

Export Subsidies and Switching Costs in an Imperfectly Competitive International Wheat Market

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Abstract

Switching costs affect importer decisions, hence impacts of subsidies over time. Dynamic, game-theoretic simulations of EU-US competition for Moroccan wheat imports suggest firms charge lower prices and governments award higher subsidies with switching costs. Switching costs do not make unilateral elimination of subsidies more attractive due to aggressive behavior of rivals.

Introduction

The European Union (EU) and the United States (U.S.) are two noncooperatively behaving “super-powers” in the international wheat market, whose actions in the market have an influence on each other’s agricultural policies as well as on world market prices (Johnson, Mahe and Roe). The most significant strategic variable have been export subsidies, reflecting the producer bias of trade policy (Abbott and Kallio). Some evidence has been provided that firm level price competition is oligopolistic (imperfect) in nature, as well (McNally; Patterson and Abbott).

Several factors affect an importing country’s purchasing decisions. Price is often the most important factor. However, it is seldom observed that an importing country purchases all of its wheat from the least expensive supplier, as is suggested by traditional spatial equilibrium models (Thompson). Another important factor is quality, requiring a model of product differentiation capturing demand by origin (e.g., an Armington model, Grennes, Thursby and Johnson).

An additional group of factors that affects an importing country’s purchasing decisions is *switching costs* (Klemperer). These costs of switching from one wheat exporter to another, which are borne by the importing country, might exist for many reasons. An importer incurs costs when negotiating a contract or agreement with a supplier, and these transactions costs with a new exporter may be higher than with an existing exporter. Another category is learning costs. There is more risk involved when buying from a new, unfamiliar source than when buying from an existing supplier. There also might exist political costs of switching between exporters. One would expect products supplied by

political allies to be viewed differently from others. In addition, guaranteed credit programs and government relationships can induce switching costs.

In a multi-period framework with switching costs exporting countries in each period face a tradeoff. They can either exploit their current market shares with higher prices and lower export subsidies or compete for larger market shares with lower prices and larger subsidies. The optimal design of an export subsidy and hence a program such as the Export Enhancement Program (EEP) is, therefore, dependent on the nature and magnitude of switching costs.

Armington-type trade models differentiate commodities according to country of origin exhibiting more realistic changes in trade shares than traditional spatial equilibrium models, but they are static. Effects of switching costs, on the other hand, are dynamic in nature.

Game-theoretic models have been used to incorporate strategic interaction into agricultural trade models (e.g., Paarlberg and Abbott; Thursby and Thursby). The most commonly used approach has been conjectural variations, which has been criticized (e.g., Tirole) as an ad hoc way to model dynamic features in a static framework. So far, a very limited number of truly dynamic, game theoretic agricultural trade models exist (e.g., Karp and McCalla; McNally), and none of them have employed the switching cost approach.

This study utilizes a dynamic, game theoretic model of international wheat trade that incorporates strategic interaction among players, and simultaneously captures impacts of switching costs on players' strategies. A multi-period model of oligopolistic competition with differentiated products and switching costs is constructed. This model incorporates into the multi-period framework of Beggs and Klemperer notion of switching costs

developed by Sapir and Sekkat, rather than Klemperer's approach which was applied by To in a static international framework.

The best markets in which to observe consequences of the strategic interaction between the EU and U.S. are the North African importers, traditional buyers of French wheat. This is because these markets have been the largest targets of the EEP. In our case study we concentrate on Moroccan wheat imports. From 1980/81 through 1993/94 over 95 percent of Moroccan wheat imports have been either from the U.S. or the EU (International Grain Council).

Importing countries do not view wheat from different sources as qualitatively identical products. Moroccan buyers find EU wheat to have lower protein content and higher moisture content than U.S. wheat. These qualitative differences have an impact on how much wheat importing countries decide to purchase from each source (Ackerman). Furthermore, support exists for the fact that wheat importers may experience some costs of switching from one supplier to another. Wilson, Koo, Carter and Tedros used a Markov model to study import loyalty in international wheat markets. They found that brand loyalty in international wheat markets exists, and the U.S. as wheat exporter seems to enjoy greater brand loyalty than the EU. Therefore, a case study is implemented here using our model to simulate U.S.-EU competition for Moroccan wheat imports, and so examine implications for the EEP.

A Multi-period International Wheat Trade Model with Switching Cost

A third-market model limited to two exporters, the U.S. and the EU, and one importer, Morocco is developed and implemented here. In each exporting country there are two players: the government and the aggregate firm. In each period ($t=1,2,\dots,T$), the governments simultaneously choose export subsidies (taxes if negative), S_t^i , to maximize their discounted future domestic welfare (export revenues less export subsidy expenditures), given the history of the game and expected behavior of the firms and the importing country in the future. After that, firms in both exporting countries simultaneously choose prices, P_t^i , to maximize discounted future profits, given government subsidies and the history of the game. Because of switching costs, the importing country's behavior depends on previous purchases of the good from a specific country. Therefore, governments' and firms' decisions in one period also have effects into the future.

The decisions of both firms and governments are appropriately analyzed as a difference game. We restrict ourselves to analyzing feedback strategies in which the past influences current decisions only through its effect on a current state vector that summarizes the direct effect of the past on the current environment. We look for a Markov perfect (feedback) equilibrium, i.e. a profile of Markov strategies that yields a Nash equilibrium in every proper subgame.

Importing country behavior

In the Moroccan wheat market foreign trade of wheat has been handled through the parastatal agency, the Office National Interprofessionnel des Céréales et Légumineuses

(ONICL). This parastatal agency also decides how much to buy from each origin. Therefore, it can be seen as a single representative consumer. Although the ONICL handles foreign trade of wheat in Morocco, it is assumed to be small relative to the total international wheat market.

In a period t , the Moroccan demand for wheat from exporting country i is described by an import demand function $M_t^i = M_t^i(P_t^i, P_t^k)$, where $i, k = US, EU$, and $i \neq k$, derived from the importing country's utility maximization problem. Following Sapir and Sekkat the aggregate utility function is assumed to be quasilinear:

$$(1) \quad u_t(Q_0, M_t^i, M_t^k) = Q_0 + \alpha^i M_t^i + \alpha^k M_t^k - \frac{1}{2}(\beta^i (M_t^i)^2 + \beta^k (M_t^k)^2 + 2\gamma M_t^i M_t^k)$$

such that $Q_0 + (P_t^i - \eta^i M_{t-1}^i)M_t^i + (P_t^k - \eta^k M_{t-1}^k)M_t^k = \text{income}$,

where Q_0 is aggregate consumption of a numeraire good.

Switching costs are captured by the terms $\eta^i M_{t-1}^i$ and $\eta^k M_{t-1}^k$, where η^i and η^k are marginal switching cost parameters. The idea of switching costs is that larger values for η^i or M_{t-1}^i make costs of purchasing again from exporter i smaller, so the importing country is less willing to switch to exporter k 's wheat.

Then an import demand function for exporting country i 's wheat is

$$(2) \quad M_t^i = a^i - b^i (P_t^i - \eta^i M_{t-1}^i) + e (P_t^k - \eta^k M_{t-1}^k),$$

where $a^i = \frac{\alpha^i \beta^k - \alpha^k \beta^i}{\beta^i \beta^k - \gamma^2}$, $b^i = \frac{\beta^k}{\beta^i \beta^k - \gamma^2}$, $e = \frac{\gamma}{\beta^i \beta^k - \gamma^2}$ and $b^i b^k - e^2 > 0$.

The Exporting Firm's Problem

In each period each firm incurs marginal cost C_t^i per unit and no fixed costs. In the general t th period, each firm aims to maximize its total discounted future profits by choosing period t prices given the current state and knowing how its choice will affect decisions and profits in the future. Firm i 's total future discounted profits are:

$$(3) \quad \Pi_t^i = \pi_t^i + \delta \Pi_{t+1}^i(M_t^i, M_t^k),$$

in which its value function from period $t+1$, Π_{t+1}^i , will depend on period t exports. Firms and governments both have the same discount factor δ .

Rearranging the first-order condition, we get firm i 's best-response function. The intersection point of the two firms' best-response functions gives equilibrium prices as a linear function of the current state (period t export subsidies and period $t-1$ export volumes)

$$(4) \quad P_t^i = K_t^{i0} + K_t^{i1} S_t^i + K_t^{i2} S_t^k + K_t^{i3} M_{t-1}^i + K_t^{i4} M_{t-1}^k$$

where K_t^{ij} , $j=0,1,2,3,4$, are functions of import demand function parameters, of opportunity cost of public funds parameters (explained in the next section), of marginal costs, and of a discount factor. By substituting (4) and the same equation for firm k into the import demand function we achieve period t equilibrium exports of country i

$$(5) \quad M_t^i = D_t^{i0} + D_t^{i1} S_t^i + D_t^{i2} S_t^k + D_t^{i3} M_{t-1}^i + D_t^{i4} M_{t-1}^k.$$

We have now completed the second stage of the period t solution process. So far, firms' price rules have been solved treating the export subsidies of both governments and previous period export volumes as exogenous to firms' profit maximization problem. To

solve for governments' export subsidy rules we need to look at the government's optimization problem.

The Exporting Government's Problem

Governments maximize their countries' discounted welfare starting from period t given previous period exports and given that they know how firms and the importing country will behave in the future. Domestic welfare is measured by total export revenues less expenditures on export subsidies. In practice each dollar spent by the government is raised through distortionary taxes (labor, capital, and excise taxes) and costs to society is more than \$1. We now write the i th government's discounted welfare function as

$$(6) \quad W_t^i = w_t^i + \delta W_{t+1}^i(M_t^i, M_t^k) = (P_t^i - (\mu^i - 1)S_t^i)M_t^i + \delta W_{t+1}^i(M_t^i, M_t^k),$$

where μ^i is the opportunity cost of public funds (Neary).

Using first-order conditions for government i and government k and computing the intersection yields period t export subsidies (taxes if negative) as a linear function of the current state:

$$(7) \quad S_t^i = H_t^{i0} + H_t^{i1} M_{t-1}^i + H_t^{i2} M_{t-1}^k,$$

where H_t^{ij} , $j=0,1,2$, are functions of import demand function parameters, of opportunity cost of public funds parameters, of marginal costs, and of the discount factor. Substituting (7) into (4) and (5) yields t th period prices and export volumes as linear functions of previous period export volumes. Finally, this allows us to compute government i 's and firm i 's objective functions as functions of previous period export volumes.

This completes our solution procedure for period t . By backward induction we have solved the price rules for firm i and k as well as export subsidy rules for governments i and k . To get the solution for the whole dynamic game we need to repeat this procedure starting at terminal period T and moving backwards to period 1 . After all of the rules are found for each time period, the system is solved forward one period at a time given initial export volumes (M_0^i and M_0^k) to find equilibrium paths of prices, subsidies, export volumes and other variables.

Empirical Implementation of the Model

Parameter values of Moroccan import demand functions for EU and U.S. wheat were econometrically estimated. Results, along with greater detail on this model, are available in Kallio. Monthly data were used because strategic interaction between players in this market happens on a transaction by transaction basis. Annual data would conceal much of the strategic interaction occurring in this market as well as price responsive behavior by the importing country. Another reason for econometric estimation is to analyze the statistical significance of switching cost parameters.

Econometric estimates of import demand functions suggested that switching costs exist in the Moroccan wheat import market and that costs of switching away from U.S. wheat were larger than costs of switching away from EU wheat. Also, this study provided more elastic estimates than previous studies as expected due to use of monthly data.

A combination of monthly producer prices and freight rates for the route US Gulf-Casablanca (EU-Casablanca) were used as a basis for deriving the marginal cost parameter

for the U.S. (EU) exporting firm. The value of discount factor parameter δ used by both exporting firms and governments is 0.99, implying an annual interest rate of about 12.8 percent. Results are not sensitive to the value of δ

The opportunity cost of public funds in the U.S., $\mu^{US} = 1.332$, is from Ballard, Shoven and Whalley. Corresponding studies for the EU do not exist, so we assume that $\mu^{US} = \mu^{EU}$. However, Laffont and Tirole mention that μ is likely to be higher in countries where tax levels are higher. We should expect μ^{EU} to be at least as large as μ^{US} .

Empirical Results

Simulation results in Table 1 explore the consequences of switching costs on export promotion behavior of exporting countries and firms. Three scenarios illustrate outcomes under different values of switching cost parameters: estimated values, no switching costs, and doubled switching costs. (Econometrically estimated values were used in the base solution.) The last two scenarios refer to the cases in which only one exporting country eliminates its export subsidy program (i.e., unilateral reform).

Models were solved for several different time horizons. Results are for a time horizon of 21 periods. Initial period exports are taken from historical data. During the intermediate time periods the model reaches a steady state. Although behaviors of the players at the beginning and at the end of the time range are important theoretical issues, the steady state is the most empirically relevant solution. In each steady-state time period the exporter faces a tradeoff situation in which it can either exploit its current market share with higher

price and lower export subsidy or compete for larger market share with a lower price and higher subsidy. Thus, it describes the most common real world market situation under which players are making their decisions on prices and export subsidies.

Beggs and Klemperer expect firms' incentives to exploit current market share to dominate their incentives to increase market share that could be exploited later, and so lead to higher prices in markets with switching costs than in markets without switching costs. In contrast to Beggs and Klemperer, the results of this study indicate that exporting firms charge lower wheat prices and higher export subsidies are awarded by governments of exporting countries when switching costs are present. Incentives to increase market share that would be exploited later dominate in this model.

Asymmetry in estimated marginal switching cost parameters in favor of U.S. wheat makes the U.S. exporting firm able to earn larger profits and the EU exporting firm to earn smaller profits than without switching costs. With switching costs, the higher per unit export subsidy leads to lower price of U.S. wheat. This makes U.S. wheat more attractive to Morocco, resulting in an increase in U.S. wheat imports to Morocco. Thus, costs from the EEP bonuses may have been underestimated, and incentives exist for larger export subsidies than are suggested in the literature (Abbott, Paarlberg and Sharples).

Switching costs do not make it more attractive for the U.S. to unilaterally eliminate its export subsidy program, however. This is because in a market with switching costs market shares matter more. Even after unilateral elimination of export subsidies by the

Table 1: Impact of Switching Costs on the United States and the European Union.

	Base Solution	No switching costs	Large Switching costs	Unilateral reform by EU	Unilateral reform by U.S.
U.S. price (\$/ton)					
steady state	165.90	177.86	150.65	186.92	180.95
U.S. exports (1000 tons)					
steady state	137.31	102.61	267.27	168.92	105.30
U.S. export subsidy (\$/ton)					
steady state	34.95	29.44	44.40	36.44	0
U.S. welfare (\$million)					
Total discounted future welfare	401.64	328.15	653.03	554.74	363.39
U.S. firm's profits (million)					
Total discounted future profits	184.48	150.91	312.43	295.66	103.70
EU price (\$/ton)					
steady state	179.74	214.11	85.07	223.47	188.21
EU exports (1000 tons)					
steady state	81.56	80.32	39.64	40.01	99.77
EU export subsidy (\$/ton)					
steady state	79.57	64.51	124.93	0	91.44
EU welfare (million)					
Total discounted future welfare	241.80	294.48	54.21	176.61	301.49
EU firm's profits (million)					
Total discounted future profits	109.43	135.43	25.02	27.69	170.01

U.S. the EU continued to aggressively subsidize its wheat exports in order to capture market share. Unilateral elimination of export subsidies by the U.S. would have resulted in a larger decrease in export volumes accompanied by lower prices paid by the importing country than in a market without switching costs.

The results further show that the exporting country and the exporting firm clearly benefit from the increased importer's costs of switching to rival's wheat. Therefore, exporting countries have incentives to exercise trade policies that would help to create switching costs. For example, exporting countries' guaranteed credit programs may be seen as one way to create switching costs, since a loan under guaranteed credit program can only be used to purchase wheat from the country who provides the credit guarantees for that loan.

The empirical model of the Moroccan wheat import market was able to provide some insight into the importance attached to market shares by exporting countries (Gehlhar and Vollrath). If an exporting country is able to increase its market share, this creates additional costs for the importing country (Morocco) to switch away from that exporting country's wheat in the future. Each exporting country and each exporting firm realize this. Therefore, their behaviors are not just driven by maximization of current period welfare (exporting country government) and profits (exporting firm), but also by the desire to increase current market share which could improve future welfare of that exporting country and future profits of the exporting firm. Hence, this provides an intuitive explanation why exporting countries and firms are often concerned with market share in addition to short run welfare and profits.

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