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IMPERFECT COMPETITION, TRADE POLICY AND PROCESSED AGRICULTURAL PRODUCTS

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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 characterised 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 US cheese imports, and also the implications of this analysis for the liberalisation of agricultural trade are considered.

Introduction

Recent developments in the international economics literature have focussed 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[(1)]. Industries in this sector commonly have imperfectly competitive market structures, characterised 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 liberalisation of agricultural trade.

1. Trade policy and Imperfect Competition

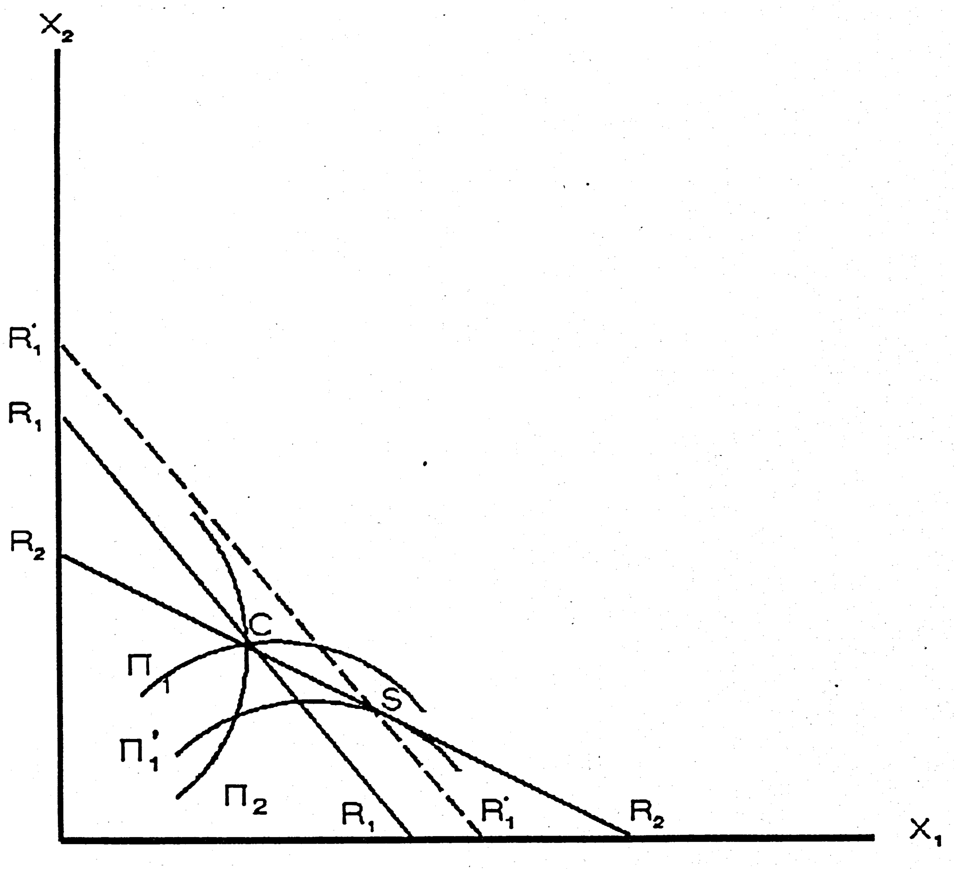
Standard international trade theory provides little first-best justification for the use of import/export taxes and subsidies. However, in recent years, "rent-shifting" arguments for intervention have been developed. The intuition behind such analysis is that where markets are imperfectly competitive 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 focussing 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 modelled as a one-period Nash quantity game, i.e. each firm sets output in order to maximise 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-maximising 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 is achieved by government 1 acting as a Stackelberg leader, whilst the two firms continue to play Nash[(2)]. This 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.

This paper considers how relevant these theoretical developments are for the analysis of agricultural trade. Although imperfect competition in international trade has received some attention from agricultural economists, this has focussed on either the role of government interactions in trade, e.g. see McCalla (1966), Alaouze, Watson and Sturgess (1978), Schmitz, McCalla, Mitchell and Carter (1981), or the presence in international markets of intermediaries such as marketing boards, e.g. see Just, Schmitz and Zilberman (1979) and Markusen (1984). However, recently, Thursby (1988) has applied the Brander and Spencer-type arguments to agricultural trade in third-country markets. The remainder

Figure 1



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.

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 their domestic agricultural sectors, the price of which 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:

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

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:

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

where $D(Y) = A - BY$ is the inverse demand function in the exporting country, Y being domestic sales, d(y) is defined as before, R is a consumption subsidy/tax, S is 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 a 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.

Assuming that the firms play a Nash quantity game, the relevant first-order conditions for profit maximisation are as follows:

$$\delta\pi/\delta y = a - 2by - bX + r - s - f - 2ky - kpc + v = 0 \tag{3}$$

$$\delta\Pi/\delta Y = A - 2BY + R - F - 2KY - KX - KPc + V = 0 \tag{4}$$

$$\delta\Pi/\delta X = a - by - 2bX + r + S - F - KY - 2KX - KPc + V = 0 \tag{5}$$

Using equations (3)-(5), the reaction functions for the monopolists can be derived. For the monopolist in the importing country, the reaction function y(X) is:

$$y(X) = \frac{a - bX + r - s - f - kpc + v}{2b + 2k} \qquad (6)$$

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

$$X(y) = \frac{[a\text{-}by+r+S](\mu)\text{-}K(A+R)\text{-}F(2B+3K)+V(2B+K)\text{-}KPc(2B+K)}{2b(\mu) + 2K(\mu) - K^2} \qquad (7)$$

where $\mu = 2B + 2K$.

Assuming stability of the reaction functions, equilibrium values for y' and X' can be derived. In the absence of government intervention (r, R, s, S and v, V = 0), the equilibrium in a one-period Nash quantity game will be the standard Cournot result.

Given this Nash quantity game between the two monopolists in the importing country, it is possible to calculate the policy choices of both governments that will maximise their respective welfare. This is done upon the assumption that each government plays Stackelberg against the two other firms, but plays Nash against the other government, i.e. each 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.

Welfare for the importing country is given as:

$$w = \int_0^{y+X} [a - b(q) + r - s]dq - \int_0^{y} [f + kq + kpc - v]dq - ry - sX - vy \qquad (8)$$

Expression (8) is maximised for $\delta w/\delta \tau$, where τ = r,v and s. The first-order condition is:

$$\delta w/\delta \tau = [a - by' - bX' - s](\delta y'/\delta r + \delta X'/\delta r)$$
$$+ [a - by' - bX' + r - s](\delta y'/\delta s + \delta X'/\delta s) - s$$
$$- [f + ky' + kpc](\delta y'/\delta v) \quad (9)$$

Using the monopolists' first-order conditions (3) - (5), and assuming an equivalence between s and S, (9) can be rewritten as:

$$\delta w/\delta \tau = [by' - r](\delta y'/\delta r + \delta X'/\delta r)$$
$$+ bX' (\delta y'/\delta s + \delta X'/\delta s) - s$$
$$- [- ky' + v](\delta y'/\delta v) \quad (10)$$

Given (10), the values of r,s and v which maximise welfare for the importing country are:

$r = by'$ i.e. a consumption subsidy

$s = bX' (\delta y'/\delta s + \delta X'/\delta s)$ where $(\delta y'/\delta s + \delta X'/\delta s)$ is negative

i.e. an import tax

$v = ky'$ i.e. a production subsidy

Welfare for the exporting country is given by:

$$W = \int_0^Y [A - B(Q) + R]dQ + [a - b(y + X) + r + S]X$$
$$- \int_0^{Y+X} [F + KQ + KPc - V]dQ - RY - SX - V(Y + X) \quad (11)$$

Expression (11) is maximised for $\delta W/\delta\tau$, where τ = R,V and S. The first-order condition is:

$$\begin{aligned}\delta W/\delta\tau &= [A - BY'](\delta Y'/\delta R)\\ &\quad + [a - 2bX' - by'](\delta X'/\delta S) - bX'(\delta y'/\delta S)\\ &\quad - [F + K(Y' + X') + KPc](\delta Y'/\delta V + \delta X'/\delta V) \qquad (12)\end{aligned}$$

Using the monopolist's first-order conditions (4) and (5), (12) can be rewritten as:

$$\begin{aligned}\delta W/\delta\tau &= [BY' - R](\delta Y'/\delta R)\\ &\quad + [- S\,(\delta X'/\delta S) - bX'\,(\delta y'/\delta S)]\\ &\quad - [-K(Y' + X') + V](\delta Y'/\delta V + \delta X'/\delta V) \qquad (13)\end{aligned}$$

Given (13), the values of R, S and V which maximise welfare for the exporting country are:

$R = BY'$ i.e. a consumption subsidy

$S = -bX'\,(\delta y'/\delta S/\delta X'/\delta S)$ where $(\delta y'/\delta S/\delta X'/\delta S)$ is negative

i.e. an export subsidy

$V = K(Y' + X')$ i.e. a production subsidy

Optimal policy intervention suggests that in the presence of distortions, there should be a tax-cum-subsidy policy addressed directly to offsetting the source of the distortion (Bhagwati, 1971). The above results show this, although the optimal policy values are not unique[3]. Therefore, from the point of view of this paper, the results show that an import tax is optimal for the importer and an export subsidy is optimal for the exporter where markets are imperfectly competetive. These results hold for an individual government no matter the behaviour of the foreign government.

It is possible to relax the assumption of a single firm in each market. The case of duopoly in each market has been examined, the results being presented in Table 1. Clearly the level of the tax and subsidy policies varies with the number of firms in the market, and it can be shown that the tax and subsidy declines asymptotically as the number of firms in the relevant market increases[4]. The rationale for this is that as the number of firms increases the lower is the level of supernormal profits.

Table 1 Optimal Policies

Monopoly in Both Markets		Duopoly in Both Markets[1]	
Importer	Exporter	Importer	Exporter
Consumption subsidy	Consumption subsidy	Consumption subsidy*	Consumption subsidy*
Production subsidy	Production subsidy	Production subsidy*	Production subsidy*
Import tax	Export subsidy	Import tax*	Export subsidy*

* Optimal policies are half the value of the policies in the monopoly-monopoly case.
[1] Derivations are available from the authors on request.

The results presented so far have been based on the assumption that firms play a Cournot-Nash game. However, it may be the case that a given number of firms can play more or less competitively than Cournot. In order to allow for this, firm's behaviour would have to be modelled as a conjectural-variations Nash equilibrium, where the conjectures can vary. Although the above model does not allow for this extension, Dixit (1988) has shown that optimal policies will vary in this parameter, i.e. the more competitive firms are in their behaviour, the lower the value of optimal taxes and subsidies. It should also be noted that if the firms' strategic variable is price rather than quantity (i.e. Bertrand rather than Cournot behaviour), Eaton and Grossman (1986) have shown that the optimal policy for an exporter will be a tax.

In conclusion, the analysis indicates that in the presence of imperfect competition, a case can be made for trade policy intervention by governments in processed agricultural product markets. However, recent developments in the international economics literature have refined the original work of Brander and Spencer suggesting caution in the application of their theoretical results. For example, Carmichael (1987) has shown that the move sequence of the game is important. In the Brander and Spencer model, governments pre-commit the subsidy/tariff and then firms simultaneously choose their outputs. However, if this move sequence is altered it is possible for firms' profits to be higher than in the Brander and Spencer case. Also, Harris (1985) and Krishna (1989) have shown that the nature of trade instrument used is important. Specifically, they highlight the non-equivalence of tariffs and quotas when industries are imperfectly competitive, the latter policy influencing the strategic behaviour of firms. Moreover, Dixit and Grossman (1986) show that protection of an industry may bid up factor prices for other industries. Consequently, in assessing the desirability of government intervention, general equilibrium effects need to be accounted for. Therefore, the application of "rent-shifting" arguments for protection in processed agricultural product markets should be set in the context of these refinements.

2. Simulation of Optimal Trade Policies

In order to give the theoretical analysis an empirical flavour, this section reports the results of a simulation exercise. Few models have been developed to assess quantitatively the impact of trade policies in an imperfectly competitive framework, the best known examples being the work of Venables and Smith (1986), Dixit (1987a) and Baldwin and Krugman (1987). The technique adopted by these authors takes the form of specifying a theoretical model where 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 US cheese market which has some of the structural characteristics outlined in the theoretical analysis. In particular, domestic cheese producers compete with imports on the US 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 US cheese market). The simulation is based upon the assumption that protection in the world dairy market is removed, i.e. the US 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 US.

In the following analysis, subscript 1 refers to US cheese processors and subscript 2 refers to US cheese imports from the EC. It is assumed that there is no entry/exit of firms, and incumbent firms face constant costs. Also, US 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 behaviour is treated as a Nash quantity game.

The aggregate demand functions for processed cheese are given as:

$$Q_1 = A_1 - B_1p_1 + Kp_2 \tag{14}$$

$$Q_2 = A_2 + Kp_1 - B_2p_2 \tag{15}$$

where all parameters are positive, $(B_1B_2 - K^2) > 0$, p_1 and p_2 are prices, and Q_1 and Q_2 are quantities. The corresponding inverse demand functions are:

$$p_1 = a_1 - b_1Q_1 - kQ_2 \tag{16}$$

$$p_2 = a_2 - kQ_1 - b_1Q_1 \tag{17}$$

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

The parameters in equations (14) to (17) can be calculated by using external data on prices and quantities and also elasticities, which is the process of calibration. Focussing on equations (14) and (15), 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, these relations are based on elasticity information. Since US produced cheese and imports are being treated as imperfect substitutes, the total market price elasticity is interpreted as the effect of an equiproportionate rise in the price of the two on the dual quantity aggregate.Therefore, letting $p_1 = P_1^0P$ and $p_2 = P_2^0P$, where P_1^0 and P_2^0 are initial prices and P is the proportional change factor, the aggregate expenditure for cheese can be written as:

$$Q = P_1^0Q_1 + P_2^0Q_2 \tag{18}$$

Given that in the calibration p_1 and p_2 are the initial prices, and substituting equations (14) and (15) into (18), the aggregate expenditure index can be re-written as:

$$Q = p_1A_1 + p_2A_2 - (B_1p_1^2 + B_2p_2^2 - 2Kp_1p_2)P \tag{19}$$

The total market elasticity of demand for cheese, ε, is then defined and evaluated at the initial point where the proportional change factor P equals 1. By differentiating (19) with respect to P, and multiplying by P/Q, the elasticity is given as:

$$\varepsilon = -\frac{B_1p_1^2 + B_2p_2^2 - 2Kp_1p_2}{Q} \tag{20}$$

and expression (20) is then set equal to the observed value of ε.

The elasticity of substitution would normally be defined as :

$$\sigma = d\log(Q_1/Q_2)/d\log(p_1/p_2) \tag{21}$$

which gives a fourth relation between the parameters when set equal to the observed value for σ. However, as Dixit notes, equations (14) and (15) in general define the ratio Q_1/Q_2 as a function of the vector (p_1,p_2) and not in terms of the ratio p_1/p_2. In order for Q_1/Q_2 to be a function of p_1/p_2, at least locally, then the parameters must satisfy the following final relation:

$$p_1(A_1K + A_2B_1) = p_2(A_2K + A_1B_2) \tag{22}$$

which implies homotheticity of the utility function. Given the definition of σ in (21) and using equations (14), (15) and (22), the final expression for the elasticity of substitution can be derived as:

$$\sigma = \frac{\frac{p_1}{p_2}(B_1B_2 - K^2)}{(B_1\frac{p_1}{p_2} - K)(B_2 - K\frac{p_1}{p_2})} \tag{23}$$

Given the structure of the model, the level of tariff that will maximise US welfare can be shown as follows:

$$t = \frac{(a_1-c_1)k(\beta_2V_1-\beta_1V_2)+(a_2-c_2)(\beta_1^2V_2-k^2V_1)}{\beta_1^2(\beta_2+V_2)-k^2(\beta_1+V_1)} \ . \tag{24}$$

where $\beta_i = b_i + V_i$. This expression is found by maximising the US's welfare with respect to the tariff (Dixit, 1988). All parameters in (24), 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 as follows.

The profits function of a typical firm is shown in (25) where i refers to either home or foreign firms:

$$\pi_i = (p_i - c_i)q_i \tag{25}$$

where q_i is its output. Profits are maximised with respect to q_i giving the first-order condition:

$$p_i - c_i + q_i dp_i/dq_i = 0 \tag{26}$$

where dp_i/dq_i is the conjectural variations parameter. If firms play Cournot then $dp_i/dq_i = -b_i$, and with perfect competition $dp_i/dq_i = 0$. Aggregating over the number of firms n_i, V_i is the aggregate conjectural variations parameter, where $V_i = -b_i/n_i$ for Cournot behaviour. Given V_i varies in n_i, the optimal tariff t will also vary in n_i.

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 liberalisation in the world dairy market, the estimated price changes being based on estimates by Tyers and Anderson (1988). Assuming no quantity constraints, the model was re-calibrated 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 US and EC cheese products is taken from Higgs (1986)[5]. The data for the re-calibration of the model are presented in Table 2[6], with the corresponding demand parameters being presented in Table 3.

Table 2 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 3 Demand Parameters

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 US cheese tariff was derived from (24). 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 4, highlight the potential gains to the US from an interventionist trade policy directed at the cheese processing sector. However, as shown 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 4 Optimal US Tariff

Import Tariff	Monopoly in US and EC	Duopoly in US and EC	Six Firms in US and EC
Dollars per lb	6.68	3.00	0.91
% of Import Price	84.00	38.00	12.00

3. Further Implications of the Analysis

So far the analysis has shown that it is optimal for a government to use trade policy in order to increase its national welfare. However, it is important to consider in more detail the possibility of simultaneous intervention by governments since the question arises as to whether under such circumstances protection is still the optimal strategy. In a one-period policy game between governments, intervention by both is the dominant equilibrium. Such a solution is similar to the outcome of the Prisoner's dilemma, which is presented in Figure 2.

Figure 2 Trade Policy Matrix

		Country 2	
		No Intervention	Intervention
Country 1	No Intervention	0,0	-2,2
	Intervention	2,-2	-1,-1

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

Assuming no cooperation between governments, it is always optimal to pursue an active trade policy whatever the strategy of the other government. Hence the Nash equilibrium of this policy game is for both governments to intervene. Since the no-intervention equilibrium is unambiguously better than one where both governments intervene, the issue is one of how to achieve the free trade outcome.

The possible solution to this lies either in tacit or explicit coordination between governments. In the former case, the theory of repeated games suggests that a no-protection equilibrium can be attained if credible sanctions can be used against governments that intervene (see Dixit, 1987b). Such a solution is stable where, for a sufficiently low discount rate, the one-period gains arising from protection are outweighed by the future losses from a trade war. In the latter case, explicit coordination can in principle be achieved through institutions such as GATT. However, it should be noted that even if trade intervention can be prohibited, governments may still use domestic measures such as production subsidies as a substitute for trade policies.

4. Conclusions

This paper has argued that in the presence of imperfect competition, theoretical arguments exist for protectionist trade policies. Following the analysis of Brander and Spencer, it has been shown that in a situation where a monopolist, exporting a processed agricultural product, is competing in the importing market with a monopolist who only produces for domestic consumption, then the optimal policy for the importing country is an import tax while the optimal policy for the exporting country is an export subsidy. It was also noted that the level of these policies varies with the number of firms in each market. In order to give this analysis some empirical flavour, an optimal tariff for US imports of blue-vein cheese from the EC was calculated.

In conclusion, the moral of this paper is that even if GATT can successfully remove distortions in farm trade, there is nevertheless still an incentive for governments to intervene in processed agricultural trade where markets are imperfectly competitive. Clearly this is an important area for future research. First, the theoretical analysis needs to be extended to deal more explicitly with the characteristics of processed agricultural product markets. Second, detailed empirical analysis is required to test these theories based on improved model specification and better quality data.

NOTES

(1) See Elleson (1988) for a classification of high value product categories.

(2) The equilibrium of this two stage model where governments choose subsidy levels in the first stage and firms simultaneously choose output in the second stage is known as sub-game perfect.

(3) These policies are not unique since if the government uses a policy to deal with the domestic distortions (i.e. a consumption or production subsidy) this will affect the optimal value of the trade policy tax or subsidy.

(4) This result was originally proved by Dixit (1984).

(5) Due to a lack of available data, the value of ε corresponds to Heien and Wessells' (1988) value for cottage cheese. Higgs' (1986) estimate for σ relates to the elasticity of substitution between home produced and imported dairy products for Australia.

(6) The initial values for prices and quantities were as follows: p_1 = \$8.65 per lb, p_2 = \$8.65 per lb, Q_1 = 32.3 million lbs, Q_2 = 4.4 million lbs. The price-cost mark-up for blue-vein cheese was taken to be 8 per cent.

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