

Autor: **Jesús Antón López**

Título: **Explaining stocks and export subsidies in agriculture: the case of wheat**

*Resumen: Este artículo desarrolla un modelo de oligopolio de gobiernos para un mercado mundial de un producto homogéneo. Los mercados nacionales están intervenidos según un patrón inspirado en la PAC: el Gobierno garantiza la compra de todos los excesos de oferta creados a un precio dado y puede subsidiar las exportaciones y almacenar stocks. Se trata de un juego no cooperativo en dos etapas en el que el Gobierno maximiza su Función de Preferencias Políticas, decidiendo primero el precio interno y después el volumen de exportaciones que subsidia. Se demuestra que la decisión de conceder subsidios a la exportación sólo puede ser óptima si el Gobierno tiene preferencias sesgadas en favor de los productores; la decisión de almacenar stocks requiere adicionalmente que el Gobierno disponga de poder de mercado. El modelo puede ayudar a entender el alcance de la reforma de la PAC y de los acuerdos agrícolas del GATT.*

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**Departamento de Análisis Económico I**

**Universidad Complutense de Madrid**

Campus de Somosaguas. 28223 MADRID.

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**Tel.:** 394.2517 / 2414 **Fax:** 394.2561 **e-mail:** ececo10@sis.ucm.es

**Abstract:**

A model of Governments Oligopoly in a world market of an homogenous commodity is built. National markets are intervened in a way inspired by the Common Agricultural Policy: Government guarantees the purchase of any excess supply at a given price and it may subsidize exports and store part or all the excess supply. The model develops a non-cooperative two stages game in which Governments maximize their Political Preference Function, deciding first the internal price and then the volume of subsidized exports. It is proof that the decision of subsidizing exports can only be optimal if Government preferences are biased for producers' welfare rather than consumers' and tax-payers'; the storing decision requires in addition the existence of world market power by the Government. The model may help to understand the scope of CAP reform and GATT's agricultural agreement.

**Key Words**

Oligopoly, international trade, export subsidy, stocks, wheat.

**Resumen:**

Este artículo desarrolla un modelo de oligopolio de gobiernos para un mercado mundial de un producto homogéneo. Los mercados nacionales están intervenidos según un patrón inspirado en la PAC: el Gobierno garantiza la compra de todos los excesos de oferta creados a un precio dado y puede subsidiar las exportaciones y almacenar stocks. Se trata de un juego no cooperativo en dos etapas en el que el Gobierno maximiza su Función de Preferencias Políticas, decidiendo primero el precio interno y después el volumen de exportaciones que subsidia. Se demuestra que la decisión de conceder subsidios a la exportación sólo puede

ser óptima si el Gobierno tiene preferencias sesgadas en favor de los productores; la decisión de almacenar stocks requiere adicionalmente que el Gobierno disponga de poder de mercado. El modelo puede ayudar a entender el alcance de la reforma de la PAC y de los acuerdos agrícolas del GATT.

**Palabras clave:**

Oligopolio, comercio internacional, subsidio a la exportación, stocks, trigo.

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**1. INTRODUCTION**

In many developed countries agricultural markets -specially in the European Union (EU)- Governments finance very expensive policies of guaranteed prices for producers. The guarantee means that Government or a Specialized Agency isolates the national market with two types of interventions:

- a) Covering the internal excess supply or demand.
- b) Imposing a variable tax/subsidy on exports/imports. This tax/subsidy will be equal to the difference between world price and national price.

This kind of Government behavior is the rule in the markets of many EU's Common Agricultural Policy (CAP) but it is also quite frequent in other developed countries. The classical explanation of this Government behavior is based on the will of stabilizing farmers' income through prices; the need of price stability is due to a very low elasticity of both demand and supply and a large variability of crops. I will analyze in this article the rationality behind fixing some given national price.

I am specially interested in explaining Government rationality when:

- 1. It is an exporting country; i.e. the guaranteed national price is above equilibrium price.
- 2. Government gives variable subsidies to exporters; i.e. national price is above world price.
- 3. Government has a high level of stocks which may grow.

This situation has been observed in different world agricultural markets during last years, specially in the wheat market. The world wheat market has had a very high concentration of exporting countries during the last three decades, with a market share of five top exporting countries above 90%; five top exporters have had also a high level of stocks, above total annual exports most of the time; additionally four top exporters have price isolation mechanisms with frequent implicit or explicit export subsidies.

The effects of the kind of policy described in a) and b) above under perfect competition in both national and world markets are explained in McCalla et Al. (1985): fixing an internal price above both the internal equilibrium and the world price generates a rigid excess supply and a lower and more variable world price; exports would be larger but total welfare of both exporting country and world as a whole would diminish. Under this perfect competition paradigm, so common among agricultural economists, government behavior is just irrational: high internal prices may only be explained by a Government's preference for producers, but stocks remain unexplained. Short run price speculation may give some rational explanation for stocks in a competitive

framework (Blakeslee and Lone (1994)), but it does not seem to be a realistic approach to Governments' behavior.

One of the main objectives of this article is finding how imperfect competition may add some rationality to the situation described in points 1), 2) and 3) above. International Trade Theory has found a rationality for unilateral intervention on trade (see Brander and Spencer (1985), Eaton and Grossman (1986) and Klette (1994)): export subsidies may be rational if there is market power; if national exporters have a "too collusive" behavior in the world market, export subsidies may force a "more aggressive" behavior which may be profitable. Indeed export subsidies are explained in this article by a similar reasoning: Government high internal price works as a "catalyzer" for a cartel of plenty of small producers; if Government does not subsidize exports, all the crop would be sold to the national market or the Government Agency, and exports would be zero. Market power gives also an explanation for stocks.

Some authors find difficult to assume non-competitive behavior in agricultural world markets because prices seem to be low; non-competitive behavior means a positive price-cost margin and seems incompatible with a low price. However the agricultural policy we consider here implies the isolation of national markets; in this context the relevant marginal cost is transportation cost, excluding production costs, and prices can be low with respect to production costs.

First oligopoly models for the wheat market are McCalla (1966) and Alauze et Al. (1978); these models do not link internal price decisions with export subsidies decisions. Internal market decisions are usually modeled using a Policy Preference Function (PPF) (Sarris and Freebairn(1983), Paarlberg and Abbott (1986), Mahé and Johnson (1991)...), despite the identification problems involved in this methodology (Von Cramon-Taubadel (1992)).

This article develops a model in which there are links between these two approaches in the literature: internal and external agricultural policy decisions are modeled under the assumptions of homogenous product and imperfect competition. The rational explanation of the behavior of a Government which subsidizes its exports and stores part of its internal excess supply, requires both a bias in Government preferences and price power in the world market. The model is a two stages non-cooperative oligopoly. In each stage Government decides the value of each strategic variable. In Stage I the most rigid decision is taken: internal price. In Stage II the most flexible variable is decided: total exports, which cannot exceed the addition of excess supply plus stocks from the past. Solution will be a subgame perfect equilibrium obtained using backwards induction. There are two kind of links between Stages I and II:

1. The price decided in Stage I determines the maximum level of exports in Stage II.
2. Earnings from exports in Stage II may create an incentive for a high price and excess supply in Stage I.

In Section 3 we develop a simplified version of the model in order to point the nature of the results we will obtain more generally in sections 3 to 6; an ex-post classification of all countries participating in the world market is also presented. Sections 3 and 4 build the complete model beginning with Stage II (world market); first and second order conditions of maximum are analyzed; section 3 already presents an important result on the necessary and sufficient condition for optimally storing. Section 5 gives some formalized results on the conditions for an optimal stock and/or export subsidy. Section 6 develops comparative statics of optimal price using Implicit Function Theorem. Section 7 presents comments on some quick empirical results in the wheat market. The article ends with a set of conclusions.

## **2. A SIMPLE VERSION OF THE MODEL**

In this paper we are going to use three different prices defined as follows:

$P_i^*$  denotes internal price guaranteed by Government "i".

$P_i^e$  denotes equilibrium price in national market "i" (demand=supply).

$P_w$  denotes the world price.

Governments are the agents participating in the world oligopoly. The key assumption all along this article is the national price policy. This is Assumption 1:

#### ASSUMPTION 1: NATIONAL PRICE POLICY

*All intervention policy is determined by fixing a guaranteed price for national producers. Government will defend this internal price using two kind of actions:*

1) *It will buy any internal excess supply at that price. In case of excess demand Government will sell this supply deficit from its stocks.*

2) *If the internal price  $P_i$  were above world price  $P_w$ , Government may subsidize exports with a variable subsidy equal to this price difference; Government will also tax imports with the same amount. This mechanism isolates national market from any world market shock.*

This section develops a simplified version of the model based also in this Assumption 1, but additionally assuming Cournot equilibrium in the world market and very simple demand and supply functions. Countries differ only in Government's preferences bias towards producers referred as  $\alpha_i$ , and in total internal production  $q_i^s$ .

#### STAGE I: National Market

Let us assume national demand and supply in country "i" are given by:

$$\begin{aligned} q_i^d &= 1 - p_i \\ q_i^s &= q_i^0 < 1 \end{aligned}$$

The Government's objective function consists on a weighted addition of producers' surplus, consumer surplus and taxpayers welfare. Government is assumed to be indifferent between consumers and tax payers (both welfare weights are equal to one). However Government gives a different weight to producers' surplus  $\alpha_i > 1$ . Under this assumptions the following relevant expressions are easy to obtain:

\* Producers' surplus:  $EP_i = p_i \cdot q_i^s = p_i \cdot q_i^0$

\* Consumers' surplus:  $EC_i = (1/2) \cdot (1 - p_i)^2$

\* Budget cost:  $B_i = p_i \cdot [q_i^s - q_i^d]$

\* Political Preference Function (PPF) defines Government maximization program:

$$\underset{p_i}{\text{Max}} \text{ PPF}_i$$

$$\text{PPF}_i = \alpha_i \cdot EP_i + EC_i - B_i = -(1/2) \cdot p_i^2 + [q_i^0 (\alpha_i - 1)] \cdot p_i + (1/2)$$

Since second order condition is satisfied, optimal price can be obtained from first order condition:

$$p_i^* = q_i^0 \cdot (\alpha_i - 1)$$

Country "i" excess supply will be:

$$ES_i^* = q_i^s - q_i^d = q_i^0 - [1 - P_i^*] = q_i^0 \cdot \alpha_i - 1$$

Therefore,  $p_i^*$  and  $ES_i^*$  are increasing functions of  $\alpha_i$  -the Government Producers bias-, as it was expected.

In addition they increase with internal production  $q_i^0$ . The excess supply in the expression above is the maximum export level for country "i".

## STAGE II: The World Market

In Stage II each country chooses its level of exports. World demand function and export cost function are assumed to be the following:

$$P_w = 1 - X$$

$$CTX_i = c_i \cdot x_i \quad \text{con} \quad c_i < 1 \quad \forall i = 1 \dots N$$

The Government Objective Function is now export earnings  $E_i$ , and its maximization program is:

$$\underset{x_i \leq ES_i}{\text{Max}} E_i = (P_w - c_i) \cdot x_i = (1 - X - c_i) \cdot x_i$$

Cournot equilibrium is defined by a set of N first order conditions:

$$(1 - X - c_i) - x_i = 0$$

Adding up these N equations we can obtain the total volume of exports and world equilibrium price:

$$X = \frac{N}{N+1} \cdot (1 - AC_N) \Rightarrow P_w = \frac{1 + N \cdot AC_N}{1 + N}$$

The optimal level of exports for oligopolist "i" is:

$$x_i^* = 1 - c_i - X = \frac{1 + N \cdot AC_N}{1 + N} - c_i = P_w - c_i$$

This quantity will be equal to actual exports only if in Stage I a big enough excess supply has been created.

## Some Intuitions

(1) Optimal exports  $x_i^*$  are determined by different factors than maximum exports (excess supply  $ES_i$ ). Both will be equal if and only if:

$$x_i^* = ES_i^* \Leftrightarrow \frac{1 + N \cdot AC_N}{1 + N} - c_i = q_i^0 \cdot \alpha_i - 1 \Leftrightarrow \alpha_i = \overline{\alpha_i^e} = \frac{1}{q_i^0} \cdot \left[ \frac{1 + N \cdot AC_N}{1 + N} - c_i + 1 \right]$$

In general they will not be equal :

$$\alpha_i > \overline{\alpha_i^e} \Leftrightarrow x_i^* < ES_i^* \Rightarrow \text{country "i" stores an amount } (ES_i^* - x_i^*)$$

$$\alpha_i \leq \overline{\alpha_i^e} \Leftrightarrow x_i^* \geq ES_i^* \Rightarrow \text{country "i" exports as much as possible}$$

Storing part of the crop may be an optimal Government decision. This is the case implicitly considered in Stage I in this Section, which allows to exclude exports income in the PPF.

(2) Storing part of the crop can only be optimal if Government has some price power in the world market. If world market were perfectly competitive, each country would always export its whole excess supply. The simplified model in this section assumes Cournot competition which may involve enough price power to lead exporters to reduce exports and create stocks.

(3) We can identify two kind of exporters:

a) Countries exporting as much as possible (competitive fringe exporters).

b) Countries exporting less than their excess supply and storing part of the crop (proper or active oligopolists).

(4) Creating stocks does not reduce the incentive to create excess supply. Once some stocks have been created, if no other circumstances change, stocks may linearly grow in the future.

### **Ex-post classification of countries.**

The relative price  $p_i^e / P_w$  determines the "natural" position of the country as exporter or importer if there were no intervention. Government bias can be guessed from  $p_i^* / P_w$  relationship; in Table 1 only three possibilities are considered: bias towards producers, no bias and bias towards consumers / tax payers. Table 1 summarizes the eight possible situations of each country in the world market when there is no market power.

*Insert Table 1*

Prices  $p_i$  and  $P_w$  are used as reference for classification; however it will be proved that the world price is a valid reference to classify Government bias only if it has no power in the world market; if there is some market power the correct reference price is between world price and internal equilibrium price (see Proposition 2's proof below). The ex post classification in Table 1 would be derived from the solution to Stages I and II in the game; the groups considered are relevant even if some countries have market power. Any net exporter from any of the four groups considered can be, in principle, a fringe exporter or an active oligopolist, depending on its power to change world prices.

### **3. STAGE II: WORLD MARKET**

Let us develop the complete general model. We start with the world market decisions. In Stage II, Governments of different exporting countries compete in the market. Stage I decision creates a ceiling for each country exports; this ceiling is equal to the excess supply plus the carrying over stocks. We assume that the rest of countries -net importers- generate a world excess demand defined by:

#### **ASSUMPTION 2: WORLD EXCESS DEMAND FUNCTION**

The world excess demand function including demand from all net importers can be written as:

$$P_w = f(X) \quad \text{with} \quad f'(X) < 0$$

### ASSUMPTION 3: A SELLER'S WORLD MARKET

World Demand is competitive, while supply is an oligopoly represented by a general conjectural variations oligopoly. Total transportation cost is a linear function of total exports:  $CTX_i = c_{x_i} \cdot x_i$

In Stage II each Government has an excess supply created by its own price decision in Stage I. Exporting to the world market does not add any production costs to the exporting country since Government will purchase the excess supply anyway from Assumption 1. The only relevant marginal exporting cost for Government is transportation cost.

Exporting decisions are made taking into account two only elements: Income from world market exports ( $P_w \cdot x_i$ ) and transportation costs linked to exports ( $CTX_i(x_i)$ ). Government tries to maximize export earnings:

$$\underset{x_i}{\text{Max}} \quad EE_i = P_w \cdot x_i - CTX_i(x_i) \quad \text{s.t.} \quad x_i < ES_i^* \quad (1)$$

Whenever the restriction is not binding, this market is just a standard oligopoly. The indirect objective function when restriction is not binding is calculated in the next lines.

First order condition is:

$$P_w - c_{x_i} + x_i \cdot f'(X) \cdot \left[ \frac{\partial X}{\partial x_i} \right]^e = 0 \Rightarrow x_i = - \frac{P_w - c_{x_i}}{f'(X) \cdot (\partial X / \partial x_i)^e}$$

$$\lambda_i = \partial \left( \sum_{j=i} x_j \right) / \partial x_i$$

First and second order conditions in terms of conjectural variations can be written as:

$$P_w - c_{x_i} + f' \cdot (1 + \lambda_i) \cdot x_i = 0 \quad (2)$$

$$(1 + \lambda_i) \cdot (2 \cdot f' + f'' \cdot x_i) < 0 \quad (3)$$

Second order condition holds for reasonable conditions on demand (for instance it holds when demand is linear). Exports by each country  $x_i^*$  and equilibrium price  $P_w$  are the solution to an (N+1) equations system given by (2) and Assumption 2.

If the restriction in (1) is binding, export profits will depend on internal policy decisions. If the restriction is not binding, export earnings do not depend on internal policy decisions. The complete indirect objective function depends on excess supply  $ES_i^*$  derived from Stage I:

$$EE_i^* = x_i \cdot (P_w - c_{x_i}) = \begin{cases} x_i^* \cdot [P_w - c_{x_i}] & \text{si } x_i^* \leq ES_i^* \\ ES_i^* \cdot [P_w - c_{x_i}] & \text{si } x_i^* > ES_i^* \end{cases} \quad (4)$$

The discrimination between these two alternative forms of profit function can be done using Proposition 1:

**PROPOSITION 1: NECESSARY AND SUFFICIENT CONDITION FOR OPTIMALLY STORING**

Storing part of the crop would be optimal in Stage II ( $0 < x_i^* < x_i^m$ ) if and only if Government-oligopolist market power (capacity for changing world price) is high enough in elasticity terms:  $\varepsilon_{P_w, x_i}(ES_i^*) > 1$ .

PROOF:

$$\begin{aligned} \text{Max}_{x_i} (P_w^i \cdot x_i) &\Rightarrow P_w^i + \frac{\delta P_w^i}{\delta x_i} \cdot x_i = 0 \Rightarrow x_i^* = -\frac{P_w^i}{\delta P_w^i / \delta x_i} \\ x_i^* < ES_i^* &\Leftrightarrow -\frac{P_w^i}{\delta P_w^i / \delta x_i} < ES_i^* \Leftrightarrow \varepsilon_{P_w, x_i}(ES_i^*) > 1 \end{aligned}$$

Using this result, each of the four groups of net exporters in Table 1 can be classified by the value of the above elasticity. This elasticity represents the perceived power of each country over world prices. We should differentiate two kinds of exporters:

(A) COMPETITIVE FRINGE OF EXPORTERS or "FRINGE":  $\varepsilon_{P_w, x_i}(ES_i^*) \leq 1$

These countries are not able to substantially modify world price. Therefore they export all their excess supply and they accept the corresponding world price. It is like a Competitive Fringe which take advantage of high prices without reducing their exports. The excess demand function in Assumption 2 is calculated subtracting Fringe's supply from world importer's demand.

(B) OLIGOPOLIST EXPORTERS or "OLIGOPOLY":  $\varepsilon_{P_w, x_i}(ES_i^*) > 1$

In this group of powerful enough exporters each country reduces its exports and stores part of its crop. The group as a whole is able to determine the world price, given the excess demand function.

**4. STAGE I: NATIONAL MARKET**

In Stage I (National Market), we assume general demand and supply functions representing the aggregation of the competitive behavior of a large number of consumers and producers:

ASSUMPTION 4: DEMAND FUNCTION IN COUNTRY "i"

The quantity demanded in country "i" is a decreasing function of the national price:

$$q_i^d = q_i^d(p_i) \quad \text{con} \quad \delta q_i^d(p_i) / \delta p_i < 0$$

ASSUMPTION 5: SUPPLY FUNCTION IN COUNTRY "i"

The quantity supplied in country "i" is an increasing function of the national price:

$$q_i^s = q_i^s(p_i) \quad \text{con} \quad \delta q_i^s(p_i) / \delta p_i > 0$$



Additionally we define the behavior of the Government using a Political Preference Function approach:

**ASSUMPTION 6: GOVERNMENT'S BEHAVIOR**

Government's internal price policy follows Assumption 1 and tries to maximize a weighted sum of producer's surplus, consumer's surplus and tax payer's loss. Weights are called respectively  $\alpha, \beta, \gamma$  :

$$\text{Max}_{p_i} PPF_i(p_i, x_i) = \alpha \cdot EP_i + \beta \cdot EC_i - \gamma \cdot BC_i \quad (5)$$

Let  $P_i^e$  be the price which gives zero excess supply:  $q_i^s(p_i^e) = q_i^d(p_i^e)$ . In Figure 1 we have a graphical representation of the areas corresponding to the welfare of each of these three groups:

Insert Figure 1

$$EP_i(p_i) = \int_{P_i^{\text{min}}}^{P_i} q_i^s(p_i) \cdot dp_i$$

1. Producer Surplus:

$$EC_i(p_i) = \int_{P_i}^{P_i^{\text{max}}} q_i^d(p_i) \cdot dp_i$$

2. Consumer Surplus:

$$3. \text{ Budget Costs: } BC_i(p_i) = p_i \cdot (q_i^s(p_i) - q_i^d(p_i)) - EE_i$$

Export profits  $E_i$  may reduce the Budget costs, but they cannot be represented in Figure 1. Producer Surplus is measured through its Profit Function. Changes in the representative producer' profits induced by a change in national price can be obtained using Hotelling's Lemma. The derivative of the Indirect Profit Function is just the marshallian supply function:

$$\frac{\delta EP_i(p_i)}{\delta p_i} = q_i^s(p_i) > 0 \quad \text{with} \quad \frac{\delta^2 EP_i(p_i)}{\delta p_i^2} = \frac{\delta q_i^s(p_i)}{\delta p_i} > 0 \quad (6)$$

That is,  $EP_i(p_i)$  is an increasing and convex function.

Consumer Surplus may be measured by the Expenditure Function. This function represents the change in consumer's income required to maintain the utility level of the representative consumer. Using Shephard's Lemma:

$$\frac{\delta EC_i(p_i)}{\delta p_i} = -q_i^d(p_i) < 0 \quad \text{con} \quad \frac{\delta^2 EC_i(p_i)}{\delta p_i^2} = -\frac{\delta q_i^d(p_i)}{\delta p_i} > 0 \quad (7)$$

That is, the function  $EC_i(p_i)$  is decreasing and convex.

Changes in Budget Costs can be written as:

$$\frac{\delta BC_i}{\delta p_i} = p_i \cdot \left[ \frac{\delta q_i^s}{\delta p_i} - \frac{\delta q_i^d}{\delta p_i} \right] + (q_i^s - q_i^d) - \frac{\delta EE_i}{\delta p_i} = \begin{cases} p_i \cdot \left[ \frac{\delta q_i^s}{\delta p_i} - \frac{\delta q_i^d}{\delta p_i} \right] + (q_i^s - q_i^d) & \text{if } x_i^* < ES_i \\ (p_i - P_w^i) \cdot \left[ \frac{\delta q_i^s}{\delta p_i} - \frac{\delta q_i^d}{\delta p_i} \right] + (q_i^s - q_i^d) \cdot \left[ 1 - \frac{\delta P_w}{\delta p_i} \right] & \text{if } x_i^* \geq ES_i \end{cases}$$

The sign of this derivative is:

$$\text{if } x_i^* < ES_i^*, \text{ then: } \frac{\delta BC_i}{\delta p_i} \begin{cases} > 0 & \text{if } p_i \geq p_i^e \\ > / < / = 0 & \text{if } p_i < p_i^e \end{cases}$$

$$\text{if } x_i^* \geq ES_i^*, \text{ then: } \frac{\delta BC_i}{\delta p_i} \begin{cases} > 0 & \text{if } p_i > \max(p_i^e, P_w^i) \\ < 0 & \text{if } p_i < \min(p_i^e, P_w^i) \\ > / < / = 0 & \text{if } p_i \in [\min(p_i^e, P_w^i), \max(p_i^e, P_w^i)] \end{cases} \quad (8)$$

And the second derivative is:

$$\frac{\delta^2 BC_i}{\delta p_i^2} = 2 \cdot \left[ \frac{\delta^2 q_i^s}{\delta p_i^2} - \frac{\delta^2 q_i^d}{\delta p_i^2} \right] + p_i \cdot \left[ \frac{\delta^2 q_i^s}{\delta p_i^2} - \frac{\delta^2 q_i^d}{\delta p_i^2} \right] - \frac{\delta^2 EE_i}{\delta p_i^2} \quad (9)$$

We will assume that the sign of this expression is positive; if it were not positive, the objective function could not be concave since both consumer and producer surpluses are convex, and therefore first order condition would describe a minimum, not a maximum.

Using the results above we can derive the first order condition for program (10). This condition may be written as (we assume second order condition holds):

$$\alpha \cdot q_i^s - \beta \cdot q_i^d - \gamma \cdot \left\{ (q_i^s - q_i^d) + \left[ \frac{\delta q_i^s}{\delta p_i} - \frac{\delta q_i^d}{\delta p_i} \right] \cdot p_i \right\} = 0 \quad \text{if } x_i^* < ES_i^* \Leftrightarrow \varepsilon_{p, x_i} > 1$$

$$\alpha \cdot q_i^s - \beta \cdot q_i^d - \gamma \cdot \left\{ (q_i^s - q_i^d) + \left[ \frac{\delta q_i^s}{\delta p_i} - \frac{\delta q_i^d}{\delta p_i} \right] \cdot \left[ p_i - P_w^i - \frac{\delta P_w}{\delta x_i} \cdot (q_i^s - q_i^d) \right] \right\} = 0$$

$$\text{if } x_i^* \geq ES_i^* \Leftrightarrow \varepsilon_{p, x_i} \leq 1 \quad (10)$$

## 5. NECESSARY CONDITIONS FOR OPTIMALLY STORING AND EXPORT SUBSIDIZING

### 5.1. Bias in Government Preferences.

**PROPOSITION 2 (Stage I):** *Government indifference is not compatible with either subsidizing exports or storing part of the crop.*

*In the context of an oligopoly defined in Assumptions 1 to 6, a Government with no preference among neither of the three groups of agents (producers, consumers and tax-payers) ( $\alpha = \beta = \gamma$ ) will never have an optimal policy leading to a net exporter position with:*

1. an export subsidy, or / and
2. a storage of part of the crop.

PROOF:

Let us assume with no loss of generality that the weights given to the three groups of agents are equal to unity:  $\alpha = \beta = \gamma = 1$ . Under this assumption we analyze the first order condition (15) for each of three net exporter cases:

**Case 1:**  $E_{p_i, \lambda} = 0$

$$\text{First order condition is: } -\left[ \frac{\partial q_i^s}{\partial p_i} - \frac{\partial q_i^d}{\partial p_i} \right] \cdot (P_w - p_i) = 0 \Rightarrow p_i^* = P_w$$

$$\text{Second order condition is: } -\left[ \frac{\partial q_i^s}{\partial p_i} - \frac{\partial q_i^d}{\partial p_i} \right] + (P_w - p_i) \cdot \left[ \frac{\partial^2 q_i^s}{\partial p_i^2} - \frac{\partial^2 q_i^d}{\partial p_i^2} \right] < 0$$

This last condition holds when internal price is the optimal one  $p_i^* = P_w$ . When there is no market power and Government is indifferent among groups, optimal internal price is just the world price and, therefore, an export subsidy would never be optimal.

**Case 2:**  $E_{p_i, \lambda} \in (0, 1)$

$$\text{First Order Condition is: } -\left[ \frac{\partial q_i^s}{\partial p_i} - \frac{\partial q_i^d}{\partial p_i} \right] \cdot (p_i - P_w) + \frac{\partial P_w}{\partial x_i} \cdot (q_i^s - q_i^d) \cdot \left[ \frac{\partial q_i^s}{\partial p_i} - \frac{\partial q_i^d}{\partial p_i} \right] = 0$$

The first term in this expression is negative if the internal price is above world price, and positive if it is below; the second term is negative if the internal price is above equilibrium price  $p_i^e$ , and positive if it is below. Only when internal price is between world price and internal equilibrium price these two terms will have opposite signs and could sum zero. If second order condition holds, the first order condition will define the maximum. Optimal position for the Government will be one of the following:

1.  $p_i^e < p_i^* < P_w$  Country "i" is a net exporter taxing its exports.
2.  $P_w < p_i^* < p_i^e$  Country "i" is a net importer taxing its imports.

Therefore an export subsidy would never be optimal in this case.

**Case 3:**  $E_{p_i, \lambda} \geq 1$

$$\text{First order condition is: } -\left[ \frac{\partial q_i^s}{\partial p_i} - \frac{\partial q_i^d}{\partial p_i} \right] \cdot p_i = 0$$

This condition does not hold for any positive value of the price. Whenever price power is so high ( $\varepsilon_{p,\lambda} \geq 1$ ) indifferent Government will always have an incentive to reduce the internal price and excess supply, which reduces price power in elasticity terms. Optimal price could never lead to such a price power  $\varepsilon_{p,\lambda} \geq 1$ , which is required for optimal storing (see Proposition 1).

The existence of a bias in the preferences of Government (for instance, a bias in favor of producers) is required in order to obtain an optimum with an export subsidy and / or with some storing; bias towards producers is a necessary condition to be an active oligopolist. The incompatibility between Government group indifference and export subsidies is due to the fact that national market is assumed competitive.

## 5.2. Market Power.

It is not possible to obtain an analogous proposition about the incompatibility between lack of market power and the same two properties of the optimum. But from Proposition 1 we know that lack of power is not compatible with optimal storing. However, export subsidies are compatible with lack of price power in the world market; this can be proved with an example: a lineal model with rigid supply and  $\alpha = 1$ . In this case second order condition holds for any value of the internal price. If additionally the world price power is zero, first order condition (10) can be written as:

$$q_i^s \cdot (\alpha - 1) + (p_i - P_w) \cdot \frac{\delta q_i^d}{\delta p_i} = 0 \Rightarrow p_i^* = \frac{(\alpha - 1) \cdot q_i^s}{-\delta q_i^d / \delta p_i} + P_w$$

This optimal price can be computed for any  $\alpha \geq 1$ . If  $\alpha = 1$  optimal price will be equal to world price. If  $\alpha > 1$  there is some bias towards producers and the optimal internal price will be higher than world price; the difference is linearly increasing in the value of  $\alpha$ . Government will subsidize exports if the bias towards producers  $\alpha$  is high enough; moreover, country "i" may change from net importer to net exporter if  $\alpha$  shifts up.

## 6. COMPARATIVE STATICS

In order to obtain comparative statics results about the optimal internal price in each country we apply Implicit Function Theorem to the first order condition (10). For any exogenous parameter "k" we know:

$$\frac{\delta p_i^*}{\delta k} = - \frac{\delta(10) / \delta k}{\delta(10) / \delta p_i} \Leftrightarrow \text{sign}\left(\frac{\delta p_i^*}{\delta k}\right) = \text{sign}(\delta(10) / \delta k)$$

since  $\delta(10) / \delta p_i < 0$  is just the second order condition. Deriving expression (10) we can easily sign the comparative statics. Table 2 presents some of these results for an exporting country. An analogous table could be obtained for an importing country.

*Insert Table 2*

Let us underline the following results:

1. World price is an exogenous parameter only when country "i" has no power to change world prices. The effect of the world price on the optimal internal price is positive in both exporter and importer. Exports by an exporting country are increasing in the world price, while imports by importing country are decreasing in the world price. This result guarantees a decreasing demand function whenever there is at least one competitive importer.

2. In an exporting country with high enough power ( $\varepsilon_{P_w, X} \geq 1$ ), a marginal increase in this market power measured by  $|\delta P_w / \delta x_i|$  will have no marginal effect on the optimal internal price. However in the alternative case of small or null price power ( $0 \leq \varepsilon_{P_w, X} < 1$ ), increasing this power will lead to a fall in internal price and exports. On the other hand, market power increases net exports of an importing country, that is, it reduces imports. Therefore market power  $|\delta P_w / \delta x_i|$  is a break for international trade from both supply and demand sides; but an increase on price power will never change a net importer into a net exporter since its effect will be null when net exports become zero.
3. Parameter weighting producer surplus has always a positive effect on the optimal internal price, while has a negative effect: the interests of producers and consumers are always in conflict.
4. The effects of parameter depends on internal and external effects of different signs. In a net exporter with an internal price above world price the effect will be negative; in a net importer with an internal price below world price, the effect will be positive. In any other case the sign is not determined.
5. When internal supply is rigid, increases in production have two opposite effects: a positive one due to increases in the producer surplus, and a negative one due to higher budget costs. If there is no price power, or if price power is high enough ( $\varepsilon_{P_w, X} > 1$ ), the positive effect on the producer is dominant; otherwise the sign is ambiguous.
6. The effect of both internal elasticities (demand and supply) has always equal sign which depends on the combination of internal and external effect; in the table the variable used is not the elasticity but the slope of supply. The internal effect is negative: a higher elasticity makes higher the marginal budget cost of a higher internal price, and therefore it reduces the optimal internal price. External effect is positive: a higher elasticity makes higher the marginal income from exports, which creates an incentive for a higher internal price. In an exporting country with high market power ( $\varepsilon_{P_w, X} > 1$ ) or with an internal price above world price, the negative internal effect will be dominant; in an exporting country with no market power and with an internal price below world price, positive external effect will be dominant; otherwise the effect in an exporting country will be ambiguous.

### 6.1. How does optimal storing begin?

An active participation in the oligopoly requires that country "i" stores part of its production. Proposition 1 proves that this storage will be optimal only if world price power is high enough:  $\varepsilon_{P_w, X} > 1$ . This condition maybe written as:

$$\varepsilon_{P_w, X} (ES_i^*) = \left[ \frac{-\frac{\delta P_w}{\delta x_i} \cdot \frac{\delta X}{\delta x_i}}{\frac{\delta Y}{\delta x_i} - \frac{\delta c_x}{\delta x_i}} \right] \cdot \frac{ES_i^*}{P_w - c_x} = e \cdot \frac{ES_i^*(P_i^*)}{P_w - c_x} > 1$$

$-e > 0$

Excess supply is a monotonous increasing function of internal price. World price is a non-increasing function of internal price. Therefore, this elasticity is a monotonous increasing function of internal price.

Shifts in some parameters may lead country "i" to have enough price power to be an "active" oligopolist that makes some storage:

1. Changes in the internal market or in Government preferences which may increase the optimal internal price and excess supply. For instance, an increase in Government preference for producers ; however the value of

has a ceiling determined by the second order condition.

2. Increases in the rigidity of demand or price power of Government  $i$ , both represented by parameter " $e$ ".

3. Reductions in the degree of collusion, leading to falls in world price. Country " $i$ " has two alternatives: 1) exporting the whole excess supply becoming part of the competitive fringe; and 2) exporting below its maximum in order to push for a higher price (active oligopoly). The competitive fringe members behave as *free riders*: they can export at higher prices without contributing to achieve them. The lower the oligopoly price, the lower the incentive to free ride.

5. Increases in the transportation marginal costs which reduce optimal exports: the most inefficient countries have more incentive to participate in the oligopoly.

*Insert Figure 2*

$$\left| \frac{\Delta P_w}{\Delta x_i} \right| = e$$

The two key variables in determining oligopoly participation are: the power to change world price ( $\left| \frac{\Delta P_w}{\Delta x_i} \right|$ ) and the preference towards producers. If these two parameters have high enough values, country " $i$ " will participate in the oligopoly; the only limit is determined by the second order condition. Figure 2 presents the values of these two parameters corresponding to oligopoly and competitive fringe assuming all other parameters remain constant. The decreasing line " $\varepsilon = 1$ " represents the values above which country " $i$ " would be an active oligopolist. There are two necessary conditions in order to be an oligopolist: some Government bias for producers' welfare ( $\alpha > 1$ ) and some capacity to change world price ( $e > 0$ ). But they are not sufficient conditions; reduced values of both parameters will bring country " $i$ " into the competitive fringe. The line " $\alpha_{max}$ " represents the second order condition when demand and supply are lineal; all the values above this line guaranty that second order condition holds.

Changing from the fringe into the oligopoly may happen when price power or / and government bias grow enough. It could even happen if one of these parameters increase enough to compensate a reduction in the other one.

## 6.2. When export subsidy is optimal?

Export subsidy will be optimal whenever  $P_i^* > P_w^j$ ; the minimum preference required for export subsidy to be optimal is smaller, the smaller the market power; this positive relationship has a kink at  $\varepsilon_{P_w} = 1$  (see Figure 2). Changing from taxing exports to subsidizing them may happen when there is an increase in Government bias or a fall in price power. We can identify four different areas in Figure 2, combining oligopoly / fringe and tax / subsidy behaviors.

## 7. SOME QUICK RESULTS ON THE WORLD WHEAT MARKET

Wheat is doubtless one of the main CAP products. Assumptions of the model developed in previous sections fit in quite well not only with European Union's CAP, but also with US, Canada and Australia's wheat policies; they does not fit in with the other main wheat exporter's policy -Argentina- which follows no price isolation policy and, therefore, it behaves as a member of the competitive fringe. A reasonable estimation of the residual demand for the oligopoly of four is (OLS log-lineal estimation):

$$G4NEXP = -7.1 - 0.26 \cdot P_{EXP} + 0.49 \cdot E - 0.94 \cdot PROD_{ROW} - 0.74 \cdot PROD_{RU} \\ + 2.71 \cdot CON_{ROW} + 0.32 \cdot TEXP_{IDC} - 0.24 \cdot D9194$$

We can use this estimation of demand elasticity ( $\varepsilon = 0.24$  ; Standar Error = 0.096) to estimate each country's behavior during the sample period. We do so selecting a relevant price-freight margin for each exporter and using their respective export shares. From the formula:

$$s_i = \frac{P - c_{x_i}}{P} \cdot \frac{1}{1 + \lambda_i} \cdot \varepsilon$$

we obtain the estimated behavior in the form of a conjectural variation  $\lambda_i$ . These values are represented in Figure 3.

*Insert Figure 3.*

It is evident that the main change of behavior during the sample period corresponds to the European Union (it is also the only statistically significant change). However since 1989 it seems to have stabilized; this change towards a less collusive behavior affects the perceived price power of the EU, which is reduced. Comparative statics have shown us that this change could never lead to an elimination of export subsidies; it could eliminate the stock storing of the EU, but not its optimal subsidy (see Figure 2).

We could try to use this wheat results as an interpretation of last CAP reform and the agricultural agreement in the framework of GATT -assuming the role of wheat was determinant in both cases-. If these reforms have been originated by a more competitive behavior of the EU -with a quite stable aggregate oligopoly margin- and they are not a result of a reduction in EU Commission's preference bias towards agricultural producers, the European Union will have no incentive to eliminate its export subsidies. If that is the case, the reforms will just lead to a reorientation of subsidies from prices to income; world prices may not be affected while exporter's stocks may be reduced. Further empirical research in this direction would require to use revealed preference techniques to estimate Commission's preferences towards producers.

## **8. CONCLUSIONS**

This article underlines some interactions between internal and world market in the case of an homogenous commodity with price-intervened national markets. The nature of this intervention (Assumption 1) is inspired by the general mechanism of the Common Agricultural Policy in the European Union. We can enumerate the following conclusions:

- (1) **Persistent "low" prices in the world market are compatible with the existence of market power.** Under internal price isolation in Assumption 1, production costs are opaque for international trade and they have no relevant influence in export marginal costs. The relevant marginal cost in the world market is equal to transportation cost. Therefore world price can be low with respect to production costs.
- (2) In this context, **there are two key determinants of world market position for each country: the perceived price power and Government preference towards producers.**
- (3) **An exporter which: a) subsidizes its exports and b) stores part of its production, should have: 1) some preference bias towards producers and 2) some market power.** Observing a) and b) necessarily means the existence of 1) and 2):

$$a) \Rightarrow 1); \quad b) \Rightarrow 1); \quad \text{y} \quad b) \Rightarrow 2).$$

- (4) **The existence of market power is not a sufficient condition to actively participate in the world market oligopoly.** Perceived capacity to change world price should be high enough in elasticity terms:  $\varepsilon_{P, \lambda} > 1$

(5) **Bias towards producers' welfare, "", is the only parameter with an unambiguous positive effect on optimal internal price.** Additionally, changes in may transform an importer into an exporter, a member of the fringe into an active oligopolist and an export tax into an export subsidy.

(6) Increases in world price power reduces both importer's imports and exporter's exports: **market power is a break for international trade.** Increases in price power cannot transform an importer into exporter, but they can transform a fringe member into oligopolist and, for a small price power, an export subsidy into an export tax.

(7) **Internal policies have great influence in the structure of international trade flows,** not only in export shares determination, but also in determining which countries export and which import. **Government preferences are much more important than production efficiency.** That is why distorting effects of these policies can be enormous.

(8) **The model fits in with world wheat market.** Estimated EU exporter behavior in this market using price-freight margins shows clearly that EU's price power has decreased in the last years. This change alone will not lead to eliminate export subsidies. This kind of empirical results may help to make a true interpretation of the scope of both CAP reform and new GATT agreement.

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**TABLES**

**TABLE 1: CLASSIFICATION OF COUNTRIES BY  
GOVERNMENT'S BIAS AND RELATIVE PRICE**

Relative Price		$p_i^e > P_w$		$p_i^e < P_w$
National/World :		"NATURAL" IMPORTER		"NATURAL" EXPORTER
Government Bias :				
$p_i^* > P_w$	PRODUCER	<u>1la</u> : $p_i^* < p_i^e$	<u>1lb</u> : $p_i^* > p_i^e$	<u>1E</u> :
Export Subsidy / Import Tax		Reduced Imports	Exports instead of Imports	"Natural" Net Exporter with increased Exports
$p_i^* = P_w$	NO BIAS	<u>2I</u> : "Natural" and Actual Net Importer		<u>2E</u> : "Natural" and Actual Net Exporter

$p_i^* < P_w$						
Export Tax	CONSUMER / TAX-PAYER	3I: "Natural" Net Importer with increased Imports	3Ea: $p_i^* < p_i^e$	3Eb: $p_i^* > p_i^e$		
/ Import					Imports instead of Exports	Reduced Exports
Subsidy						

TABLE 2: COMPARATIVE STATICS OF AN EXPORTER'S OPTIMAL PRICE:

		Sign of $\frac{\delta p_i^*}{\delta k}$						
		World Market		Government Preferences			National Market	
	K=	$\left  \frac{\delta P_w}{\delta x_i} \right $	$P_w$				$\left  \frac{\delta q_i^s}{\delta p_i} \right $	$q_i^s$
$\varepsilon_{P_w, x_i} = 0$	Subsidy	-	+	+	-	-	-	+
	Tax	-	+	+	-	-/+	+	+
$\varepsilon_{P_w, x_i} \in (0, 1)$	Subsidy	-		+	-	-	-	-/+
	Tax	-		+	-	-/+	-/+	-/+
$\varepsilon_{P_w, x_i} \geq 1$	Subsidy	0		+	-	-	-	+
	Tax	0		+	-	-	-	+

FIGURES

FIGURE 1

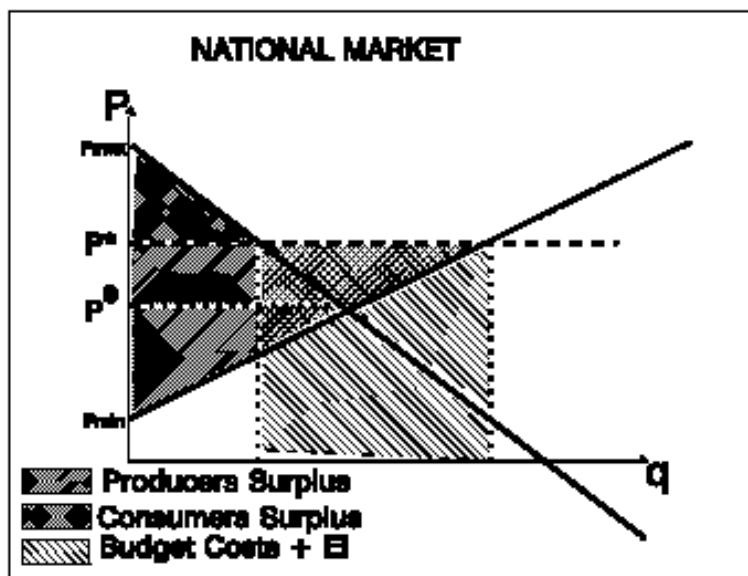


FIGURE 2

### FRINGE vs OLIGOPOLIST / TAX vs SUBSIDY

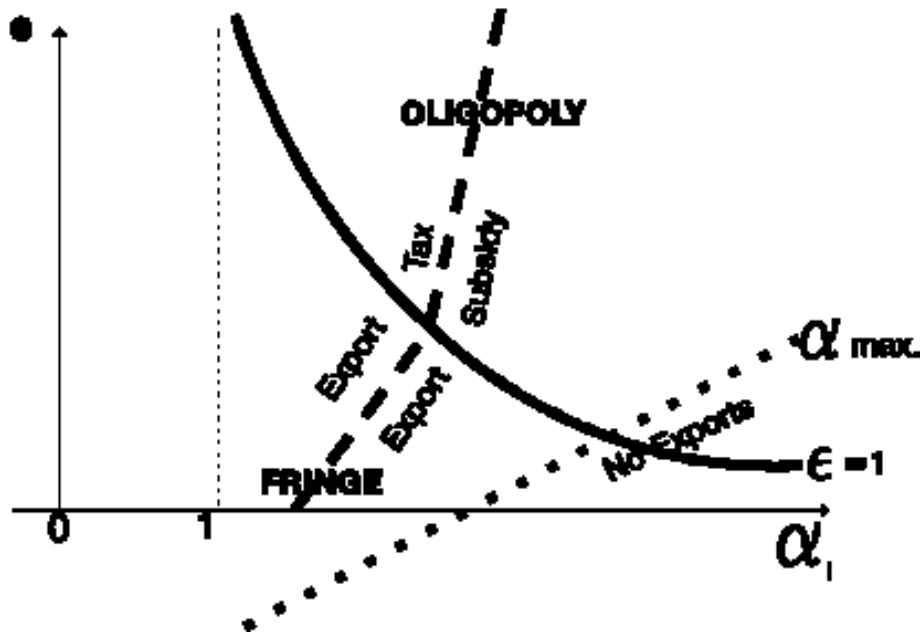


FIGURE 3

### Estimated Degree of Collusion (log scale)

