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STRUCTURE OF THE WORLD WHEAT MARKET: SOME IMPLICATIONS FOR STRATEGIC TRADE POLICY?[1]

C.S.C.SEKHAR[2]

Abstract

Market structure has a crucial bearing on the price formation mechanism. The present study is an attempt to analyze the market structure of the world wheat market. Market power of the 'traditional oligopolists' (US, Canada and Australia) is assessed using the standard oligopoly models. Structural and partially reduced-form models are used in the estimation of market power. The results indicate absence of market power in international markets for any of the major wheat exporters. The absence of market power in international markets has one important implication for trade policy of the exporting countries. In the absence of evidence of any imperfection in international market structure, the present subsidization of wheat production and exports by EU and US cannot be justified on the grounds of strategic trade policy of the new trade theories.

Keywords: World Wheat Market, Market Power, Strategic Trade Policy, New Trade Theories, Empirical Industrial Organization

JEL Classifications: C32; C50; C51; Q17;Q18

Agriculture is one of the most distorted sectors in international trade, often characterized by high levels of domestic subsidies and export subsidies in the developed countries. The avowed objective of these interventions is income support (to producers). Although the ineffectiveness of these instruments in meeting the stated objectives is clearly demonstrated (Johnson 1991, Hertel *et.al* 2006), these policies still prevail, particularly in the US and EU, and are likely to continue for some time into the future (OECD 2005). The current impasse in the multilateral trade negotiations at the World Trade Organization (WTO) has once again underlined the need to understand the rationale underlying such interventions by national governments in the developed countries and their implications for developing countries, in order to find an informed solution that is agreeable to all the countries.

New trade theories provide one plausible reason for the continuance of such policies in the developed countries. In the new trade theories, increasing returns to scale and imperfect

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[2] Associate Professor, Institute of Economic Growth, University of Delhi Enclave, Delhi-110 007. e-mail: sekharcsc@yahoo.com

competition are advanced as the possible reasons for national governments' intervention in international markets (Brander and Spencer 1985, Baldwin 1992). Brander and Spencer (1985), in their influential paper have argued that an export subsidy, as opposed to free trade, could be welfare-improving in an *imperfectly competitive* international market. They argue that the provision of the subsidy will change the nature of the oligopoly, shift profits from foreign firm to the domestic firm and move the subsidizing country's firm to the Stackelberg leader's position.

Thus, imperfect competition and market power are important in the price formation mechanism in international grain markets and agricultural trade. However, these issues are normally assumed away in the literature on agricultural trade (McCalla 1981, Cramer et al. 1993, Sekhar 2003). Even the studies that analysed price formation in an oligopolistic framework adopted simplifying assumptions in order to obtain a determinate price solution (McCalla 1966, Taplin 1969, Alaouze et al. 1978, Geer 1971, McCalla 1981).

Market structure is inextricably linked to the process of price formation. International market structure impinges on price formation in the world market, which in turn, has implications for changes in the comparative advantage of a country. Considerations of comparative advantage determine long-run trade policy of the country. Thus, market structure is a crucial determinant of price formation in the world market and the long- run policy environment in the major countries that constitute that market.

Strategic trade policy provides compelling argument in favour of national governments' intervention in international markets, notwithstanding some forceful critiques (Dixit 1984, Eaton and Grossman 1986, Salant 1984, Krugman 1987). However, the critical factor influencing the selection of the appropriate (trade) instrument is the *existence* and the *nature* of imperfection in the international market (Eaton and Grossman 1986). The appropriateness of the instrument hinges crucially on the exact knowledge about the structure of international market. This important and interesting empirical question appears to have received only scant attention in agricultural commodity modeling literature. One of the possible reasons for this is the difficulty involved in integrating the imperfect competition theories, which are partial in nature, into the dominant general equilibrium neo-classical trade theory. But the advent of imperfect-competition-based theories of international trade in the late 1970 s (Spence 1976, Dixit and Stiglitz 1980, Dixit and Norman 1980, Krugman 1979, Lancaster 1980) provided the necessary theoretical framework and the new empirical industrial organization approaches or NEIO (Bresnahan 1989) provided the appropriate empirical methodology.

Although theoretical work on imperfect grain markets dates back to the 1960s and 1970s (McCalla 1966, Taplin 1969, Alouze *et.al*. 1978), which is prior to the new trade theories, there is little empirical evidence based on market structure related studies, to evaluate policy intervention. The present paper attempts to address this issue by empirically assessing the market power, if any, possessed by the traditional 'oligopolists' of international wheat market, namely US, Canada and Australia. The study also attempts to draw implications, based on the inference about the market structure of international wheat market, for the strategic use of subsidies by major exporting countries. The present study differs from most of the recent attempts to model price formation in world wheat markets in the sense that perfect competition is *not assumed* but the empirical validity of the same is *tested*.

The specific objectives of the study are the following.

a) To analyze the international market structure of wheat

b) Draw broad implications for policy and institutional arrangements

The paper is organized as follows. Section 2 provides a brief review of literature. Section 3 outlines the theoretical framework followed by a brief outline of the empirical methodology and data. Section 4 presents a short overview of the world wheat market. The empirical results are presented in section 5. Section 6 presents the summary and policy implications

2. Literature Review

Early theoretical work on imperfect markets in international wheat trade and market power can be traced to McCalla (1966), Taplin (1969) and Alaouze *et.al* (1978), which have used the oligopoly framework. McCalla and Taplin models are based on a collusive duopoly between US and Canada, with other producers either following the price set by the duopolists or pricing sufficiently below the price set by duopolists to clear their stocks. Both models describe pricing along the residual demand curve facing the duopolists, and the way in which North American exports are shared between US and Canada. But, the maintenance of some minimum share of the total export market, as an essential condition for the stability of the duopoly, is recognized in both the models. Alaouze *et.al* (1978) postulated a triopoly model by including Australia, with Canada as revenue-maximizing price leader. All the three models, although situated in an overall framework of oligopoly, achieve deterministic solutions through an implicit assumption of collusion. Mitchell and Duncan (1987) showed results similar to those of Alaouze *et.al* (1978). However, a very different argument is put forward by Carter and Schmitz (1979). Using an optimal tariff model, they argued that market power existed for the importers (Japan and EEC) and not the exporters. Kolstad and Burris (1986) developed a spatial imperfect competition model to test these three popular imperfect competition models of world wheat market. (namely, McCalla 1966, Alaouze et al.1978, Carter and Schmitz 1979). The results of the study indicate that the duopoly (McCalla) and the triopoly (A-W-S) models performed much better, in terms of the model forecasts being much closer to the actual values. Duopsony (Carter and Schmitz) fared very poorly. However, one major limitation of K-B model is that the supply and demand functions are estimated under assumptions inappropriate to the assumed market structures.

Some of the other important studies on wheat sector are the following. Sarris and Freebairn (1983) modeled international wheat prices as Cournot interactions of national excess demand functions, which in turn, are solutions of domestic welfare optimization problems. Riethmuller and Roe (1986) also used a similar model to analyze Japan's wheat and rice policies. Love and Rausser (1997) extended the model further and obtained flexible policy rules for US wheat sector using stochastic control methods. Just *et.al* (1979) incorporated the actions of STAs and large private firms in international price formation model and showed that if the actions of these institutions resulted in a non-competitive world price, additional instruments are needed alongwith domestic price controls. Anania et al. (1992), evaluating the US wheat export enhancement program (EEP) from the perspective of strategic trade theory, found that the EEP is an expensive beggar-thy-neighbour policy with no exporting-country gains to US and only slight harm to the intended loser- the EU. Carter, MacLaren and Yilmaz (1999) analyzed the structure of world wheat market and showed that a competitive structure in international wheat market cannot be ruled out.

The abovementioned imperfect market models have either used a single market structure for empirical estimation (Carter and Schmitz 1979) or have used cost and demand estimates

inappropriate to the assumed market structure (Kolstad and Burris, 1986) or have assessed market power at a specific import market (Carter et al. 1999). The present study attempts to address some of these limitations. The study attempts to assess the market power possessed by US, Canada and Australia in the world wheat market, assumed to be the traditional 'oligopolists' (McCalla 1966, Taplin 1969, Alouze *et.al*. 1978). Supply and demand functions, which are appropriate to the hypothesized market structure of the world market, are formulated and estimated. The cross-equation coefficient restrictions are tested to assess the empirical validity of the hypothesized market structure.

3. Analytical Framework

We have used the following two models in this study

i. The structural model of Carter-MacLaren (1997), which is derived from Bresnhan (1989)

ii. The Partially Reduced Form Model of Goldberg-Knetter (1999) derived from Baker-Bresnahan (1988)

The econometric estimation is carried out using Hsiao (1997a, 1997b) methodology, which is equipped to deal with non-stationarity and cointegrated regressors.

The degree of competition in a market is generally expressed as a relation between mark-up of price (P) over marginal cost (MC) i.e.(P-MC)/ P (Lerner 1934). The limitation with this approach is the difficulty involved in collecting information on marginal cost. Some of the improved approaches found in the literature, which belong to the New Empirical Industrial Organisation (NEIO) framework, include structural models (Bresnahan 1989, Carter and MacLaren 1997) and partially reduced form models (Baker and Bresnahan 1988; Goldberg and Knetter 1999; Carter *et.al*, 1999). In these approaches the performance (price-cost margin) is not taken to be observable. The MC needs to be inferred from the behaviour of the firm or alternatively, the market power is inferred without measuring cost at all. We have attempted to assess market power through both the approaches.

The structural models involve estimating particular functional forms of demand and cost equations by applying simultaneous equations techniques. The advantage of these models is that they yield complete information about entities of interest; own and cross price elasticities of demand, marginal costs and conduct.

The partially reduced form model (alternately, the partially structural form model) is slightly simpler and uses the elasticity of the residual demand curve (faced by the exporter) as a measure of competition. Steeper residual demand curve implies a higher mark-up (and market power) for the exporter and vice-versa. In case of perfect competition, the residual demand curve is completely flat.

The main difference between these two models is in the way the demand equation is formulated. In the structural model, the demand function is of the standard form, including the current endogenous prices of all the substitute commodities as explanatory variables. On the other hand in the partially reduced framework, only one current endogenous variable appears as explanatory variable on the right hand side of the demand function (hence the name 'partially reduced').

General Framework

The general framework of the two models is as follows (for details see Goldberg-Knetter 1997). Consider an exporter selling in a particular destination. Let p^{ex} and q^{ex} be the price of export good (in terms of the destination market currency) and quantity exported respectively. $p^1,.....,p^n$ are similarly defined for the n competitors. Let z be a vector of demand shifters in the destination country. Demand functions for the exporter and the n competitors may be written as

$$p^{ex} = D^{ex}(q^{ex}, p^1, ..., p^n, z) \quad \ldots (1)$$

$$p^k = D^k(q^k, p^j, p^{ex}, z) \quad \ldots (2)$$

where $j = 1,\ldots\ldots,n$ and $j \neq k$

In the destination market the exporter attempts to solve the following profit maximization problem

$$\max_{q^{ex}} \pi^{ex} = p^{ex} q^{ex} - e.c^{ex} \quad \ldots (3)$$

where e is the exchange rate, given by the number of units of destination country currency per one unit of exporting country currency and c^{ex} is the cost in source country currency units. Using appropriate assumptions, the following first order conditions can be derived for the group of exporters and competitors respectively.

$$p^{ex} = e.MC^{ex} - q^{ex} D_1^{ex} \varphi \quad \ldots (4)$$

$$p^k = e.MC^k - q^k D_1^k \quad \ldots (5)$$

where $k = 1,2,\ldots..,n$.

$p^{ex}, q^{ex}, p^k, q^k, e$ are as defined earlier. MC^{ex}, MC^k and D_1^{ex}, D_1^k ($k = 1,2,\ldots..,n$) are the marginal cost and marginal revenue functions for the exporter and the competitors respectively. MC^{ex}, MC^k ($k = 1,2,\ldots..,n$) are functions of the quantity and other cost shifters(w). φ Captures competitive behaviour between exporting country and foreign competitors. The equilibrium values of p and q are obtained by estimating and solving the system of equations given by 1,2 (demand) and 4,5 (supply). Market structure is assessed by deriving first-order conditions (eqns 4 and 5) under various assumptions about the structure and testing the resulting cross-equation coefficient restrictions.

3.1 Structural Model

The structural model is very similar to the general framework outlined above. Suppose there are three exporters -US, Canada and Australia. Let the inverse demand function of the three exporters respectively be

US: $P_u = \alpha_u + \beta_{uu} q_u + \beta_{ua} P_a + \beta_{uc} P_c + \gamma_u y$ ... (6)

Australia: $P_a = \alpha_a + \beta_{aa} q_a + \beta_{au} P_u + \beta_{ac} P_c + \gamma_a y$ ... (7)

Canada: $P_c = \alpha_c + \beta_{cc} q_c + \beta_{cu} P_u + \beta_{ca} P_a + \gamma_c y$ ... (8)

For notations see sub-section 3.1.1.

Let the cost function facing the three exporters respectively be of a simple linear form as follows

US: $C_u = \delta_{u0} + \delta_{u1}q_u$ ... (9)

Australia: $C_a = \delta_{a0} + \delta_{a1}q_a$ ... (10)

Canada: $C_c = \delta_{c0} + \delta_{c1}q_c$ ... (11)

For ease of exposition, we have excluded other explanatory variables. The actual model has a larger set of explanatory variables.

a) Cournot-Nash Equilibrium:

MR-MC = 0 for country i yields

$MR\text{-}MC = \partial(P_iq_i - C_i)/\partial q_i = p_i + q_i\,\partial P_i/\partial q_i - \delta_{u1} = 0$

$q_i = (-1/(\partial P_i/\partial q_i))\,(p_i - \delta_{i1})$

$q_i = \delta_{ii}\,(p_i - \delta_{i1}) = (-1/\beta_{ii})\,(p_i - \delta_{i1})$ where i = u, a or c

More specifically the supply functions can be written as

$q_u = \delta_{uu}\,(p_u - \delta_{u1}) = (-1/\beta_{uu})\,(p_u - \delta_{u1})$ ... (12)

$q_a = \delta_{aa}\,(p_a - \delta_{a1}) = (-1/\beta_{aa})\,(p_a - \delta_{a1})$ ... (13)

$q_c = \delta_{cc}\,(p_c - \delta_{c1}) = (-1/\beta_{cc})\,(p_c - \delta_{c1})$ ... (14)

Equations (6), (7), (8) together with equations (12), (13), (14) form the system of six simultaneous equations in six unknowns p_i, q_i.

The cross equation restrictions to be tested in <u>Cournot model</u> are

$\delta_{ii} = (-1/\beta_{ii})$ ... (*)

b) *Stackelberg Leadership in Quantity* (US Leadership with Canada and Australia as followers):

Let the inverse demand function facing each of the exporters be given by (6), (7), (8) and the cost be given by equations (9), (10), (11). Suppose US is the Stackelberg leader in quantities.

$$\partial\Pi_u/\partial q_u = p_u + q_u\,\partial P_u/\partial q_u - \delta_{u1} = 0 = p_u + q_u\,(\beta_{uu} + \beta_{ua}\partial P_a/\partial q_u + \beta_{uc}\partial P_c/\partial q_u) \quad \text{... (15)}$$

But

$dP_c/dq_u = (dP_c/dP_u)\,.\,(dP_u/dq_u) = \beta_{cu}\beta_{uu}$

$dP_a/dq_u = (dP_a/dP_u)\,.\,(dP_u/dq_u) = \beta_{au}\beta_{uu}$

since $dP_u/dq_u = \beta_{uu}$, $dP_u/dP_c = \beta_{uc}$ and $dP_u/dP_a = \beta_{ua}$

Substituting the above values into (15) we get

$P_u + q_u\,(\beta_{uu} + \beta_{uu}\beta_{ua}\beta_{au} + \beta_{uu}\beta_{uc}\beta_{cu}) - \delta_{u1} = 0 \rightarrow$

$$q_u = [-1/(\beta_{uu}\,(1 + \beta_{ua}\beta_{au} + \beta_{uc}\beta_{cu})]\,p_u - [-1/(\beta_{uu}\,(1 + \beta_{ua}\beta_{au} + \beta_{uc}\beta_{cu})]\,\delta_{u1} \quad \text{... (16)}$$

(Supply function for US)

or more generally, $q_u = \delta_{ii}\,(p_i - \delta_{i1})$, i=u,c,a where δ_{ii} is given by the cross-equation restriction (i) given below for i = u and by restriction (ii) for i = c,a

The six equations (16) & (6) for US and (13, 14) & (7, 8) for Australia & Canada respectively form the system of six simultaneous equations in six unknowns pi and qi, i=u,c,a.

Similar sets of equations can be derived when the other two countries i.e., Australia and Canada act as leaders.

The cross equation restrictions to be tested in the Stackelberg model are

$\delta_{uu} = [-1/ (\beta_{uu} (1+ \beta_{ua}\beta_{au}+\beta_{uc}\beta_{cu}))]$

$\delta_{ii} = (-1/\beta_{ii}),\ i=c,a$ **... (**)**

In the present study, market power is tested using the Cournot-Nash, Stackelberg leadership models. Quantity is assumed to be the strategic variable.

3.1.1 Estimated Model

The following structural model is formulated on the lines of the theoretical framework outlined in the previous section. The demand functions are in inverse form. The explanatory variables included are the quantity exported (by exporter of interest), competitors' prices and importing countries' aggregate income. All the variables except quantity are expected to show a positive sign. The supply functions are in the standard form with the explanatory variables included being border price, exchange rate, stocks at the beginning of the year and irrigated area. All the variables are expected to have a positive effect on export supply.

In the supply function, irrigation has been used as proxy for the important variable of technology because most of the technological advances in wheat sector have been irrigation-intensive. The 'irrigated area' variable is, therefore, expected to capture these effects. One important supply shifter is weather but owing to lack of reliable data across countries over a long time period and also due to the fact that cereals (wheat and rice) are grown under irrigated conditions in most countries, this variable has not been included in our analysis.

Supply shifters like irrigated area and stocks, excluded from the demand function, allow identification of the demand function. Similarly demand shifters like income that are excluded from the supply function aid in identifying the supply function.

Inverse Demand Functions

Australia: $P_a = \alpha_{a0} + \beta_{aa}q_a + \beta_{au}P_u + \gamma_a y$

Canada: $P_c = \alpha_{c0} + \beta_{cc}q_c + \beta_{cu}P_u + \gamma_c y$

US: $P_u = \alpha_{u0} + \beta_{uu}q_u + \beta_{uc}P_c + \gamma_u y$

Supply Functions

Australia: $q_a = \delta_{a0} + \delta_{aa}* P_a + \delta_{a1}*ER_a + \delta_{a2}*ST(-1)_a + \delta_{a3}*IRR_a$

Canada: $q_c = \delta_{c0} + \delta_{cc}* P_c + \delta_{c1}*IRR_c + \delta_{c2}*ST(-1)_c$

US: $q_u = \delta_{u0} + \delta_{uu}* P_u + \delta_{u1}*IRR_u + \delta_{u2}*ST(-1)_u$

Notation

P_a –Australia's real export price of wheat in $/ton (const 1995)
P_c –Canada's real export price of wheat in $/ton (const 1995)
P_u –US' real export price of wheat in $/ton (const 1995)
q_a - Australia's wheat exports
q_c - Canada's wheat exports
q_u - US' wheat exports

IRR_a –Australia's irrigated area (gross) in ha
IRR_c – Canada's irrigated area (gross) in ha
IRR_u – US' irrigated area (gross) in ha
ER_a – Australia's official exchange rate (LCU/$)
ER_c – Canada's official exchange rate (LCU/$)
$ST(-1)_a$ – Australia's lagged wheat stocks (tons)
$ST(-1)_c$ – Canada's lagged wheat stocks (tons)
$ST(-1)_u$ – US' lagged wheat stocks (tons)
P_{da} – Australia's real domestic wheat producer price ($/ton) (const 1995)
P_{dc} – Canada's real domestic wheat producer price ($/ton) (const 1995)
P_{du} – US' real domestic wheat producer price ($/ton) (const 1995)
y - Importing countries' aggregate GDP (const 1995 US$)
α, β, γ and δ are the parameters to be estimated.

3.2 Partially Reduced-Form Model

Deriving the partially reduced form model from the general model involves manipulating the system of equations defined by (1), (2), (4) and (5), in order to obtain a single equation denoting the residual inverse demand curve of the exporter. First, Eqns (2) and (5) are solved for prices and quantities of the n competitors. After solving the system of 2n equations defined by (2) and (5), price (p^k) of each of the competitors is derived as a function of the cost shifters in the respective competing country (w^k), demand shifters in the destination market (z) and the quantity exported by the exporter (q^{ex}).

$$p^k = p^k(q^{ex}, w^k, z) \qquad k=1,2,\ldots\ldots n \qquad \ldots (19)$$

Let w^N denote the union of all the country-specific cost shifters, excluding the exporter. Then

$$p^k = p^{k*}(q^{ex}, w^N, z) \qquad k=1,2,\ldots\ldots n \qquad \ldots (20)$$

Each $p^k = p^{k*}(.)$ represents a partially reduced form with only one current endogenous variable, q^{ex}, appearing on the right hand side. The dependency of p^k on q^{ex} arises because only the 2n equations of the n competitors have been solved out and the exporter's equation is excluded.

To obtain the residual inverse demand curve of the exporter, we substitute the n expressions defined by (20) in (1), thereby eliminating the competitors' prices from (1), yielding the following equation.

$$p^{ex} = D^{ex}(q^{ex}, p^{1*}, \ldots\ldots, p^{n*}, z) = D^{res.ex}(q^{ex}, w^N, z) \qquad \ldots (21)$$

This equation for residual inverse demand curve has three observable arguments; quantity exported by the exporter (q^{ex}), demand shifters in the destination market (z) and the vector of cost shifters in the competing countries (w^N). The slope of the residual inverse demand

curve faced by the exporter, therefore, takes into account the aggregate competitive interaction of all other players in the market.

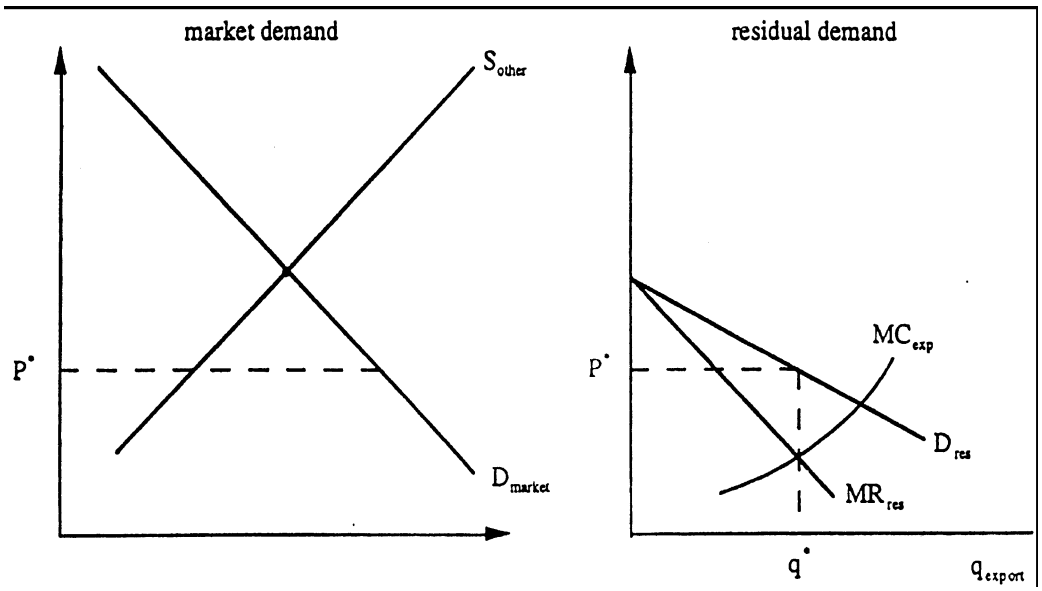

Figure 1. Residual Demand Curve Facing an Exporter or Group of Exporters (Goldberg and Knetter, 1999)

Figure 1 (Goldberg-Knetter 1999) depicts the residual demand curve for an exporter (or group of exporters) facing competition from price-taking competitors from other countries. The left panel of the diagram depicts the market demand curve D_{market} for the product in the destination country, as well as the supply curve S_{other} of all competitors other than the exporting country of interest. The good is assumed to be homogeneous. The right panel plots the residual demand curve facing the exporter group of interest, D_{res}, along with their supply schedule MC_{exp}, given by the marginal cost curve. Residual curve is derived as the difference between the market demand curve and competitors' aggregate supply curve, given in the left panel. The residual demand elasticity (RDE) depends on properties of both the market demand schedule and the supply schedules of other firms in the market. The condition required to estimate the RDE is that there be some exogenous shock that shifts the costs of production of exporting country relative to competitors. Exchange rate fluctuations between the exporting country and destination market do exactly that, by shifting the source country firms' supply curve. Exchange rate fluctuations between the other competitors and the destination market, on the other hand, shift the supply curve in the left panel, which shifts the residual demand in the right panel in fig 1. Fluctuations in the currency of the importing country (destination market) against all exporters have both effects. Stockholding behaviour of the competitors also has an interesting role to play in this model. When the competitive fringe releases stocks in a narrow price band, the competitors' supply curve becomes flatter, which in turn, may lead to a flatter residual demand curve faced by the exporter (price wars of mid 1960s). On the other hand, if the competitors' stock schedule is steeper, then

residual demand faced by the exporter also has steeper slope and results in some market power to the exporter. Thus, stocks have an important role to play in a dynamic oligopoly model.

The following log-linear version of equation 21 is generally used for estimating the residual inverse demand elasticity or RIDE (Goldberg and Knetter 1999).

$$\ln p_t^{ex} = \alpha + \beta \ln q_t^{ex} + \lambda_1 \ln z_t + \lambda_2 \ln w_t^N + \varepsilon_t$$

where p_t^{ex} and q_t^{ex} are the export price and quantity of the country of interest. β is the RIDE and α, λ_1, λ_2 are the other parameters to be estimated. w_t^N is the set of cost shifters in the competing countries and Z_t is the vector of demand shifters in the importing countries (mainly importing countries' aggregate income). It is important for the purpose of identification that w_t^N does not include cost shifters of the exporting country. This implies that a separate equation needs to be specified for each exporter.

A supply equation is also specified for each of the exporters. The entire set of demand and supply equations is estimated using simultaneous equation techniques and solved to obtain the equilibrium values of p_t^{ex} and q_t^{ex} of each of the exporters. It needs to be noted here that although the entire set of demand and supply functions is estimated simultaneously, in effect, simultaneity exists only between demand and supply functions of the same country, because the competitors' supply functions are solved out. This does not materially affect the econometric results.

3.2.1 Estimated Model

The following partially reduced form model is formulated on the basis of the theoretical framework outlined above.

Residual Inverse Demand Functions

Australia: $P_a = \alpha_{a0} + \beta_{aa}q_a + \beta_{au}P_{du} + \beta_{ac}ER_c + \gamma_a y$

Canada: $P_c = \alpha_{c0} + \beta_{cc}q_c + \beta_{cu}P_{du} + \beta_{ca}ER_a + \gamma_c y$

US: $P_u = \alpha_{u0} + \beta_{uu}q_u + \beta_{uc}P_{dc} + \gamma_u y$

Supply Functions

Australia: $q_a = \delta_{a0} + \delta_{aa}* P_a + \delta_{a1}*ER_a + \delta_{a2}*ST(-1)_a + \delta_{a3}*IRR_a$

Canada: $q_c = \delta_{c0} + \delta_{cc}* P_c + \delta_{c1}*IRR_c + \delta_{c2}*ST(-1)_c$

US: $q_u = \delta_{u0} + \delta_{uu}* P_u + \delta_{u1}*IRR_u + \delta_{u2}*ST(-1)_u$

In the residual inverse demand function, the demand shifters may include time trend, real income, population, price level etc. Exchange rate fluctuations are normally used as cost shifters in international economics literature. We have followed this convention too. In the case of US, the relevant cost shifter is taken to be the domestic producer price, since there is no suitable aggregate measure of production costs in US. Also, the price support provided through commodity loan program makes producer price an appropriate cost shifter for US.

The parameter of interest is β which can be directly interpreted as the residual inverse demand elasticity. An estimate of β equal to zero indicates perfect competition. Larger the value of β, greater is the departure from perfect competition.

The 'quantity exported' variable is expected to show a negative effect. Similarly, exchange rate of the competing country is also expected to show a negative sign. This is because higher the exchange rate, higher will be the competitor's supply and lower will be the price received by the exporter. However, the effect of domestic producer price in the competing country is expected to be positive. This is because, higher the domestic producer price in a competing country, higher will be the budgetary cost of domestic and export subsidies and more intense will be the efforts to limit production through acreage restrictions. This, in turn, will have a positive effect on the price received by the exporter of interest.

Turning to the supply function, we have included border price, exchange rate, and stocks at the beginning of the year and irrigated area as explanatory variables. All the variables are expected to have a positive influence on export supply. Positive effects of border price, exchange rate and stocks have a straightforward interpretation. Irrigated area, as in case of structural model, is expected to capture the effects of technology and hence the positive effect.

Econometric Methodology and Data

The two models – structural and partially reduced form models are estimated in a simultaneous equations framework using 3SLS method. Hsiao (1997a, 1997b) has shown that even if the variables are non-stationary, standard methods like 2SLS and 3SLS can still be applied, provided the variables are cointegrated. Market power is assessed by testing the cross-equation coefficient restrictions (eqns * and ** outlined in section 3.1) using the Wald test.

Data: Data on trade flows are mainly drawn from the various issues of Trade Yearbook of FAO and FAO website www.fao.org. The sample period is from 1967 to 2000. Australia emerged as a major exporter of wheat around mid 1960s. Therefore, we have chosen 1967-2000 as the period of our analysis. We have mainly used real variables like exports, imports, stocks, production and consumption. Expenditures on subsidies and other policy-related variables are not used for two reasons. First, such a dataset, according to our knowledge, is not available over a long time period across countries in a comparable form. Second, and the more important reason, is that the effect of all types of policies and technology changes has to finally manifest in terms of real variables.

4. World Wheat Market - A Broad Overview

United States is the world's largest wheat exporter (FAO) with an average share of 35% (in quantity terms) and 33% (in value terms) during the period 1960-2003, followed by Canada (19% and 20%), Australia (12% and 12%) and Argentina (6% and 5%). The average aggregate share of all the four exporters during this period was 71% (in quantity terms) and 70% (in value terms). When the other major exporter - European Union (EU-25) - is also included, they together account for about 80 percent of world wheat exports (ERS-USDA, 2005). Excluding Argentina and the EU-25, the aggregate share of the three traditional exporters, whose behaviour is modeled in the present study, is about 66% and 65% in quantity and value terms respectively.

The pattern of world wheat trade has undergone some change over the last two decades. In the later part of the 1980s and early 1990s, a wheat export subsidy competition ensued between the United States and the European Union. The United States used the Export Enhancement Program (EEP) to pay transaction-specific bonuses that varied from day to day. European Union (EU-25) subsidized exports through restitution (subsidy) payments for exports of

government intervention stocks at prices below acquisition costs. Although the EU-25 continues to subsidize exports, the subsidies in recent years have been relatively small. On the import side also, several important importing countries, including Egypt, have liberalized imports, allowing private importers in addition to STE s. As a result, large grain companies have expanded their role in many countries. These changes have made international wheat trade relatively more market-oriented in recent years.

Egypt has been the world's largest importer for many years. The EU-25 imports large volumes of wheat each year, exceeding 7 million tons in 2003-04 and 2004-05. However, EU-25's mostly subsidized exports remain nearly double their import levels. China is another major importer of wheat but China's wheat imports have fluctuated wildly over the last two decades due to shifts in government policy. Other important wheat importing countries are Japan, Brazil, Algeria, Indonesia, Mexico, South Korea, Nigeria and Iraq. There are many countries importing smaller quantities because of which the global import demand is much less concentrated than export supplies.

5. Results

Results of the stationarity tests and cointegration showed that all the sets of variables are I(1) and cointegrated. The 3SLS estimates are satisfactory (table 1). In the structural model, estimates of the inverse demand function indicate that the demand elasticities are not significant at 5% level of significance for any of the major exporters. However, the cross-price elasticities have the expected signs and are significant for all the exporters. The income elasticity of demand is insignificant, which may be understood given the importance of wheat in food consumption basket of most importing countries. Turning to the supply function, the price elasticity of supply is positive and significant for Australia and US but is insignificant for Canada. The other supply shifters – exchange rate, stocks and irrigated area – all have the expected signs and are significant.

In Partially Reduced Form model, the residual inverse demand elasticity is not significant for any of the major exporters. This result is in agreement with the result from structural model and has the crucial implication that no exporting country possessed market power. The competitors' cost shifters have the expected signs and are significant, except in case of Canada. The supply function estimates show that aher2(pric)-2(e)-45(el)-4(as)-3(,(pl)-4(y)18i)5(es)of fters

and Anderson (1989) also show that there is little evidence of any individual country possessing strong monopoly or monopsony power in the long run in international food markets.

Table 1. Estimation Results

Structural Model														
Demand Function								Supply Function						
		Export Price of competitors												
	Export Quantity (q)	Export Price of US (pu)	Export Price of Canada (pc)	Export Price of Australia (pa)	Importing Countries Income (y)	$\bar{R}^2$	D-W		Export Price (p)	Exchange Rate (ER)	Irrigated Area (IRR)	Stocks (ST)	$\bar{R}^2$	D-W
Australia	-0.06	1.22**	-	-	0.03	0.93	1.60	Australia	0.57*	1.51**	0.75	0.17**	0.49	1.56
US	-0.01	-	0.99**	-	0.04	0.94	1.62	US	0.49**	-	2.47**	0.17**	0.6	1.54
Canada	0.01	1.01**	-	-	-0.04	0.95	1.69	Canada	0.01	-	1.35**	0.23**	0.68	1.84
Partially Reduced Form Model														
Demand Function								Supply Function						
		Cost Shifters of Competitors												
	Export Quantity (q)	US	Canada	Australia	Importing Countries Income (y)	$\bar{R}^2$	D-W		Export Price (p)	Exchange Rate (ER)	Irrigated Area (IRR)	Stocks (ST)	$\bar{R}^2$	D-W
Australia	-0.02	1.19**	-0.49	-	0.03	0.92	2.07	Australia	0.6**	1.46**	0.93*	0.16**	0.48	1.55
US	0.10	-	0.6**	-	-0.15	0.85	1.66	US	0.58**	-	2.61**	0.15**	0.56	1.54
Canada	0.15	0.66**	-	-0.71**	-0.04	0.92	1.69	Canada	0.08	-	1.34**	0.17*	0.66	1.80

Note: * and ** denote significance at 5% and 1% level of significance respectively

Table 2. Wald Tests for Assessing Market Power

Null Hypothesis	*Coefficient Restriction*	*Wald Statistic*	*P-Value*
Structural Model			
No Market power for Australia	$\beta_{aa}=0$	0.32	0.57
No Market power for Canada	$\beta_{cc}=0$	0.18	0.67
No Market power for US	$\beta_{uu}=0$	0.57	0.45
No Market power for any of the three exporters	$\beta_{aa}=\beta_{cc}=\beta_{uu}=0$	0.95	0.81
Partially Reduced Form Model			
No Market power for Australia	$\beta_{aa}=0$	0.02	0.88
No Market power for Canada	$\beta_{cc}=0$	1.04	0.31
No Market power for US	$\beta_{uu}=0$	0.27	0.60
No Market power for any of the three exporters	$\beta_{aa}=\beta_{cc}=\beta_{uu}=0$	1.33	0.72

6.4 Limitations of the Study

a) The study does not test for the market power of importing countries i.e., oligopsony or duopsony

b) The model is partial in nature and does not take into account other crop sectors within agriculture or other sectors in the economy. General equilibrium models may offer an alternate theoretical framework of analysis. Also, panel data methods provide an alternate framework of estimation.

c) Effects of trade policy instruments like tariffs, quotas and subsidies could not be incorporated because of the non-availability of time-series data in comparable form across countries.

d) Role of futures markets, private intermediaries and other possible price-influencing institutions could not be analyzed, again mainly because of data constraints.

7. Summary and Conclusions

Results of our study suggest that there is little empirical evidence of market power for any of the traditional oligopolists in world wheat market. This result is in conformity with some of the earlier literature. New trade theories suggest that export subsidies are justified if international markets are imperfect and the effect of such subsidies is to move the subsidizing country to the leader's position in a Stackelberg oligopoly. Neither of these seems to be borne out by our results. From our results (and also from the literature), there is no evidence of any major imperfection in international wheat market, when seen over a long time horizon. Also, the intended effect of moving the domestic country (US in this case) to the position of a Stackelberg leader has not been realized either. The increase in domestic profits and reduction of foreign profits also does not appear to have been realized, at least in case of US (Anania *et.al*. 1992). The only effect that appears to have been realized is lowering of the world price (of wheat) due to increased production as a result of subsidies (Johnson 1991). Also, the political economy arguments against free trade (Krugman 1987), namely, retaliation and consequent trade wars and capture of rents by special interest groups seem to be supported by the recent empirical evidence (Anania 1992, Miljkovic 2004, Hertel *et.al* 2006).

Therefore, it is hard to justify the current level of subsidies by countries like the US and EU either by appealing to the imperfect nature of international wheat market or by the expected (but not realized) benefits of subsidization. The political economy implications of protectionist policies make such policies even more undesirable.

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