

Imperfect Competition, Trade Policy and Processed Agricultural Products: Some Initial Results

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Abstract

This paper applies some recent developments in international trade theory to processed agricultural product markets. Theoretical results are derived showing that when such markets are characterized by imperfect competition, there may be a case for government intervention in the form of subsidies and tariffs. In order to provide some empirical background, a simulation model is used to assess the level of an optimal tariff on U.S. cheese imports. The implications of this analysis for the liberalization of agricultural trade are also considered.

Introduction

Recent developments in the international economics literature have focused on the impact of imperfect competition in international markets. In particular, a theoretical rationale has been given for the use of protectionist trade policies. The aim of this paper is to explore the relevance of these theoretical developments to agricultural

trade, with specific reference to trade in highly processed agricultural products. Industries in this sector commonly have imperfectly competitive market structures, characterized by high seller concentration, economies of scale and product differentiation.

The paper is outlined as follows: Section 1 presents a theoretical analysis of international trade policy when markets are imperfectly competitive; Section 2 reports the results of a simulation exercise which estimates the level of an optimal tariff for an importing country; Section 3 considers some further implications of this analysis for the liberalization of agricultural trade.

1. Trade Policy and Imperfect Competition

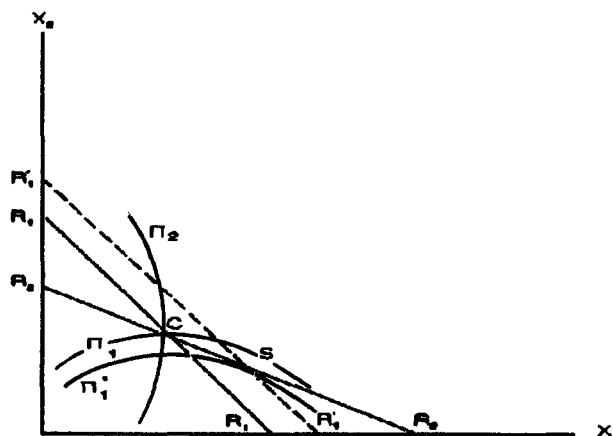
Standard international trade theory provides little first-best justification for the use of import/export taxes and subsidies. However, in recent years, "rent-shifting" arguments for intervention have been developed. The intuition behind such analysis is that where markets are imperfectly

competitive, there is a role for government to use trade policies in order to capture a greater share of supernormal profits; i.e., a country can gain by "shifting" profits away from its foreign competitors to its domestic industry.

Brander and Spencer (1985) initially developed this argument focusing on the strategic interaction between firms in international markets. The underlying assumptions of their model are as follows: there are two firms in an industry based in country 1 and country 2, respectively; there is no domestic consumption of the product, all production being exported to a third country; the firms' interaction in the third country is modeled as a one-period Nash quantity game; i.e., each firm sets output in order to maximize profits, given the output of the other firm; the cost structures of the two firms are identical.

The Brander and Spencer result is best described using a reaction function diagram. In Figure 1, x_1 and x_2 are outputs of firms 1 and 2, respectively; and R_1R_1 and R_2R_2 are the relevant reaction functions, which describe the profit-maximizing levels of output for each firm, given the output of the other firm. In the absence of government intervention, the Nash equilibrium is given at C (i.e. the Cournot equilibrium), with firms 1 and 2 earning profits π_1 and π_2 , respectively. Firm 1 can only attain profits of π'_1 with the aid of government intervention. If government 1 can credibly pre-commit to paying an export subsidy to firm 1, then R_1R_1 can be shifted to $R'_1R'_1$. The new equilibrium at S increases country 1's welfare, since the iso-profit functions can be interpreted as iso-welfare functions. Extending the analysis to trade between the two countries, it is clear that governments also have an incentive to shift profits to their home firms, by using import tariffs.

Figure 1



Recently, Thursby (1988) has applied the Brander and Spencer-type arguments to agricultural trade in third-country markets. The remainder of this section extends Thursby's analysis to the situation where a firm exporting a processed agricultural product competes with domestic producers in an importing country. (For brevity, the full derivations have been excluded; these can be found in McCorrison and Sheldon, 1989).

It is assumed initially that the market structure of a homogeneous processed agricultural product is dominated by monopoly firms in both the importing and exporting countries. Each monopolist purchases the raw agricultural product from its domestic agricultural sectors; the price can be directly influenced by government. The monopolist in the importing country produces only for the domestic market, while the monopolist in the exporting country can produce for both foreign and domestic markets.

The monopolist in the importing country has the following profits function:

$$\pi = [d(y) + r - s]y - [c(y) - v]y \quad (1)$$

where $d(y) = a - b(y + X)$ is the inverse demand function in the importing country, y being domestic sales and X being imports. r is a consumption subsidy/tax and s is an import subsidy/tax. $c(y) = f + k(y + pc)$ is the monopolist's cost function, where f is fixed costs, ky is variable costs and kpc is the price of the raw agricultural product. v is a subsidy/tax relating to the monopolist's use of the raw agricultural product. All parameters (a , b , f and k) are positive.

The monopolist in the exporting country has the following profits function:

$$\begin{aligned} \Pi = [D(Y) + R]Y + [d(y) + r + S]X \\ - [C(Y + X) - V](Y + X) \end{aligned} \quad (2)$$

where $D(Y) = A - BY$ is the inverse demand function in the exporting country, Y being domestic sales, $d(y)$ defined as before, R a consumption subsidy/tax, S an export subsidy/tax. $C(Y + X) = F + K(Y + X + Pc)$ is the monopolist's cost function, where F is fixed costs, $K(Y + X)$ is variable costs and KPc is the price of the raw agricultural product. V is subsidy/tax relating to the raw agricultural product. All parameters (A , B , F and K) are positive.

Before considering the market equilibrium, it is important to outline the intuition of the policy parameters in expressions (1) and (2). The consumption subsidy/tax, r , R , is aimed at dealing with any distortions in the processed product market; i.e., in the case of monopoly power on the part of the processor, it will be a subsidy. The export subsidy/tax, S , and import subsidy/tax, s , are the policy variables associated with the Brander and Spencer-type analysis, designed to improve the trade position of the relevant firm. Finally, the production subsidy/tax, v , V , is aimed at dealing with market distortions in the purchase

of the raw agricultural product; i.e., if the processor has monopsony power, a subsidy is used.

From the profits functions of the two firms, it is possible to derive the reaction functions of the two firms in the importing market, which describe the profit-maximizing level of outputs for each firm, given the output of the other firm, costs, and the policy parameters. For the monopolist in the importing country, the reaction function $y(X)$ is as follows:

$$y(X) = \frac{a - bX + r - s - f - kpc + v}{2b + 2k} \quad (3)$$

For the monopolist in the exporting country, the reaction function $X(y)$ is the following:

$$X(y) = \frac{[a - by + r + S](\mu) - K(A + R) - F(2B + 3K) + V(2B + K) - KPc(2B + K)}{2b(\mu) + 2K(\mu) - K^2}$$

$$\text{where } \mu = 2B + 2K$$

Although these expressions look complex, they have a simple intuition. In the absence of any government intervention (r , R , s , S , and v , $V = 0$), the equilibrium in the importing market will be the standard Cournot result, similar to point C in Figure 1. However, focusing on expression (3) for the monopolist in the importing country, it is straightforward to predict the impact of policy on its equilibrium level of output. The profit-maximizing output level y of this firm varies inversely to the output level X of the exporting firm; i.e., if the exporter's government pays an export subsidy ($+S$), the exporter increases output X and the firm in the importing country cuts back output y . y also varies positively in the consumption subsidy ($+r$), positively in the import tariff ($-s$) and positively in the production subsidy ($+v$). Similar analysis of the exporting firm's reaction function can also be conducted.

Given this interaction between the two monopolists in the importing country, it is possible to calculate the policy choices of both governments that will maximize their respective welfare. This is done upon the assumption that each government takes the other government's policy choice as given. Each country's welfare is measured as the sum of consumer surplus, producer surplus and net government revenue; and when this is maximized, it can be shown that for the importing country, it is optimal to use a consumption subsidy, an import tax, and a production subsidy, while for the exporting country, it is optimal to use a consumption subsidy, an export subsidy and a production subsidy (see McCorrison and Sheldon for proofs). This outcome conforms to the theory of optimal policy intervention, which suggests that each market distortion should be offset at source by a tax-cum-subsidy policy (Bhagwati, 1971). These results still hold if the assumption of a single firm in each market is relaxed; however, it can be shown that the levels of the policies are halved with two firms in each market and that they decline asymptotically as the number of firms increase. The rationale for this is that as the number of firms increases, the lower is the level of supernormal profits and, hence, the smaller the monopoly distortion. In the limit, there would be no government intervention.

The model outlined indicates that the full optimum requires all distortions to be offset at source; however, given the focus of this paper and the likelihood that policies designed to offset the monopoly/monopsony distortions will not be viable instruments, only the constrained optimum of trade policies will be considered in Section 2.

2. Simulation of Optimal Trade Policies

In order to give the theoretical analysis an empirical flavor, this section reports the results of a simulation exercise based on a theoretical model originally suggested by Dixit (1988). The technique takes the form of specifying a theoretical model in which some of the parameters are taken from external empirical sources and the remainder are calculated by a process known as calibration such that they are consistent with equilibrium in a given period.

In this paper, Dixit's model is applied to the U.S. cheese market, which has some of the structural characteristics outlined in the theoretical analysis. In particular, domestic cheese producers compete with imports on the U.S. market; in many cases, cheese is a highly processed product; and, also, the processing industry is, to some degree, imperfectly competitive (see Hornig, 1987, for a recent discussion of the U.S. cheese market). The simulation is based upon the assumption that protection in the world dairy market is removed; i.e., the U.S. cheese quota and tariff system and EC cheese export subsidies are eliminated. The aim of the exercise, therefore, is to assess the optimal level of the import tariff for the United States.

In the following, subscript 1 refers to U.S. cheese processors, and subscript 2 refers to U.S. cheese imports from the EC. It is assumed that there is no entry/exit of firms and that incumbent firms face constant costs. Also, U.S. processed cheese and cheese imports are treated as imperfect substitutes. The latter assumption introduces more realism into the model since, in the earlier analysis, for simplicity, goods were treated as homogeneous. Further, in order to be consistent with the earlier theoretical analysis, oligopolistic behavior is treated as a Nash quantity game; i.e., firms will act Cournot.

The aggregate demand functions for processed cheese are given as:

$$Q_1 = A_1 - B_1 p_1 + K p_2 \quad (5)$$

$$Q_2 = A_2 + K p_1 - B_2 p_2 \quad (6)$$

where all parameters are positive, $(B_1 B_2 - K^2) > 0$, p_1 and p_2 are prices, and Q_1 and Q_2 are quantities. The corresponding inverse demand functions are:

$$p_1 = a_1 - b_1 Q_1 - k Q_2 \quad (7)$$

$$p_2 = a_2 - kQ_1 - b_1Q_1 \quad (8)$$

where all parameters are positive and $(b_1b_2 - k^2) > 0$.

The parameters in equations (5) to (8) can be calculated by using external data on prices and quantities and also elasticities, which is the process of calibration. Expressions (5) and (6) indicate that there are five unknown parameters: A_1 , A_2 , B_1 , B_2 and K . Since prices and quantities give two relations between them, three further relations are required to solve the system. Following Dixit (1987), these relations are based on elasticity information (see McCorrison and Sheldon for derivations).

Given the structure of the model, the level of tariff that will maximize U.S. welfare can be shown as follows:

$$t = \frac{(a_1 - c_1)k(\beta_2V_1 - \beta_1V_2) + (a_2 - c_2)(\beta_1^2V_2 - k^2V_1)}{\beta_1^2(\beta_2 + V_2) - k^2(\beta_1 + V_1)} \quad (9)$$

where $\beta_i = b_i + V_i$. This expression is found by maximizing U.S. welfare with respect to the tariff (Dixit, 1988). All parameters in (9), with the exception of costs c_i and the parameter V_i , are taken from the calibration. Values of c_i are taken from outside estimates, and the values of V_i are derived from the model. The V_i are parameters which are designed to capture the nature of firms' behavior. They are derived by maximizing profits functions (see McCorrison and Sheldon); and for Cournot behavior, $V_i = b_i/n$, where b_i is the slope of the demand function and n is the number of firms; and for perfectly competitive behavior, $V_i = 0$. Expression (9) indicates that the optimal tariff varies in the parameters of the demand system, the relative costs of U.S. and EC firms and also the nature of competition captured in V_i ; i.e., as V_i increases, it implies that firms are acting less competitively and, hence, the tariff should increase in order to capture the increased profits.

Using price, quantity and elasticity data for blue-vein cheese, the model was calibrated for the year 1980, when consistent price and quantity data were available. Blue-vein cheese was chosen because its market has some of the characteristics of the model outlined earlier. Initially, the model was used to simulate the effects on prices and quantities following liberalization in the world dairy market, the estimated price changes being based on estimates by Tyers and Anderson (1988). Then, the model was recalibrated such that the model's parameters are consistent with these hypothetical free market equilibrium values. Price, quantity and cost data were derived from Hornig, the value of the elasticity of demand ϵ is based on an estimate by Heien and Wessells (1988), and a proxy value of the elasticity of substitution σ between U.S. and EC cheese products is taken from Higgs (1986).¹ The data for the recalibration of the model are presented in Table 1, with the corresponding demand parameters being presented in Table 2.

Table 1

Calibration Data

P_1	7.01 (\$/lb)
P_2	7.91 (\$/lb)
Q_1	39,827,240 lbs
Q_2	4,062,971 lbs
ϵ	-1.1
σ	1.6

Table 2

Demand Parameters		Inverse Demand Functions	
Aggregate Demand Functions		Inverse Demand Functions	
A ₁	79,814,357	a ₁	27.96
A ₂	11,920,122	a ₂	14.54
B ₁	10,440,856	b ₁ (10 ⁻⁷)	1.49
B ₂	4,713,346	b ₂ (10 ⁻⁷)	3.30
K	4,197,634	k (10 ⁻⁷)	1.33

Given the estimated parameters, the value for the optimal U.S. cheese tariff was derived from (9). The number of firms n_i was varied to allow for monopoly in each market, duopoly in each market and six firms in each market. The first two cases are consistent with the earlier theoretical analysis; the latter case approximates to the market situation for blue-vein cheese as described in Hornig. The results of this exercise, shown in Table 3, highlight the potential gains to the United States from an interventionist trade policy directed at the cheese-processing sector. However, as noted in the theoretical results, the optimal tariff will vary with the number of firms in the market. A similar analysis could be conducted for the optimal EC subsidy, using a calibrated model of the EC cheese market.

Table 3

Optimal U.S. Tariff			
Import Tariff	Monopoly in US & EC	Duopoly in US & EC	Six Firms in US & EC
Dollars per lb.	6.68	3.00	0.91
% of Import Price	84.00	38.00	12.00

3. Implications of the Analysis

This paper has indicated that in the presence of imperfect competition, theoretical arguments exist for protectionist trade policies. However, some care should be taken in interpreting both the theoretical and simulation results. First, the theoretical results are sensitive to the way in which a firm's behavior has been captured. As Eaton and Grossman (1986) have shown, optimal policies depend on whether firms compete in price or in quantity; so that if price is the firms' strategic variable, the optimal policy for an exporter will be a tax. Second, the simulation results can only be regarded as illustrative; better data for a wider range of products is required for further work. Third, it can easily be shown that if one government has an incentive to adopt an interventionist policy, then so does the other government; consequently, it would appear that the policies cancel each other out. However, the game being played between governments has the structure of the familiar Prisoner's Dilemma. As Figure 2 indicates, in the absence of cooperation between the two governments, intervention by both governments will be the dominant equilibrium. This is because it is always optimal for an individual government to pursue an active trade policy whatever the strategy of the other government.

Hence, the conclusion to this paper is that even if GATT can successfully remove distortions in farm trade, there is, nevertheless, still an incentive to intervene in processed agricultural trade where markets are imperfectly competitive. As the no-intervention equilibrium is clearly better than one where both governments intervene, the issue is one of how to achieve and maintain the free trade outcome.

Figure 2

Trade Policy Matrix

		Country 2	
		No Inter- vention	Inter- vention
Country 1	No Inter- vention	0,0	-2,2
	Inter- vention	2,-2	-1,-1

The first entry in each section of the matrix relates to Country 1.

Endnote

¹Due to a lack of available data, the value of ϵ corresponds to Heien and Wessells' value for cottage cheese. Higgs's estimate for σ relates to the elasticity of substitution between home-produced and imported dairy products for Australia.

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