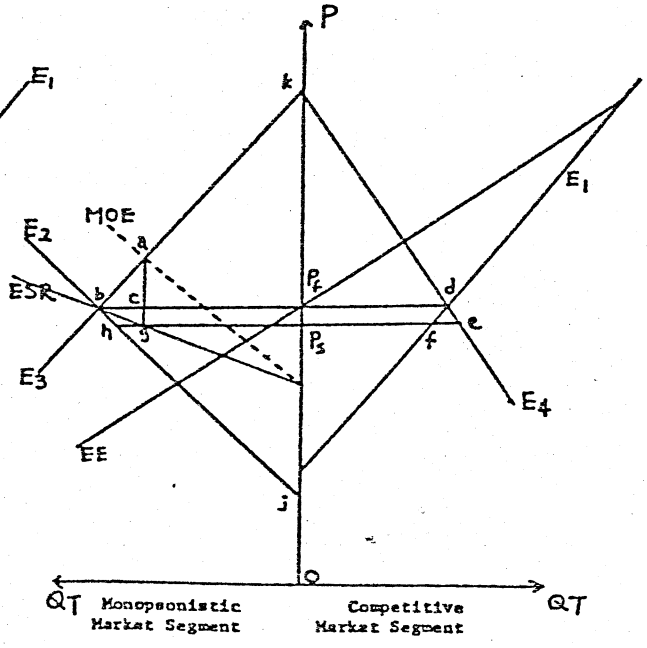


Figure 3. Monopsonistic Market Equilibrium with Potential Monopolist Behaving Competitively.

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