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## POLICY COORDINATION IN THE WORLD WHEAT MARKET\*

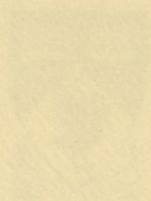
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Agricultural Economics  
Discussion Paper: 4/91

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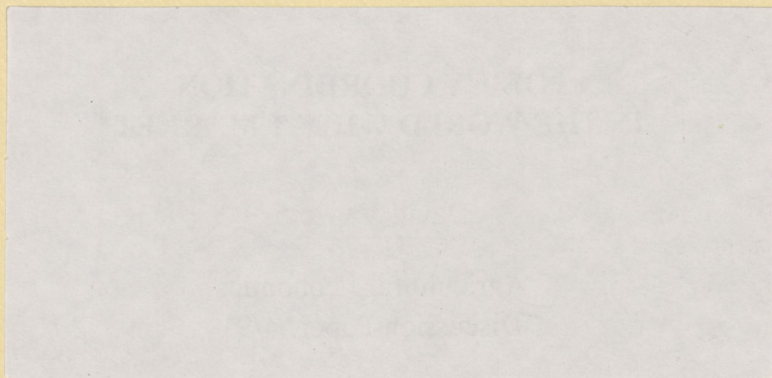
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**POLICY COORDINATION  
IN THE WORLD WHEAT MARKET\***

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# POLICY COORDINATION IN THE WORLD WHEAT MARKET

David Vanzetti

The University of Western Australia

## Introduction

In spite of the oft-repeated and seemingly persuasive espousal by economists of free trade, a feature of agricultural trade over the last two decades is the increasing insulation of domestic from international markets. One reason for this occurrence is that raising trade barriers may be a welfare-increasing policy, at least in respect to a single commodity, even if other traders do likewise. If rivals do respond, perhaps by raising tariff barriers on other commodities, all parties may be worse off. Thus, international trade is a problem of collective action, where participants need assurance that others will not free ride on any agreement by setting in place trade or domestic policies which impinge on the free flow of trade.

It is apparent that free trade can be treated as a public good, having the characteristics of non-rivalry in consumption (a particular trader is not disadvantaged by others operating in the international market place) and non-excludability (it is not possible to exclude traders from enjoying the benefits of liberalised trade) (Runge, von Witzke and Thompson 1987). As with other public goods, benefits and costs are not shared evenly, with benefits being widely dispersed but costs falling on those traders that are uncompetitive. It is tempting to protect uncompetitive sectors, while espousing the virtues of free trade for the sectors in which one is competitive. This is essentially free riding on the public good of free trade.

Furthermore, each country with the ability to influence the world price has an incentive to free ride by setting optimal trade taxes. With a large number of traders, it is difficult for one country to punish another for defection. Cooperation is required to provide assurance that all or most countries abide by the agreed policies, otherwise the resulting outcomes are undesirable for all countries. If it is in no countries interest to reduce trade barriers unilaterally, even though the benefits of collective action are clear, then in the absence of enforceable and binding agreements, a second best global welfare outcome will result.

Such issues can be analysed using game theory. The main objective of this paper is to provide a framework for analysing behaviour in international trade using game-theoretic techniques. Of particular interest is the potential for coordination of policies in inducing a movement towards trade liberalisation. An alternative possibility, if collective action fails, is coordination at a regional level to offset the market power of large traders, particularly the USA and the European Community (EC). The analysis is applied to the world wheat market.

To analyse cooperative behaviour, a non-spatial trade model is specified. Policies are set so as to maximise a welfare function with varying weights on the surpluses attributed to producers, consumers and tax-payers. In setting policy, other countries reactions are taken into account. The interdependence between policies is thus modelled. Different assumptions regarding the degree and nature of cooperation lead to different equilibrium solutions.

The next section introduces some game-theoretic concepts. A mathematical model is described in the following section, and data and results are then presented. Policy implications and conclusions are drawn in the final section.

### Some Game-Theoretic Concepts

Cooperation and conflict can be analysed using game theory. Game-theoretic solutions or equilibriums take into account interdependencies between the actions of the various players. Such interdependencies occur when a change in one player's policy leads to a change in another players payoff (welfare). For example, imposing a tariff or subsidy in one country not only changes other countries' welfare but may also change their optimum policy. Game theory takes these interdependencies into account<sup>1</sup>.

Game theory can be categorised as cooperative or noncooperative, depending on whether players can make binding agreements with each other. *Constant-sum* games imply that a given payoff is shared between the participants. *Zero-sum*

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1 A review of game theory in economics can be found in Schotter and Shwodiauer (1980). McMillan (1986) reviews applications of game theory to international economics.

games imply that gains equal losses. International trade is a not a constant sum game because cooperation can increase global welfare. *Static* games conclude after one period, whereas *repeated* games (supergames) allow for players to learn from the outcome of previous sub-games. *Dynamic* games contain links between periods. *Stochastic* games involve an uncertain payoff, whereas *deterministic* games do not. In this paper, noncooperative and cooperative games are used in a non-zero-sum, static, deterministic framework.

### Game-Theoretic Solutions

Game-theoretic outcomes or equilibria depend on the assumptions relating to player behaviour. A commonly used equilibria is Cournot-Nash. This is an equilibrium from which no player would want to move, given that all others are playing their optimum strategies. Each player attempts to maximise the payoff taking as given the actions of the other players. Unless at equilibrium, other players' actions do change, and a convergence towards the solution occurs.

Consider a two-player non-zero-sum single-shot bi-matrix game. Suppose two players (A and B) can set optimal (welfare maximising) tariffs (T) or follow a free trade (F) strategy. Of the four possible outcome (designated  $F_A F_B$ ,  $F_A T_B$ ,  $T_A F_B$ , and  $T_A T_B$ ), the free trade solution is globally optimal. Assume the various strategies lead to hypothetical payoffs as in the prisoners' dilemma game, shown in Table 1.

Table 1. Prisoners' Dilemma

		Country B	
		Free Trade	Tariff
Country A	Free Trade	3, 3	1, 4
	Tariff	4, 1	2, 2*

\* Cournot-Nash solution

Country A's payoff is the first of each pair shown in the table. The respective payoffs for Countries A and B are 3 and 3 if both follow a free trade policy. The payoffs are



symmetric, suggesting that the players are of equal size or have equal market power. Assuming no retaliation, A's welfare maximising policy is to set a tariff, increasing its payoff from 3 to 4. A's preferred ranking of policies can be represented as

$$T_A F_B > F_A F_B > T_A T_B > F_A T_B$$

B's optimal response is to retaliate, thus improving its payoff from 1 to 2. From a free trade position, B's best policy is also to set a tariff, given its assumption that A will not respond. Thus both countries set tariffs, and both are worse off as a result. The Cournot-Nash outcome,  $T_A T_B$ , is unique and stable. Global welfare, the sum of the two payoffs, is of course reduced.

The resolution to the prisoners' dilemma lies in cooperation. If each can trust the other not to renege, each is better off by agreeing not to set tariffs. This may be learnt through repeated games, or else a cooperative solution can bring about the Pareto equilibrium.

Consider the following game characterised by asymmetry. This game is sometimes known as 'deadlock' because of the difficulty of attaining the cooperative solution.

Table 2. Deadlock

		Country B	
		Free Trade	Tariff
Country A	Free Trade	10,5	8,6
	Tariff	12,1	11,2*

\* Cournot-Nash solution

Country A's preferred policy is to set a tariff, irrespective of B's actions.

$$T_A F_B > T_A T_B > F_A F_B > F_A T_B$$



Any tariff imposed by B makes A worse off, but it is still better off than with free trade. Solution  $T_A T_B$  is the noncooperative Cournot-Nash solution, and once again the global payoff is inferior to the  $F_A F_B$  case. This result arises because of the asymmetry in size or market power. There is little Country B can do to influence A's strategy. This outcome is known as the 'Johnson case' in the trade literature, after its exposition by Johnson in 1954. Johnson showed that tariffs may be optimal even allowing for retaliation by trading partners.

Where two countries are of similar size (i.e. have similar market share), the outcome is more likely to represent the prisoners' dilemma rather than deadlock. In analysing trade issues, it is important to formulate the game correctly, as one offers an escape from a tariff-ridden marketplace, whereas the other does not. Which game is the more realistic? Prisoners' dilemma may characterize the competitive subsidisation of wheat exports by the United States and the EC. Conflict between the United States and Australia is better represented by deadlock, as there is little Australia can do to influence the behaviour of the Americans.

More than one commodity may be the subject of a trade dispute. Each country may be able to bargain with different commodities. For example, Australia has market power in raw materials such as wool and uranium, and conceivably, this power could be used to improve market access for commodities such as wheat characterised by little market power.

The examples given here relate to just two countries and two possible decisions. The framework can be applied to any number of players with little increase in complexity so long as players act noncooperatively. Likewise, players may be allowed to set policies at three or more various levels, without changing the intrinsic nature of the game. With three or more players, however, the nature of the game would change if binding agreements could be made. Cooperative game models would then be more relevant.

#### Coalitions and Cartels

The potential for the formation of coalitions complicates the analysis. Coalitions are inherently unstable. Consider the following example. Three players, A, B and C, wish to divide

\$1 between them and agree to abide by a majority vote. They initially split it evenly, 33.3 cents each. Player C can offer A a split of 50 cents each, with B getting nothing. B can respond with a counter-offer to A of 60 cents, and so gain 40 cents. Rather than receive nothing, C can then make a counter-offer to B of somewhat more than 40 cents, and so on. There is no stable solution to this game.

Not all cooperative games suffer such inherent instability. Cartels have sometimes been suggested as a means of increasing the market power of several small countries, particularly following the apparent success of OPEC in controlling oil production. (Schmitz, A., McCalla, A.F., Mitchell, D.O. and Carter, C. 1981). Management of a cartel represents a policy coordination problem. A successful cartel requires agreement between the members on the appropriate level of exports, a means of allocating exports between countries, and a means of controlling or enforcing the agreement. These requirements involve conflict between the member countries, as the optimum level of aggregate exports or share between countries will vary from country to country, and hence there are incentives to cheat on any agreement reached. The incentives are particularly strong for low-elasticity producers who lack the ability to switch production to other commodities. Cheating may be relatively easy to detect when quantity of exports is the relevant variable, but agreement to maintain a given level of protection, for example, is much more difficult to monitor.

Gardner (1987, p. 334) has noted several practical difficulties with cartels, apart from dividing the output and the detection of cheating. Stockholding is necessary to control output, and this must be allocated along with output quotas (Schmitz et al. p. 129). Multi-commodity effects would diminish the impact of a cartel, depending upon the degree of substitutability in production and consumption. If wheat only was to be controlled, the increase in production of other grains may reduce the demand for wheat after a few years. Additionally, there must be some means of restricting non-member producers from entering the market in response to the higher world prices. Finally, importing countries may respond by setting up importer cartels to redress the balance of market power.

### Trade Model

In this section a simple non-spatial trade model is presented. The model is applied to the international wheat market in the following section.

Consider  $n$  countries trading an homogeneous product with linear supply and demand curves:

$$\begin{aligned} D_i &= \alpha - \beta P_i^d \\ S_i &= \gamma + \delta P_i^s \end{aligned}$$

where  $D_i$  and  $S_i$  are consumption and production in country  $i$ ,  $P_i^d$  and  $P_i^s$  are prices paid by consumers and received by producers and  $\alpha$ ,  $\beta$ ,  $\gamma$  and  $\delta$  are non-negative demand and supply parameters. The parameters are derived from the quantity, elasticity ( $E_i^d$ ,  $E_i^s$ ) and price data (see Table 1.) as follows

$$\begin{aligned} \beta_i &= E_i^d D_i / P_i^d \\ \alpha_i &= D_i + \beta_i P_i^d \\ \delta_i &= E_i^s S_i / P_i^s \\ \gamma_i &= S_i - \delta_i P_i^s. \end{aligned}$$

With no change in stocks, the market clearing equation is

$$\sum_i^n (D_i - S_i) = 0.$$

The free trade price, in which  $P_i^d$  and  $P_i^s$ , equals  $P^w$  is

$$P^f = \frac{\sum_i^n (\alpha - \gamma)}{\sum_i^n (\beta + \delta)}.$$

With trade taxes, the world price,  $P^w$ , becomes

$$P^w = P^f - \frac{\sum_i^n (\beta_i t_i^d + \delta_i t_i^s)}{\sum_i^n (\beta + \delta)}$$

where

$$\begin{aligned} t_i^d &= P_i^d - P^w \\ t_i^s &= P_i^s - P^w. \end{aligned}$$

National welfare for country  $i$  is the sum of consumer surplus  $CS_i$ , producer surplus  $PS_i$ , and tax revenue,  $TR_i$ , which may be either negative or positive. An export subsidy, for example, represents negative revenue. The various components can be

weighted according to policy-maker preferences. Welfare is therefore

$$W_i = w_{ic} CS_i + w_{ip} PS_i + w_{ig} TR_i$$

where  $w_{ic}$ ,  $w_{ip}$  and  $w_{ig}$  are the welfare weights relating to consumers, producers and tax-payers respectively.

The various components of welfare can be represented as

$$\begin{aligned} CS_i &= D_i^2 / 2\beta \\ PS_i &= (S_i^2 - \gamma^2) / 2\delta \\ TR_i &= t_i^d D_i - t_i^s S_i. \end{aligned}$$

If policy-makers are setting policies in order to maximize national welfare, then  $W_i$  can be differentiated with respect to  $t_i^d$  and  $t_i^s$ , and the partial derivatives set equal to zero. These first order conditions can be generated for each country. They show that optimal taxes in country  $i$  are a function of parameters and taxes in all countries. By solving simultaneously, a set of Cournot-Nash equilibrium tariffs can be obtained<sup>2</sup>. This is the outcome of a noncooperative trade war, in which each country sets its policy so as to maximize welfare, with the interactions with other countries' policies taken into account.

Welfare weights can be estimated by assuming that the observed taxes represent a Cournot-Nash outcome, and then using the first order conditions to solve for the weights. This is in contrast to assuming values (unity) for the weights and estimating the optimum taxes.

In some instances policy-makers will be interested primarily or only in producer surplus, and thus a low or zero weight can be given to consumer surplus and tax revenue. This approach can be used to analyse producer cartels.

### The International Wheat Trade

The analysis outlined in the previous section is applied to the international wheat market, which is characterised by export subsidisation by two major exporters, and a highly

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<sup>2</sup> A detailed explanation of the solution procedure is unnecessary here. It can be found, along with an explanation of the estimation of welfare weights, in Vanzetti and Kennedy (1988).



concentrated export sector. Australia, although a significant exporter, has limited ability to influence world prices.

Following presentation of the data, a free trade solution is shown. Optimal taxes without retaliation are then presented for comparison with the trade war solution, in which retaliation is assumed. Welfare weights are estimated. Using these weights, the equilibrium for a coalition of minor exporters is compared to the noncooperative solution.

### Data

Quantity data were obtained from ABARE (1990) and relate to the crop year 1988-89. Supply was adjusted to account for changes in stocks. The taxes for OECD countries in the analysis are derived from producer and consumer subsidy equivalents and refer to 1988. (OECD 1990). Taxes for Argentina were calculated from price data to be zero in this period. The world price is taken to be US\$166, the US No. 2 hard red winter wheat (Gulf) price in 1988-89. Elasticities are the same as those used in the USDA's SWOPSIM model, and reflect a medium term response. The Rest of World demand elasticity is assumed to be 0.5 for much of the analysis, but this is varied to test the sensitivity of the results to changes in this parameter.

The raw data are presented in Table 3.  $P^S$  and  $P^D$  are presented as proportion of the world price. The Rest of World is assumed to be on the competitive fringe, and not to set taxes or tariffs.

Table 3. Base Simulation Data 1988-89

Region	Supply mmt	Demand mmt	$E^S$	$E^D$	$P^S/P^W$	$P^D/P^W$
United States	64.5	26.5	0.6	0.35	1.39	1.07
EC	77.3	58.9	0.5	0.27	1.30	1.29
Argentina	8.4	4.5	0.6	0.32	1.00	1.00
Australia	14.3	2.8	0.9	0.24	1.11	1.00
Canada	18.2	5.8	0.5	0.20	1.45	1.24
Rest of World	349.3	433.5	0.5	0.50	1.00	1.00

World price US\$166.

## Results

### Trade liberalisation

If all countries removed trade barriers, and producers received and consumers paid the world price, the resulting free trade equilibrium would be as shown in Table 4.

Table 4. Free Trade Solution

Region	Demand	Supply	Trade	CS	PS	Welfare
United States	26.61	55.23	-28.62	6781	7109	13890
EC	61.77	70.08	-8.30	25690	9539	35229
Argentina	4.42	8.69	-4.27	1125	1057	2182
Australia	2.76	13.69	-10.92	942	1326	2268
Canada	5.97	15.73	-9.76	3163	2179	5342
Rest of World	421.14	359.26	61.88	67915	46842	114757

World price US\$175. Global welfare US\$173670m.

The free trade world price is US\$175, compared to a base value of US\$166. Total trade (which excludes trade between members of the Rest of World group) falls from 84 mmt (not shown in Table 3) to 62 mmt. Thus, liberalisation diminishes trade flow. US exports fall from 38 to 28 mmt, and EC exports are 8.3 as opposed to 18.3 mmt. In contrast to these significant reductions, Australian exports are 10.9 compared to 11.5 mmt previously. These changes reflect the stimulation given to production by the high domestic prices in the USA and the EC, and the relatively low assistance provided in Australia.

The welfare figures provide a benchmark for later comparisons. The linear supply and demand curves lead to overestimation of the welfare levels. Changes in welfare in response to small changes in prices and quantities are a more useful indicator of the impact of a policy.

### Optimal taxes

Optimal trade taxes without retaliation are shown in Table 5. The Rest of World is assumed not to set trade taxes.

Two points are apparent here. First, the optimum tax structure involves setting the same price for consumers as producers. This eliminates a source of domestic distortion. Second, the welfare maximising policy for a nation in which consumers, producers and tax-payers are treated equally is an export tax. This is the corollary of a tariff for importers. In each case, the tax is non-zero only if the country has some influence over world prices.

Table 5. Taxes Without Retaliation with Unitary Weights

Region	$T^d$ US\$/t	$T^s$ US\$/t
United States	-9.63	9.63
EC	-2.80	2.80
Argentina	-1.43	1.43
Australia	-3.66	3.66
Canada	-3.27	3.27
Rest of World	0.00	0.00

The optimal taxes are quite small, reflecting the medium term nature of the elasticities and, excepting the United States, the relatively low market shares.

Where market power exists, it is unlikely that retaliation would not occur. Furthermore, most traders would realise this and take it into account in setting policy. The impact of retaliation can be seen by calculating the Cournot-Nash solution. This is presented next.

#### A Noncooperative Trade War

Table 6 shows the optimal trade taxes with retaliation. This solution assumes unitary welfare weights. The welfare weights associated with deviations from this optimal solution are also shown.

Table 6. Cournot-Nash Taxes and Welfare Weights

Region	T <sup>*</sup> US\$/t	T <sup>d</sup> US\$/t	T <sup>s</sup> US\$/t	W <sub>c</sub>	W <sub>p</sub>	W <sub>g</sub>
United States	9.64	11.62	-64.74	0.904	1.145	0.951
EC	2.87	48.14	-49.80	0.912	1.108	0.980
Argentina	1.44	0.00	0.00	0.997	1.004	0.999
Australia	3.68	0.00	-18.26	0.961	1.072	0.967
Canada	3.28	39.84	-74.70	0.920	1.119	0.961
Rest of World	0.00	0.00	0.00	1.403	0.597	1.000

T\* refers to optimal taxes, which are equal for consumers and producers, and T<sup>d</sup> and T<sup>s</sup> refer to observed consumer and producer taxes respectively. Negative taxes represent a subsidy.

The most interesting aspect of these results is that retaliation from rival exporters (importers are following a free trade policy) has very little effect on the optimal tax. The impact of a tax works through the world price. The optimal taxes here have little impact on the world price and hence on the tax for any given country.

The optimal taxes vary quite significantly from the observed taxes. The welfare weights reflect this. The weight on producer surplus is greater than unity for all exporters, confirming that producers are favoured by policy-makers in all these countries. Consumers and, to a lesser extent, tax-payers provide this support. The weights for the Rest of World suggest that importers could benefit by imposing a joint import tariff. This would require a degree of cooperation which has been assumed away in this analysis.

Table 7 provides more detail on the welfare and trade effects of the unitary-weighted Cournot-Nash solution. These are in comparison with the free trade solution. Domestic prices for exporters are lower than the free trade level because of the export tax. The world price is slightly higher, and as a result, trade flows are down by 6 per cent for the USA, nearly 2 per cent for Australia, and 4 per cent overall. As a result, welfare levels in exporting nations have increased, with consumers and tax-payers gaining at the expense of producers. Importers' welfare and global welfare is marginally lower than under free trade.



Table 7. Cournot-Nash Trade and Welfare Effects

Region	Price	Welfare	Trade Change %	Welfare Change %
United States	166.94	13912	-6.55	0.16
EC	173.70	35237	-5.38	0.02
Argentina	175.13	2186	-0.30	0.22
Australia	172.89	2279	-1.74	0.51
Canada	173.29	5352	-0.97	0.20
Rest of World	176.58	114690	-4.23	-0.06

World Price US\$176.58. Global Welfare \$173659m.

Trade and welfare changes are from free trade values.

#### A Cooperative Solution

Australia has little bargaining power by virtue of its low market share. To assess the scope for increasing market power by cooperating with other exporting countries, a cooperative solution was obtained by horizontally aggregating demand and supply curves across a number of countries and treating that trading bloc as one player. Aggregating the supply curves is straight forward, but a simple addition of individual country demand schedules results in a kinked demand curves unless they coincidentally share the same vertical intercept. This is a problem because it is not possible to estimate optimal taxes using the method described here if the demand curve is non-linear. To get around this problem,  $\alpha$  for the bloc is a simple summation of the individual  $\alpha$ s, and a  $\beta$  is found such that the consumer surplus for the bloc is the sum of the consumer surpluses of the individual members.  $\beta$  is found by numerical iteration.

Welfare weights are also aggregated across member countries. The weight on consumer surplus is an average of the individual  $w_c$ s weighted by consumption. The producer surplus coefficient is weighted by production and the tax-payers weight is a residual derived from the condition that the three weights sum to three.

Australia, Argentina and Canada are assumed to cooperate and behave as a cartel. The Cournot-Nash cartel solution is shown in Table 8.

An export subsidy of US\$25/t is optimal for the trade bloc. Exports are 24.7 mmt compared to an aggregate of 27.8 mmt for the individual member countries in the non-cooperative trade war solution. Cartel welfare, as measured in conventional terms, is increased marginally from US\$9441m to US\$9532m. However, this disguises significant distributional changes. Consumer surplus changes from US\$5121m to US\$5363m, producer surplus from US\$5717m to US\$5175m and tax expenditure from US\$1398m to US\$1005m. Thus the distributional changes within countries are far greater than between countries.

Table 8. Cartel Solution with Weighted Welfare Functions

Region	$T^d$ US\$/t	$T^s$ US\$/t	Trade mmt	Welfare \$m
United States	11.31	-64.77	-38.08	13285
EC	48.24	-49.64	-18.48	34857
Cartel	-0.73	-24.73	-26.73	9532
Rest of World	0.00	0.00	83.28	115416

World Price US\$166.39. Global Welfare \$173090m.

These results are very dependent on the weights given to the cartel aggregate welfare. Here it is assumed that the weights are an (weighted) average of the member countries' weights. In 1988 Canada had a high weight for producers whereas Australia and Argentina did not. Choosing an appropriate weight highlights the difficulty of allocating benefits to the various cartel members, for each of whom an alternative policy would be more appealing.

#### Alternative values for Rest of World import demand.

To assess the sensitivity of the results to changes in the demand elasticity for the Rest of World, the model was rerun with an elasticity of 1.0 and 2.0 rather than 0.5.

Table 9. Impact of Variations in Import Demand Elasticity

Elasticity	Subsidy US\$/t	Exports mmt	Welfare \$m
0.5	26.73	24.73	9532
1.0	27.91	27.12	9506
2.0	30.70	27.52	9491

An increasing import demand elasticity for the Rest of World implies decreasing market power in the exporting countries as they have less influence over world price by changing supplies. A very large elasticity would imply a perfectly competitive market. As the elasticity is increased in this analysis, the optimal level of exports is increased and welfare is reduced, as expected when market power declines.

#### Implications and Conclusions

Several implications can be drawn from the theoretical and empirical results. First, game theory is a suitable method of analysis for international trade issues, because of the conflicts involved trade relations. Both multilateral and regional negotiations lend themselves to this form of analysis.

Contrary to what is commonly observed, export taxes are the optimal policy for nations with the ability to influence world prices. Taxes, rather than subsidies, are similar to tariffs on imports in pushing world price in the direction favourable to the trader.

Trade taxes and subsidies have relatively small overall welfare effects, from a national perspective, but involve significant distributional effects. Producers are made worse by exports taxes. To obtain producer support for such a policy, some form of compensation or sidepayments may be necessary.

Although free trade is the globally optimal solution, some countries gain from trade barriers, even following retaliation. Thus, international trade, in wheat at least, appears to conform more closely to the deadlock game rather than prisoners' dilemma. Retaliation, in the form of other

exporters setting optimal taxes, has little impact. This result would not necessarily hold if importers were also able to impose taxes rather than follow a free trade policy, as assumed here. A multi-commodity analysis would modify these results, as countries with market power in one commodity do not have it in all.

Cooperation is necessary for the optimum functioning of a free trade system, as many countries have incentives to free ride by imposing disguised trade barriers. This highlights the needs for transparent measures of support to ease negotiated reductions.

Espousal of free trade is a means of coercing other players into a cooperative outcome. One such approach involves attempting to change the weights which other countries' policy-makers affix to their welfare function. Australia has taken this approach by showing that EC and USA policy objectives could be achieved in a more efficient manner (BAE 1985, ABARE 1989).

In this paper it has been shown that trade conflicts and strategic interaction can be analysed with game theoretic models. The use of welfare weights reveal the apparent preferences of policy-makers, and provide a workable rationale for export subsidies. Optimal policies were found to be only marginally affected by retaliation and hence the formation of coalitions between the minor exporters is unlikely to have a significant impact on the policies of the major players.



## References

- Bureau of Agricultural Economics (BAE) (1985), *Agricultural Policies in the European Community: Their Origins, Nature and Effects on Production and Trade*, Policy Monograph No. 2, AGPS, Canberra.
- Australian Bureau of Agricultural and Resource Economics (ABARE) (1989), *U.S. Grain Policies and the World Market*, Policy Monograph No. 4, AGPS, Canberra.
- Australian Bureau of Agricultural and Resource Economics (ABARE) (1990) *Commodity Statistical Bulletin*, AGPS, Canberra.
- Gardner, B. (1987) *The Economics of Agricultural Policies*, Macmillan, New York.
- Johnson, H.G. (1953-54), 'Optimum tariffs and retaliation', *Review of Economic Studies* 21(2), 142-53.
- OECD (1990) *Agricultural Policies Markets and Trade: Monitoring and Outlook 1990*, Paris
- Runge, C.F., von Witzke, H and Thompson, S. (1987) 'International agricultural and trade policy: a political economic coordination problem', in von Witzke, H., Runge, C.F. and Job, B. (eds) *Policy Coordination in World Agriculture*, Wissenschaftsverlag Vaul Kiel KG, Kiel.
- Schotter, A. and Schwodiauer, G. (1980), 'Economics and the theory of games: a survey', *Journal of Economic Literature* 18(2), 479-527.
- Schmitz, A., McCalla, A.F., Mitchell, D.O. and Carter, C. (1981) *Grain Export Cartels*, Ballinger, Cambridge, Massachusetts.
- Vanzetti, D.M. and Kennedy, J.O.S. (1988) 'Endogenous price policies and international wheat prices: comment', *American Journal of Agricultural Economics* 70(3), 743-46.

