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Politically Acceptable Trade Compromises  
Between The EC and The US:  
A Game Theory Approach

by

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POLITICALLY ACCEPTABLE TRADE COMPROMISES BETWEEN  
THE EC AND THE US: A Game Theory Approach

Martin Johnson, Louis Mahe and Terry Roe

ABSTRACT

A model is developed to quantify the special status of agriculture in the US and the EC trade negotiations. The role of special interests are measured by a policy goals function (PGF) whose weights are estimated for each special interest group. The analysis searches for mutually acceptable, mutually advantageous trade agreements between the US and the EC using a partial equilibrium world trade model coupled with game theory. Results suggest that it is in the best interest of the US (resp. EC) for the EC (resp. US) to liberalize while the other follows the status quo policies of 1986. Mutual gains in PGF values to both countries pursuing "large" liberalizations are unlikely to exist, although "small" liberalizations may give rise to "small" mutual gains. Altering each country's action space, and permitting compensatory payments to the most influential groups yields trade liberalization, but free trade does not result.

Key words: game theory, trade liberalization, trade negotiations

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## POLITICALLY ACCEPTABLE TRADE COMPROMISES BETWEEN

### THE EC AND THE US: A Game Theory Approach

The difficulty of obtaining an agricultural trade agreement during the Uruguay round suggests that economic efficiency is not the only criterion motivating government behavior, and that the policy actions of one country impinge on the political economy of the other. The paper focuses on these issues. A model is presented quantifying the special status of agriculture in the US and the EC by measuring the economic and political impacts of agricultural policies on the most affected special interest groups, producers, consumers, and taxpayers. The analysis focuses on the respective negotiating positions of the US and the EC and searches for mutually acceptable, mutually advantageous trade agreements between the two using a partial equilibrium world trade model coupled with game theory.

There are three principal findings. Major trade liberalization will likely be difficult to attain without some form of decoupled payments. Decoupled payments allow both the US and the EC to liberalize because liberalization leads to political and net social gains, regardless of the action of the other, but free trade does not result. Without decoupled payments, there still exist policies which yield political gains to both countries, but they introduce previously unused instruments for some commodities and new trade barriers.

Many authors summarize the motives behind agricultural policy through the welfare of producers, consumers and policy costs. Gardner models the objective of agricultural policy as the maximization of producer welfare subject to budget and consumer welfare constraints. Rausser and Freebairn,

and Riethmueller and Roe model the objective of agricultural policy as the unconstrained maximization of a weighted, additive social welfare function over producer welfare, consumer welfare and taxpayers. This paper adopts the latter approach and, for the remainder of the paper, refers to the social welfare function as a policy-goals function (PGF).

Following, for instance, Olson and Paarlberg an interpretation of the PGF is that agricultural producers band together in lobbies to achieve through the government what they could not achieve in the market. However the policies which they promote impinge on the welfare of other groups who lobby to counteract the agricultural lobby. Hence, in the PGF, a group's welfare weight reflects the relative political influence wielded by the group in the determination of policies. Becker models this process. By distorting agricultural markets, these policies distribute the gains from production, consumption, and trade to favor groups with greater political weights.

Others have modeled the strategic interaction of governments in agricultural trade, for example Karp and McCalla; Sarris and Freebairn; Paarlberg and Abbot; Tyers, and more recently Harrison et. al. Like Karp and McCalla and Sarris and Freebairn, the solution to the game is a Nash equilibrium. In contrast to Paarlberg and Abbot, and Tyers, governments' beliefs about their abilities to influence world prices are consistent with and implied by world market clearing conditions. Harrison et. al. use a general equilibrium, global trade model developed by Whalley (1985, 1986) to search for a Nash Equilibrium and the possibility of a treaty that would leave both the US and the EC better off. Their payoffs are money metric measures of utility change from a base period as opposed to the PGF employed here. Their aggregation of agricultural policies precludes the analysis of protection and support of individual commodities, which differ widely across

commodities. Our approach approximates the actual policy instruments manipulated by the two countries and hence measures the instrument's effects on commodity specific interest groups more closely. Still, the results share the feature that free trade is not in the interests of both countries and that dominant strategies exist.

Our scope is limited to a single period game within which we search for the presence of a Nash equilibrium and the action space of possible treaties. This scope is not too limiting since, within the paradigm of game theory, the successful resolution of treaty negotiations requires that, (1) there must exist at least one action which leads to values of the policy-goals functions which are greater than their values at the status quo; (2) if many such actions exist, then negotiations must ensure that just one is chosen; and (3) there must be no incentive to deviate from the terms of the treaty. (1) is a prerequisite to (2) and (3). For without (1), there is no need to negotiate, (2), and (3) becomes trivial. Condition (2) is a bargaining problem and (3) is a problem of the extensive form game.

Policy-goals functions are estimated for the US and the EC under the hypothesis that observed policies are a single period Nash equilibrium to a noncooperative game; the US and the EC choose policies which maximize their PGF given the actions of the other and the economic environment. Simulations are conducted to discover whether actions exist which are consistent with the treaty proposals of the US and the EC and which lead to values of the PGF that are greater than the values of the status quo.

#### THEORY

This section has two parts. Part one presents a model of trade in N agricultural commodities between two "large" countries (an individual government's policies affect world prices) and the rest of the world, an aggregation of many "small" countries where an individual government's

policies do not affect world prices. Part two contains a noncooperative game in agricultural policies between the governments of the two "large" countries. Each government forms preferences over its <sup>①</sup> producers, <sup>②</sup> consumers and the net budget cost of agricultural policies. The governments are assumed to choose agricultural policies to maximize their preferences given the agricultural policies of the other. Throughout the following it should be understood that all vectors are row vectors unless otherwise defined and the country subscript is suppressed when the intent is clear.

### Production, Consumption, and Trade

Large country  $i$  has  $M$  farms. Each farm produces some subset of the  $N$  traded commodities in order to maximize profit given its production technology and resource endowments. It sells its outputs and purchases its inputs taking prices as given. The indirect profit function for farm  $m$  is defined as

$$(1a) \quad \pi_m(P_f; Z_{fm}); m = 1, \dots, M; P_f \in R_{++}^N;$$

where  $P_f = (P_{f1}, \dots, P_{fN})$  is the vector of the farm prices of the  $N$  traded commodities, and  $Z_{fm}$  is a vector of exogenous factors peculiar to each farm, e.g., prices of inputs that are unaffected by sector demand, factor endowments and so on.

Similarly, define the vector of net supply of the  $N$  commodities for farm  $m$ ,

$$(2) \quad Y_m(P_f; Z_{fm}) = (Y_{1m}(P_f; Z_{fm}), \dots, Y_{Nm}(P_f; Z_{fm})).$$

As  $Y_{nm}$  is positive or negative,  $Y_{nm}$  is sold or purchased. Summing over all  $M$  farms, the vector of aggregate net supply of the  $N$  agricultural commodities is

$$(3) \quad Y(P_f; Z_{fm}) = \sum_{m=1}^M Y_m(P_f; Z_{fm}).$$

When (1a) is differentiable, the effect of a change in price on quasi-rents

earned in the production or employment of the n-th commodity is given by the line integrals

$$\pi_{nm} = \int_{p_n}^{p'_n} (\partial \pi_m / \partial P_{fn}) dP_{fn}, \text{ or } \pi_{nm} = - \int_{p_n}^{p'_n} (\partial \pi_m / \partial P_{fn}) dP_{fn},$$

as commodity n is a net output or net input respectively, so that

subsectoral quasi-rents are given by  $\Pi_n = \sum_{m=1}^M \pi_{nm}$ . Let

$$(1b) \quad \Pi(P_f; Z_f) = (\Pi_1(P_f; Z_f), \dots, \Pi_N(P_f; Z_f))$$

denote the vector of quasi-rents over the N subsectors where  $Z_f =$

$$(Z_{f1}, \dots, Z_{fM}).$$

Consumption is characterized by a single aggregate consumer of agricultural commodities. Preferences between agricultural and non agricultural commodities are assumed separable, so that one may define the indirect utility from the consumption of agricultural goods as

$$(4) \quad U_a(P_c; Z_c);$$

where  $Z_c$  is a vector of exogenous variables and  $P_c$  is an N by one vector of prices paid in the consumer market for the N commodities. The vector of demand functions for the agricultural commodities is

$$(5) \quad X(P_c; Z_c) = (X_1(P_c; Z_c), \dots, X_N(P_c; Z_c)); \forall P_c, P_c \in \mathbb{R}_{++}^N.$$

If the n-th good is not a final good, e.g., animal feed, then the n-th element in (5) is zero.

Excess demand is defined as

$$(6) \quad E(P_f, P_c; Z) = X(P_c; Z_c) - Y(P_f; Z_f), \quad (P_f, P_c) \in \mathbb{R}_{++}^{2N},$$

where  $Z = (Z_f, Z_c)$ . Denoting the generic element of E as  $E_n$ , commodity n is exported or imported as  $E_n$  is negative or positive.

To define the budget in the N agricultural commodities, let  $\tau$  denote transpose. Then, aggregate consumer expenditures are  $P_c X^T$ , producers receive  $P_f Y^T$ , and excess demand is purchased (sold) in world markets at prices  $P_w$  for  $P_w E^T$  ( $-P_w E^T$ ). Hence, the budget is:  $P_c X^T - P_f Y^T - P_w E^T$ , where  $P_w$  is expressed in domestic currency. For simplicity, exchange rates are



subsumed in the notation. Using (3) and (5) and substituting for Z with (6) yields:

$$(7) \quad B(P_f, P_c, P_w; Z) = (P_c - P_w) * X^T(P_c; Z_c) - (P_f - P_w) * Y^T(P_f; Z_f), \quad (P_f, P_c, P_w) \in \mathbb{R}_{++}^{3N}$$

Reintroducing the subscript 1 to denote the three countries, let the rest of the world be country 3. Excess demand in the rest of the world is  $E_3(P_w; Z_3)$ , where  $Z_3$  is a vector of exogenous excess demand parameters in the rest of the world and  $E_3$  is defined for all positive prices. By competitive assumption, world markets clear at equilibrium, therefore

$$(8) \quad E_1(P_{f1}, P_{c1}; Z_1) + E_2(P_{f2}, P_{c2}; Z_2) + E_3(P_w; Z_3) = 0;$$

where 0 is an N by one vector of zeros.

#### A One Period, Noncooperative Game Between Two Governments

Formal representations of games are defined over a set of players, a set of actions available to each player, and a vector of functions (one function for each player) which map the actions of players into a payoff for every player. This section specifies a one period, noncooperative game between two governments nested in the trade model described above, describes the strategic interaction that leads to a Nash equilibrium, and characterizes the Nash equilibria of the game for the differentiable case.

The two governments of the two large countries compose the set of players. The first step characterizes policy instruments as actions.

Instruments are divided into two groups, price instruments and demand/supply shift instruments. Price instruments, denoted  $A_{fn}^P$  and  $A_{cn}^P$  for producers (f) and consumers (c) of the n-th commodity, indirectly or directly affect the farm and consumer prices of the N commodities, e.g., taxes, subsidies, tariffs, price fixing. Thus, for the n-th commodity,

$$(9) \quad P_{fn} = P_{fn}(A_{fn}^P, P_{wn}), \text{ and } P_{cn} = P_{cn}(A_{cn}^P, P_{wn}), \quad n = 1, \dots, N.$$

If the action sets a domestic price, then world price is a trivial argument

in the function. If no action is taken, then domestic price equals world price. If a fixed tariff or a fixed subsidy is in place, then domestic price is a function of world price and the price instrument. If a tariff  $t_n$  is in place, then  $A_{fn}^P$  and  $A_{cn}^P$  equal  $t_n$ , and by definition,  $P_{fn} = P_{cn} = (1 + t_n)P_{wn}$ .

Shift instruments,  $A_{fn}^S$  and  $A_{cn}^S$ , shift supply and demand curves by altering other aspects of the decision problems of producers and consumers, e.g., input subsidies, acreage reduction schemes and so on. In the previous section, they are implicit elements of the vectors of exogenous variables  $Z_f$  and  $Z_c$ . To make their existence explicit, make the following partitions:  $Z_f = (A_f^S, \bar{Z}_f)$  and  $Z_c = (A_c^S, \bar{Z}_c)$  where  $A_f^S$  and  $A_c^S$  are the analogous row vectors. Let the number of instruments used by the government be  $Q$ ; then the action space  $A$  is defined as a subset of  $\mathbb{R}^Q$  such that all domestic prices are positive and production and consumption levels are non-negative.

World prices are affected by government actions. Using equations (3), (5) and (9), and the partitions defined above, form the composite functions of the world market clearing condition (8),

$$(10) \quad E_1(P_{f1}(A_{f1}^P, P_w), P_{c1}(A_{c1}^P, P_w), A_{f1}^S, A_{c1}^S; \bar{Z}_1) + E_2(P_{f2}(A_{f2}^P, P_w), P_{c2}(A_{c2}^P, P_w), A_{f2}^S, A_{c2}^S; \bar{Z}_2) + E_3(P_w; Z_3) = 0.$$

For the game to be well defined, (10) must implicitly define world prices as functions of the actions of the two governments. Suppose this is so, then

$$(11) \quad P_w = P_w(A_{f1}^P, A_{c1}^P, A_{f2}^S, A_{c2}^S; \bar{Z}_1, \bar{Z}_2, Z_3), \quad (A_{f1}, A_{c1}, A_{f2}, A_{c1}) \in A_1 \times A_2$$

where  $A_{fi} = (A_{fi}^P, A_{fi}^S)$  and  $A_{ci} = (A_{ci}^P, A_{ci}^S)$ ,  $i = 1, 2$  and  $\times$  denotes the

Cartesian product. Sufficient conditions for (11) to be well defined are straight forward for some action spaces. For example, a sufficient condition is that  $E_3(P_w, Z_3)$  is monotonic in  $P_w$  if both governments set their domestic prices.

The payoff function is defined as a policy goals function, a weighted,

additive social welfare function over sectoral quasi-rents (1b), consumers of agricultural goods (4), and the budget (7). However, these must be expressed as functions of the policy instruments. To condense notation, let  $-i$  be the "other" country, let  $A_i = (A_{fi}, A_{ci}) = (A_{fi}^P, A_{fi}^S, A_{ci}^P, A_{ci}^S)$ , and suppress  $\bar{Z}_1, \bar{Z}_2, Z_3$ . Using (1b), (9) and (11), form the composite function for sectoral quasi-rents,

$$(12) \quad \bar{\Pi}_i(A_i, A_{-i}) = \Pi_i(P_{fi}(A_{fi}^P, P_w(A_i, A_{-i})), A_{fi}^S).$$

Using (4), (9) and (11), form the composite utility function for consumers,

$$(13) \quad \bar{U}_{ai}(A_i, A_{-i}) = U_{ai}(P_{ci}(A_{ci}^P, P_w(A_i, A_{-i})), A_{ci}^S).$$

Using (7), (9) and (11), form the composite budget function,

$$(14) \quad \bar{B}_i(A_i, A_{-i}) = B_i(P_{fi}(A_{fi}^P, P_w(A_i, A_{-i})), P_{ci}(A_{ci}^P, P_w(A_i, A_{-i})), P_w(A_i, A_{-i}), A_{fi}^S, A_{ci}^S).$$

Normalizing on the budget and using (12), (13) and (14), the policy-goals function is defined as

$$(15) \quad V_i(A_i, A_{-i}) = \bar{\Pi}_i(A_i, A_{-i}) * \lambda_{fi} + \bar{U}_{ai}(A_i, A_{-i}) \lambda_{ci} + \bar{B}_i(A_i, A_{-i})$$

where  $\lambda_{fi}$  is an N by one, strictly positive vector and  $\lambda_{ci}$  is a strictly positive scalar.  $(\lambda_{fi}, \lambda_{ci})$  are the weights corresponding to each interest group, (i.e., commodity sectors) and the aggregate consumer in country i. Hence, to define the game formally, there are two players, government one and two, an action space,  $A_1 \times A_2$ , and two payoff functions  $V_1(A_1, A_2)$  and  $V_2(A_2, A_1)$ .

To determine the outcome of the one period game, we must specify why governments choose. Formally, the game is solved through a Nash equilibrium defined using best response correspondences. For any given  $A_{-i}$ , government i chooses  $A_i^*$ , a best response to  $A_{-i}$ , such that

$$(16) \quad V_i(A_i^*, A_{-i}) \geq V_i(A_i, A_{-i}), \forall A_i \in A.$$

The set of actions which satisfy (16) defines the best response

correspondence of  $A_{-i}$ ;  $A_{-i}$  may have many best responses. A Nash equilibrium

is a pair of actions  $(A_1^*, A_2^*)$ , such that  $A_1^*$  is a best response to  $A_2^*$  and vice versa. Intuitively, the political process determines the best political compromise given the policies of the other government. At equilibrium, the other governments' policies, upon which the best political compromise is based, are realized. This is analogous to the competitive assumption that assumed prices are realized.

Consider the differentiable case of the model. Differentiating (15) with respect to  $A_{fi}$  and  $A_{ci}$ , the first order necessary conditions for a maximum are:

$$(17) \quad \begin{bmatrix} \frac{\partial V_i}{\partial A_{fi}} \\ \frac{\partial V_i}{\partial A_{ci}} \end{bmatrix} - \begin{bmatrix} \frac{\partial \bar{\pi}_i}{\partial A_{fi}} & \frac{\partial \bar{U}_{ai}}{\partial A_{fi}} \\ \frac{\partial \bar{\pi}_i}{\partial A_{ci}} & \frac{\partial \bar{U}_{ai}}{\partial A_{ci}} \end{bmatrix} * \begin{bmatrix} \lambda_{fi} \\ \lambda_{ai} \end{bmatrix} + \begin{bmatrix} \frac{\partial \bar{B}_i}{\partial A_{fi}} \\ \frac{\partial \bar{B}_i}{\partial A_{ci}} \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$$

An element by element description of (17) is available from the authors.

For a given  $A_{-i}$ , if  $V_i$  is concave in  $A_i$  then any  $A_i^*$  which solves (17) maximizes  $V_i$ , so it is a best response to  $A_{-i}$ . Thus (17) implicitly defines the best response correspondence  $A_i^*(A_{-i})$ .  $A_i^*(A_{-i})$  is single valued, i.e., a function if and only if  $V_i$  is strictly concave in  $A_i$  for all values of  $A_{-i}$ .  $(A_1^*, A_2^*)$  is a Nash equilibrium if

$$(18) \quad \begin{bmatrix} \frac{\partial V_1}{\partial A_1} \\ \frac{\partial V_2}{\partial A_2} \end{bmatrix} \Big|_{(A_1^*, A_2^*)} = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$$

Furthermore, by the Implicit Function Theorem,  $(A_1^*, A_2^*)$  is a locally unique Nash equilibrium if the Jacobian of (18) is of full rank.

In sum, this section presented a model of rational government behavior; the governments of the two large countries are assumed to choose agricultural policies as though they maximize their PGFs given the policies

of the other. No normative statement about the "rightness" of the PGF or the (Pareto) efficiency of the policies is intended. The preference weights  $(\lambda_{fi}, \lambda_{ci})$  are estimated in the next section based on this behavioral assumption.

#### ESTIMATION OF PREFERENCE WEIGHTS

Based on the theoretical model described above, a game between the US and the EC in agricultural policies is constructed in this section. As in the theoretical model, before the specification of the game it is necessary to define an economic environment. The MISS trade model provides the economic environment. The model is initialized for the base year 1986. The model resembles that of Tyers and Anderson and the SWOPSIM model developed by the USDA (Roningen). It is a static, partial equilibrium trade model which specifies production and demand elasticities for the US, the EC, and as an aggregate, for the rest of the world for the seven commodities: wheat and coarse grains (grains), oil seed cakes, feed grain substitutes (FGS), (this includes millings and other vegetable byproducts, corn gluten feed, monioc and citrus-pulp), beef, pork and poultry, milk and milk products (dairy), and sugar. Production elasticities satisfy the profit maximizing conditions of a firm with a multi output production technology, and demand elasticities satisfy the implications of utility maximization. The empirical properties of the model are provided in Mahe, Travera and Trochet, and hence are not discussed here.

There are six sectors in the US and the EC defined over the seven commodities mentioned. Animal feeds is an aggregate of oil seed cakes and feed grain substitutes. Of course, actual farms produce more than one commodity. But the assumption of joint production technologies inherent in MISS captures these sectoral effects and estimates the quasi rents.

As mentioned, even though actions from different action spaces may lead

to identical economic results, solutions to respective games will differ. An intuitive example, the first order necessary conditions of the differentiable case will hold for the actual instrument but not necessarily for an economically equivalent action. Therefore to characterize the game between the two countries adequately, it is necessary to closely approximate the actual US and EC policy instruments.

A brief characterization of the US commodity policies are the following. For grains, there is the target price coupled with the set-aside program, and the Export Enhancement Program (EEP). For oil seeds there is a Commodity Credit Corporation (CCC) loan rate. There is no support program for pork and poultry. For sugar, there are import quotas to support a fixed domestic price. Support prices exist for dairy, with consumer price slightly below producer price. Milk prices are average prices since there exist price differentials by geographic region set by the federal government. For beef there is a tariff linked to quotas on beef imports. Thus, there are seven relevant US policy instruments (USDA, 1989).

For the EC a variable levy fixes consumer prices in grains while the coresponsibility payment system decreases farm prices from consumer prices at the margin. For oil seed cakes and FGS, consumer price equals world price by a previous GATT agreement which fixed the tariff at zero for most of these products. Producer price of oil seed cakes is supported through a subsidy. Milk and sugar producers are also protected by the variable levy system. Production quotas also exist on milk production. Beef and pork and poultry are also supported by the variable levy system. Hence, there are seven instruments for the EC (Mahe and Tavera).

Assume that MISS approximates the differentiable case of (15). If the number of instruments of the US and the EC exceeds the number of political weights, then  $(\lambda_{us}^{86}, \lambda_{ec}^{86})$  can be found using numerical approximations of (17)

such that observed policies are a Nash equilibrium. The estimation procedure proceeds as follows.  $B_i$  is readily observable. Given differentiable indirect profit and utility functions, duality theory admits the inference of  $\partial \bar{\pi}_i / \partial A_{fi}$  and  $\partial \bar{U}_{ai} / \partial A_{ci}$  from observable demand and supply functions. MISS is used to obtain these estimates.

Let  $A_{us}^{86}$  and  $A_{ec}^{86}$  be the instruments set by the the US and the EC in 1986, the calibration year of MISS. The weights  $\lambda_{us}^{86}$  and  $\lambda_{ec}^{86}$ , which may be consistent with the Nash equilibrium hypothesis, are estimated using approximations of the partial differentials  $\partial \bar{\pi}_{ni} / \partial A_{fi}$ ,  $\partial \bar{\pi}_{ni} / \partial A_{ci}$ ,  $\partial \bar{U}_{ai} / \partial A_{fi}$ ,  $\partial \bar{U}_{ai} / \partial A_{ci}$ ,  $\partial \bar{B}_i / \partial A_{fi}$  and  $\partial \bar{B}_i / \partial A_{ci}$ ,  $n = 1, \dots, 7$ ,  $i = us, ec$ , evaluated at instrument levels  $A_{us}^{86}$  and  $A_{ec}^{86}$ . The approximation of the differentials are obtained by taking small changes in  $A_{fi}$  and  $A_{ci}$  from  $A_{fi}^{86}$  and  $A_{ci}^{86}$ , denoted  $\Delta A_{fi}$  and  $\Delta A_{ci}$ , respectively, and calculating the resulting changes in  $\bar{\pi}_{ni}$ ,  $\bar{U}_{ai}$ , and  $\bar{B}_i$ , denoted  $\Delta \bar{\pi}_{ni}^{86}$ ,  $\Delta \bar{U}_{ai}^{86}$ , and  $\Delta \bar{B}_i^{86}$  (all other policies held constant).

Then, the ratios

$$\frac{\Delta \bar{\pi}_i^{86}}{\Delta A_{fi}}, \frac{\Delta \bar{U}_{ai}^{86}}{\Delta A_{ci}}, \frac{\Delta \bar{U}_{ai}^{86}}{\Delta A_{fi}}, \frac{\Delta \bar{\pi}_i^{86}}{\Delta A_{ci}}, \frac{\Delta \bar{B}_i^{86}}{\Delta A_{ci}}, \text{ and } \frac{\Delta \bar{B}_i^{86}}{\Delta A_{ci}}, \text{ for } n = 1, 2, \dots, 7, \text{ and } j =$$

$1, \dots, N_i$ ,  $i = us, ec$ , are formed.

Thus consider the discrete approximation of (17).

$$(19) \quad \begin{bmatrix} \frac{\partial v_i}{\partial A_{fi}} \\ \frac{\partial v_i}{\partial A_{ci}} \end{bmatrix} = \begin{bmatrix} \frac{\Delta \bar{\pi}_i^{86}}{\Delta A_{fi}} & \frac{\Delta \bar{U}_{ai}^{86}}{\Delta A_{fi}} \\ \frac{\Delta \bar{\pi}_i^{86}}{\Delta A_{ci}} & \frac{\Delta \bar{U}_{ai}^{86}}{\Delta A_{ci}} \end{bmatrix} * \begin{bmatrix} \lambda_{fi}^{86} \\ \lambda_{ci}^{86} \end{bmatrix} + \begin{bmatrix} \frac{\Delta \bar{B}_i^{86}}{\Delta A_f} \\ \frac{\Delta \bar{B}_i^{86}}{\Delta A_c} \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix}, \quad i = 1, 2.$$

$$\text{If } \begin{bmatrix} \frac{\Delta \bar{\pi}_i^{86}}{\Delta A_{fi}} & \frac{\Delta \bar{U}_{ai}^{86}}{\Delta A_{fi}} \\ \frac{\Delta \bar{\pi}_i^{86}}{\Delta A_{ci}} & \frac{\Delta \bar{U}_{ai}^{86}}{\Delta A_{ci}} \end{bmatrix}^{-1} \text{ exists, then } \begin{bmatrix} \lambda_{fi}^{86} \\ \lambda_{ci}^{86} \end{bmatrix} = - \begin{bmatrix} \frac{\Delta \bar{\pi}_i^{86}}{\Delta A_{fi}} & \frac{\Delta \bar{U}_{ai}^{86}}{\Delta A_{fi}} \\ \frac{\Delta \bar{\pi}_i^{86}}{\Delta A_{ci}} & \frac{\Delta \bar{U}_{ai}^{86}}{\Delta A_{ci}} \end{bmatrix}^{-1} * \begin{bmatrix} \frac{\Delta \bar{B}_i^{86}}{\Delta A_{fi}} \\ \frac{\Delta \bar{B}_i^{86}}{\Delta A_{ci}} \end{bmatrix}$$

Table 1 presents the estimates of  $\lambda_f^{86}$  and  $\lambda_c^{86}$ . However, before

interpreting these weights a number of qualifications should be mentioned. That  $(\lambda_{us}^{86}, \lambda_{ec}^{86})$  satisfy approximate first order conditions is not sufficient to ensure that 1986 policies are a Nash equilibrium. First, they are only necessary conditions, and second, they are approximations. Third, voluntary farmer participation in the US programs and production quotas in the EC imply PGFs are not differentiable and possibly not continuous over the entire range of policy instruments. Fourth, the actions are only a subset of all policy instruments. Consequently, simulations were run to test the hypothesis that 1986 policies are best responses of each other given the estimated PGFs as payoff functions and therefore that they are Nash equilibrium. This hypothesis was found to be quite robust.

Furthermore, although the estimated PGFs rationalize the 1986 policies, it can be shown in principle that alternative PGFs based on alternative action spaces and estimated from the analagous equation (17) may also rationalize the 1986 policies but predict different treaty actions. Treaty actions require that the other's action changes. (17) is estimated holding the other's action constant. *cet. par.* In the simulations of the next section, the search for treaty actions within the proposals of the EC and the US implicitly tests the estimated model. For if proposals are actions of governments then they must also be rational; there must be actions within the proposals which are treaty actions.

The estimated weights reveal the political influence of the various groups in determining US and EC agricultural policy in 1986. For example, sugar policy in the US requires that producers gain only at the expense of consumers. Taking the ratio of sugar producer weight to consumer weight, the acceptable trade at the margin is a one dollar gain in quasi rent of sugar producers for a \$1.90 loss in consumer surplus. This result reflects the political influence of sugar producers relative to consumers in 1986. A



Table 1: Policy-Goal Function Weights and Their Ranking by Interest Group for the U.S. and the E.C., Based on 1986.<sup>a/</sup>

	United States		European Community	
	Rank	Weight ( $\lambda_{US}$ )	Rank	Weight ( $\lambda_{EC}$ )
Sugar	1	1.56	1	1.57
Dairy	2	1.29	2	1.46
Animal Feeds	3	1.23	4	1.32
Grains	4	1.15	3	1.34
Budget	5	1.00	6	1.00
Beef	6	0.92	4	1.32
Consumers	7	0.87	8	0.83
Pork & Poultry	8	0.85	7	0.95

<sup>a/</sup> Estimated values of  $\lambda_i$  are based on equation (19).

strict application of these weights to the current negotiations requires a stable political process and economic environment.

#### SIMULATIONS OF US AND EC PROPOSALS

The simulations explore the rationale of the US and the EC negotiating positions in the GATT. Simulations are conducted in the spirit of, but not on, the US and EC proposals; they fit into three categories: games, tariffication, and harmonization. The 1986 US proposal in favor of trade liberalization and decoupled payments is examined within a game where US and EC strategies correspond to a range of trade liberalizing actions. The analysis of the game demonstrates the crucial role of decoupled payments in arriving at policy actions that appear both politically feasible and welfare improving.

The EC negotiating position is related to tariffication and includes rebalancing of animal feed protection. We focus first on animal feeds only by considering the PGF pay-offs to various combinations of EC producer price support cuts and import tariffs when the US follows the status quo. The harmonization simulations extend the approach to grains where the EC trades cuts in grain and feed prices for tariffs on animal feed imports given degrees of US liberalization. An EC indifference mapping based on its PGF is obtained from this analysis, and an action space is found with the property that neither country is made worse off than the status quo.

#### Games: the US Proposal

The action space of the game is designed as progressive steps toward free trade by first eliminating export subsidies and then by liberalizing all but the dairy and sugar sectors. Article XVI of the GATT disallows the use of export subsidies except to relieve a temporary domestic surplus of a primary agricultural commodity. (Dam) Of course this exception has been badly misused by the US and the EC. The (ber) simulation is designed to

explore the consequences of an agreement prohibiting subsidies and restitution for exported commodities. These prohibitions remove the budget costs of producer price subsidies for an exported commodity which then forces governments to cut producer price supports and to decrease consumer prices when they exceed world price. Sugar and beef prices in the US and oil seed cake prices in the EC are unchanged because the US and the EC are net importers of these commodities. The partial free trade (pft) simulation is free trade for most of the crop (grains and oils seeds) and the beef sector. Dairy and sugar policies remain at the status quo since they are viewed as being particularly resistant to change. The last simulation is free trade in all commodities.

More precisely, the possible actions simulated for the US are:

- sq- The status quo of 1986;
- ber- Ban on producer and export subsidies; free trade in all commodities except beef, sugar, and dairy, self-sufficiency in dairy is followed while sugar prices and beef quotas remain at the status quo;
- pft- Partial free trade; free trade in grains, animal feeds, beef, and pork and poultry; dairy and sugar policies remain at the status quo;
- ft- Free trade; free trade in all commodities;

and for the EC they are

- sq- The status quo of 1986;
- ber- Ban on export restitution; Ad valorem tariffs are used to attain self-sufficiency in grains, beef, pork and poultry, dairy, and sugar; price differentials, in percent, between producers and consumers remain at the status quo; the farm price of oil seed cakes is unchanged;
- pft- Partial free trade; Ad valorem tariffs of 20 percent are imposed on grain and beef, the oil seed cake support is reduced to 20 percent more than world price, pork and poultry price is set to world prices, dairy and sugar prices remain at the status quo;
- ft- Free trade; Free trade in all commodities.

Two games are presented in Table 3; the US chooses the row, the EC chooses the column. The economic results are summarized in Table 2. Before

discussing the game matrix of the PGF values, the key economic outcomes are summarized.

### Economic Results

The economic results of the simulations can be only briefly summarized here (Table 2). For comparable experiments, namely free trade, the results obtained from the model are similar to those obtained from (EEC). In general, liberalization causes large increases in the world prices of grains, beef, sugar, and dairy, decreases in the prices of oil seed cakes and FGS, and smaller changes in the price of pork and poultry. Three factors drive these results: crop production shifts in the US from grains to oil seeds, feed input substitution in the EC from oil seed cakes and feed grain substitutes to grains, and lower feed input demand of beef, dairy, and pork and poultry producers in the EC due to the contraction of the animal sector.

Supply and Price Effects of U.S. Liberalization When the E.C. Follows the Status Quo. In the partial free trade simulation (pft), the abolition of the target price system decreases the farm price of grains in the US with the result that resources flow into the production of soybeans and to some extent into sugar. Consequently, the world price of grain increases, and the world prices of animal feeds and sugar decrease. Lower animal feed prices increase the production of pork and poultry and dairy in the US, resulting in lower world prices for these commodities. The removal of beef protection in the US increases the world price of beef; but the combination of a lower domestic beef price and lower feed prices results in a negligible change in US beef production.

Unilateral  
(EEC)

The ber simulation departs from pft by maintaining US beef protection while decreasing the farm and consumer price of milk until the US is self sufficient. The abolition of the target price system produces the same

Table 2: Economic Results From Game Simulations; Producer, Consumer and Budget Surplus and World Price Changes, Relative to the Status Quo of 1986.

EC Option	US Option	Crop	(sq) Welfare Est. in Billion ECU	World Price Change %	(ber) Welfare Est. in Billion ECU	World Price Change %	(pft) Welfare Est. in Billion ECU	World Price Change %	(ft) Welfare Est. in Billion ECU	World Price Change %
			BS 0		BS 8.5		BS 4.7		BS 11.74	
		Grains	PS 0	0	PS -16.4	5.1	PS -13.0	6.9	PS -27.7	7.7
		Cakes	CS 0	0	CS 14.2	-6.9	CS 11.4	-0.2	CS 24.4	-6.3
		FGS	SG 0	0	SG 6.4	-16.7	SG 3.0	-14.2	SG 8.5	-25.6
(sq)		Beef	BS 0	0	BS 1.9	6.5	BS 2.0	11.2	BS 2.5	17.4
		Pork-Po.	PS 0	0	VA -0.9	1.5	PS -0.9	1.7	PS -2.3	-3.2
		Dairy	CS 0	0	CS -0.6	18.3	CS -0.7	-3.4	CS 0.1	29.9
		Sugar	SG 0	0	SG 0.3	5.2	SG 0.4	-3.9	SG 0.3	18.7
			BS 0.3		BS 8.6		BS 4.9		BS 11.7	
		Grains	PS 0.0	8.6	PS -16.6	13.6	PS -11.1	14.0	PS -27.1	14.9
		Cakes	CS -0.1	-2.7	CS 14.4	-8.6	CS 9.5	-1.4	CS 24.3	-6.9
		FGS	SG 0.4	-2.1	SG 6.6	-18.4	SG 3.3	-10.7	SG 8.9	-25.8
(ber)		Beef	BS 16.3	-1.2	BS 16.2	2.7	BS 16.3	8.3	BS 16.1	12.5
		Pork-Po.	PS -16.2	-0.7	PS -14.5	1.0	PS -15.5	-5.8	PS -13.5	-2.4
		Dairy	CS 2.4	7.4	CS 0.8	26.6	CS 1.9	5.6	CS -0.3	35.9
		Sugar	SG 2.5	-0.5	SG 2.3	4.9	SG 2.3	-3.6	SG 2.3	17.4
			BS 0.2		BS 8.4		BS 4.8		BS 11.6	
		Grains	PS -0.0	9.1	PS -16.5	14.7	PS -12.4	14.4	PS -27.5	15.3
		Cakes	CS 0.1	-2	CS 14.4	-7.5	CS 11.3	-0.7	CS 24.7	-6.5
		FGS	SG 0.1	-1.5	SG 6.3	-17.3	SG 3.7	-14.0	SG 8.9	-25.3
(pft)		Beef	BS 14.9	1.1	BS 13.8	5.3	BS 14.9	8.8	BS 15.4	12.9
		Pork-Po.	PS -14.4	-0.5	PS -10.8	1.3	PS -11.7	1.5	PS -11.7	-2.4
		Dairy	CS 1.0	-1.8	CS -2.2	10.0	CS -1.5	-3.3	CS -1.7	40.3
		Sugar	SG 1.5	-0.4	SG -0.8	4.4	SG 1.8	-3.6	SG 2.0	24.5
			BS 0.6		BS 8.8		BS 5.9		BS 11.7	
		Grains	PS -0.1	7.1	PS -16.7	12.5	PS -12.9	12.4	PS -26.7	14.4
		Cakes	CS 0.3	-4.9	CS 14.7	-10.4	CS 11.7	-3.9	CS 23.8	-8.0
		FGS	SG 0.9	-3.4	SG 6.8	-19.2	SG 4.7	-16.3	SG 8.3	-25.9
(ft)		Beef	BS 16.5	0.1	BS 16.7	4.4	BS 16.7	7.8	BS 16.6	12.4
		Pork-Po.	PS -21.0	-1.4	PS -18.5	0.2	PS -18.7	0.5	PS -16.4	-2.4
		Dairy	CS 7.5	22.0	CS 4.4	36.6	CS 5.3	20.1	CS 2.5	40.3
		Sugar	SG 3.0	7.4	SG 2.6	12.4	SG 3.3	4.0	SG 2.7	24.5

Grains = Wheat and coarse grains; Cakes = Oil seed cakes and veg. protein; FGS = Cereal substitutes (millings and other veg. by-products, corn gluten feed, monicoc and citrus-pulp; Beef = Beef meat, Pork-Po. = Pork and poultry; Dairy = Milk and byproducts. BS = Budget savings; PS = Producer surplus; CS = Consumer surplus; SG = Social gain, equals BS + VA + CS.

shift of crop production from grains into animal feeds and sugar as did pft, but the lower US price for dairy products depresses demand for animal feeds. Consequently, under ber the decline in world price of animal feeds is greater and the increase in the world grain price is less than under pft. Lower feed prices than pft means higher world production of beef and pork and poultry, thus reducing the world prices of these commodities relative to pft.

The removal of dairy supports and beef protection in the free trade simulation decreases the domestic demand for animal feeds and increases US excess supply with the result that world market prices decline by about 4.9 percent and 3.4 percent for oil seed cakes and FGS, respectively. However, relative to pft this decline reduces the amount of resources transferred from grain production. Consequently, the increase in world grain prices tends to be smaller under free trade than under the previous scenarios. Lower animal feed prices increase the production of pork and poultry thereby lowering the world price of pork and poultry. The change in US excess demand for beef is negligible because of the countervailing effects of declines in beef and feed prices.

Production and Price Effects of EC Liberalization When the US follows the Status Quo. In the pft simulation, EC grain, beef, and oil seed cakes prices are reduced dramatically. Consequently, resources flow out of grain and oil seed cakes. Lower EC prices for grains lead EC beef, pork and poultry, and dairy producers to substitute grains for animal feeds. This substitution effect and the contractionary effects to beef, and pork and poultry due to liberalization decrease EC excess demand for oil seed cakes and animal feed substitutes thereby strongly depressing the world price of FGS (about 14 percent). World price of grains and beef increase by 6.9 and 11.2 percent respectively.

*Unilateral  
(EC)*

Under ber, grain and beef protection is higher than under pft. Hence, the increases in the world beef and grain prices are smaller than under pft. However, EC milk and sugar prices decline substantially in imposing self sufficiency in these products thereby reducing excess supply to zero and increasing world prices of these commodities by 18.3 and 5.2 percent respectively. The prices of the remaining commodities change only marginally. Together, the policies of ber cut the world prices of animal feeds more than the policies of pft and increase the world price of the other commodities.

Finally, the free trade simulation increases the world market prices of grain, sugar, beef and dairy more than ber or the pft simulation since ft results in the largest cuts in EC subsidies of these commodities and the resulting decline in their excess supplies. Thus the crop and input demand effects of these liberalizations on animal feed prices are greatest under ft. Indeed, the world price of FGS declines by 25.6 percent as opposed to the estimated 16.7 and 14.2 percent declines in the ber and pft simulations. The decline in the price of oil seed cakes is slightly less under free trade than under ber as the abolition of the cake subsidy in the EC offsets the liberalization of other policies.

Bilateral Liberalization: Bilateral liberalization has mixed effects on world prices across commodities (see the diagonal of Table 2). For grains, dairy, and sugar, bilateral liberalization tends to reenforce the direction of price changes under unilateral liberalization. For instance, in the case of grains, world price increases are greater under bilateral than under unilateral liberalization. For animal feeds, beef, and pork and poultry, a distinct pattern of price changes under bilateral relative to unilateral liberalization does not emerge because the direct effects of liberalization are confounded by the indirect effects of the liberalization of other

commodities.

Welfare and Budget Implications of Liberalization. As is well known, the EC variable levy system transfers income to producers from consumers and the budget. Hence EC liberalization gives rise to large consumer gains which range from 11.4 billion ECUs for pft to 24.4 billion ECUs for free trade. Budget savings is also large but always smaller than the consumer surplus gains. Furthermore most EC budget savings are realized under ber since most budget outlays are from export restitutions.

In the US case, most income transfers to producers occur through the budget, except for dairy and sugar policies. Hence consumer surplus gains in the US range from only .99 billion ECUs under pft to 7.51 billion under free trade when sugar and dairy are liberalized. In contrast, the budget savings range from 14.9 billion ECUs under pft to 16.54 billion under free trade. Consequently, the greatest marginal budget saving occurs from sq to pft when deficiency payments on grains and oil seed cakes are removed.

Under ber sectoral quasi rents decline about 16.5 billion ECUs. From ber to ft they decline an additional 11 billion ECUs, approximately. Thus incremental losses are large from both liberalizations. For the most part they are spread across all sectors as well. However, in the US quasi rents of the grain, dairy, and sugar sectors decline greatest under liberalization. The declines range from 14.4 billion ECUs under pft (mostly losses to grain producers) to 21.1 billion under free trade (mostly losses to grain, dairy, and sugar producers).

\* The US and the EC exhibit similar levels of political influence (Table 1) but their different instruments require different PGF trade offs with liberalization. In the EC a key trade off is between consumers and producers through the variable levy system. Consequently, EC budget savings, which is vitally important to decoupling, is not sufficient to



compensate completely the losers from liberalization. In the US, the PGF trade off is between the budget and producers under pft, but the trade off consumers for producers becomes important under ber and ft.

The welfare effects of bilateral liberalization are largely determined by the effects of unilateral liberalization. Liberalization in the US (resp. EC) does have welfare consequences in the EC (resp. US) but they are always small compared to effects of any unilateral liberalization. For example, the budget savings in the US from ft is at least 16 billion ECUs, but the greatest change in budget savings to the US from an EC liberalization is only 0.2 billion from sq to ber.

#### The Results of the Game:

Game One: By inspection, the status quo is the unique Nash equilibrium of game one (Table 3); it is a strongly dominant action for the US and the EC. Note also that when the US (EC) plays the status quo, it always gains from EC (US) liberalization<sup>1</sup>. Hence, it appears in the self interest of each to encourage the other to liberalize while maintaining its own status quo. Moreover, there is no mutual liberalization for which the EC gains, but the US gains if it pursues pft or ber and the EC pursues pft or ft. The EC would not be interested in these options, since it loses in each of these mutual liberalizations. Finally, it is irrational for the US to propose just ft,ft because it experiences a loss.

The net social gains (SG) of the game appear in Table 2. If the US and EC objectives were to maximize SG, then inspection reveals that ft,ft is a Nash solution when the game is based on these values<sup>2</sup>. And, the only action pair that is not a candidate for a treaty action is pft,ber since the US in

<sup>1</sup>Gains (losses) refer to an increase (decrease) in the value of the PGF for the respective country unless otherwise indicated.

<sup>2</sup>Our treatment of actions are discrete. Thus, it is possible that the Nash solution only lies "close" to free trade.

Table 3: Policy-Goal Function Values For Alternative U.S. and E.C. Trade Liberalization Strategies and Decoupled Payments.

Game One: Using 1986 Action Space					
us\ec <sup>a/</sup>	sq	ber	pft	ft	
sq	0, 0 <sup>b/</sup>	412, -1699	637, -2385	697, -5407	
ber	-560, 517	-234, -1554	165, -1458	233, -4691	
pft	-653, 299	-144, -1795	192, -1805	540, -4948	
ft	-2075, 1020	-1472, -1433	-1329, -656	-877, -4409	

Game Two: Using Decoupled Payments					
us\ec	sq	ber'	pft'	ft'	
sq	0, 0	412, 2057	637, -798	697, 16	
ber'	-2216, 517	2484, 2242	2853, 354	2968, 640	
pft'	1466, -299	1905, 1931	2071, -168	2606, 424	
ft'	1559, 1020	2099, 2255	2400, 1334	2600, 868	

<sup>a/</sup> See text for definition of actions.

<sup>b/</sup> x,y is  $x = V_{us}^{86}$  and  $y = V_{ec}^{86}$

terms of SG, is made worse off relative to the status quo. Consumer groups and those concerned with US and EC budget transfers would tend to advocate free trade actions. However, there are numerous instances where US consumers are made worse off while there are no cases where EC consumers are made worse off. These results also suggest that various interest groups prefer different treaty actions. The problem faced by the political process is the relative importance to attach to these diverse groups; the PGF summarizes the resolution of the competition among these groups for political influence.

Game Two: The 1986 proposal of the US at the Uruguay Negotiating Round called for free trade in agricultural products with the provision that governments could make decoupled payments as income transfers to farmers (National Center). Since 1986, the US has based payments to farmers on traditional yields and acreage whether they plant or not as part of the set-aside program (USDA, 1989). Similarly the EC has instituted production quotas, land set-a-side and less favored areas programs which weaken the link between income transfers and production incentives.

In the spirit of these policies, Game Two alters the action space of Game One. Explicit transfers of the budget savings accruing from the liberalization policies simulated in Game One are made to commodity sectors as compensation for the income losses to producers associated with liberalization. The compensation rule is as follows. Complete compensation is offered to sectors with the highest policy-goal weights first and proceeding to sectors of lower weights until the budget savings are exhausted. Sectors with weights lower than one are excluded from compensation. The distributional rule maximizes the PGF given that the total transfer is no larger than the budget savings from trade liberalization and that no one is over compensated. As such it is a partial

Pareto compensation rule.<sup>3</sup>

For every US liberalization and any EC policy, the US budget savings is sufficient to compensate sectors with weights greater than one fully. However, for no EC liberalization in Game One is the budget savings sufficient to compensate the losers completely regardless of the US action, because, in contrast to the US, income support in the EC is largely from consumers. EC budgetary savings occur only on exports and cannot fully compensate farms for the lost income which was transferred from consumers through high domestic prices.

The ' appended in the payoff matrix of game two (Table 3) to an action reflects the addition of the transfer to each of game one's actions. Through decoupling, only actions sq, pft' and pft', pft' are not treaty actions since the EC suffers a political loss relative to the status quo.

Although the addition of the transfer has no effect on production and consumptions decisions, hence prices, the introduction of transfer payments produces a new Nash equilibrium, both play ber'. In fact, ber' strongly dominates every other strategy of the US and the EC. It is in the best interest of each to pursue ber' regardless of the policy choice of the other. Because the expedient political choice is still to let the consumer make an income transfer to farms through a higher domestic price, freer trade results. Free trade does not.

*leads to unilateral liberalization*

#### Partial Tariffication: Animal Feeds in the E.C.

The October 1989 proposal of the US called for tariffication, i.e., the

<sup>3</sup>The compensation rule of game two assumes that one dollar in a decoupled transfer has the same marginal impact on the PGF as a dollar transferred through commodity policy. If decoupled transfers require more lobbying effort to sustain than do commodity transfers, then the assumption is violated and larger budget transfers would likely be required to retain the status quo. The marginal impacts are also likely to be different for the US than the EC because of differences in the source of transfer (budget relative to consumers) and political structures.

transformation of all trade barriers into their tariff equivalents (USDA publication) However, no tariffs exist on animal feed in the EC but producers of oil seed cakes receive subsidies on domestically produced oil seeds. In this case, tariffication concerns any mutual advantage that might exist in trading a tariff on animal feeds in the EC for cuts in subsidies to producers of oil seed cakes. This trade-off is investigated in this section. The results suggest that the EC and the US can gain from the imposition of tariffs on animal feeds for a reduction of subsidies to oil seed cakes producers.

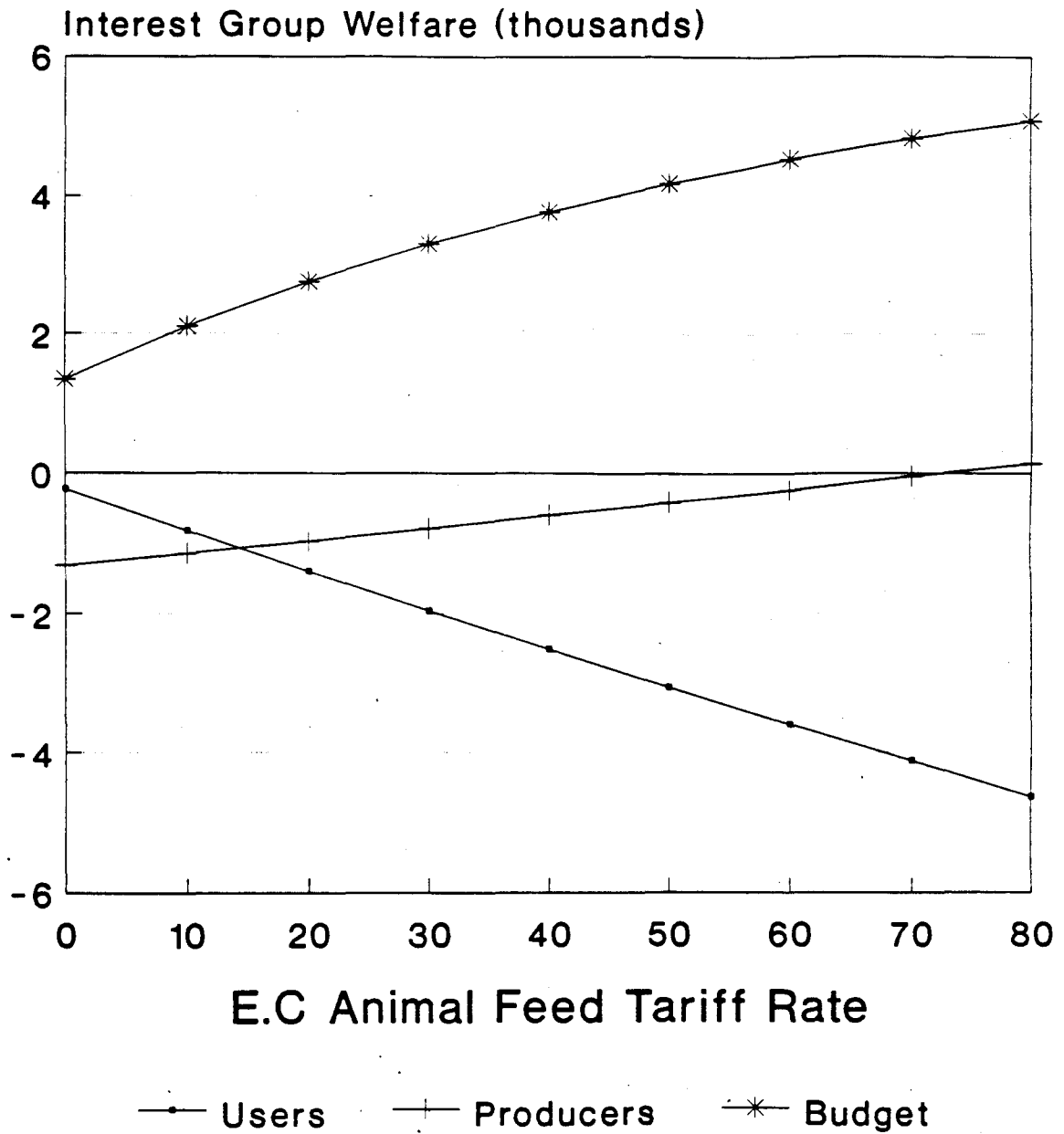
Nine simulations were performed. Holding all other EC policies at the status quo of 1986, tariffs are imposed on oil seed cakes and feed grain substitutes in increments of ten percent, from zero to eighty percent. No change is made in US policies. Tariffication on oil seed cakes requires equality of farm and consumer prices; hence these prices differ from world price by the amount of the tariff. For FGS, farm and consumer prices are already equal; tariffication merely introduces a wedge between domestic and world prices. The effects of tariffication are shown in the Figures 1, 2, and 3.

Tariffication causes changes in the EC budget, consumer surplus and incomes of animal feeds, beef, dairy, and pork and poultry producers. These measures crucially determine the value of the PGF,  $V_{ec}^{86}$ . To ease the graphic analysis (Figure 1), the applied welfare measures of the direct and indirect users of animal feeds are aggregated using the welfare weights of Table 1. For every level of tariffication, the users of animal feeds in the EC suffer income losses and the EC's net budget position improves. The producers of animal feeds experience income losses except for the largest tariffs.

The users of animal feeds lose at zero tariffs because the world price

# FIGURE ONE

## Tariffication Effects on E.C. Welfare



increases for oil seed cakes. Since producer subsidies are zero domestic cake production contracts. As a consequence, EC excess demand increases pushing the world price of animal feeds up. The EC net budget position improves both directly and indirectly from tariffication. It improves directly as tariffs on animal feeds earn revenues and oils seed cakes producers are protected and not subsidized. It improves indirectly because tariffs increase animal feed costs of beef, dairy, and pork and poultry. Hence, the quantity of animal products supplied is reduced cutting excess supply in the EC thereby reducing restitution payments. The subsidies received by EC producers of oil seed cakes in the base year are larger than the protection afforded by the range of tariffs simulated. Their quasi rent loss is greatest at zero tariffs and decreases as greater tariffs increase domestic price.

Changes in world markets resulting from EC tariffication alter the US budget, consumer surplus, and the producer surpluses of animal feeds, beef, dairy, and pork and poultry; they determine the PGF of the US. However, a different scenario transpires in the US because it uses different instruments. US feed producer and user prices follow world prices. At zero tariffs, the gain to US feed producers is largest because the world prices of animal feeds is greatest. Increasing tariffs depress world prices. When world prices fall the change in producer surplus turns from a gain to a loss. For users the reverse is true. At low tariff levels, when world price of animal feeds lies above the world price at the status quo, the users experience a welfare loss. As world price falls below the status quo world price users gain. Budget savings occur because lower oil seed cake prices decrease oil seed cake production in the US which in turn decreases budget outlays. Figure (2) depicts these results.

Figure (3) shows the  $V_{us}^{86}$  and  $V_{ec}^{86}$  of tariffication which result from the

weighted summation of user value, producer value, the budget, and the smaller gains and losses of producers of other commodities in the US and EC respectively. When the EC must tie the producer price of oil seed cakes to the consumer price of oil seed cakes the protection of producers occurs only at the expense of users. The result is that  $V_{oc}^{86}$  is maximized not at the status quo level of producer prices but at the lower level of forty percent. For the US when tariffs are between zero and fifteen percent,  $V_{us}^{86}$  is positive because the gains to producers and the budget outweigh the loss to users. For tariff rates from fifteen to forty percent, the gains to users and budget outweigh the loss to producers hence  $V_{us}^{86}$  is still positive. After forty percent the losses to producers dominate the gains of users and the budget. Consequently  $V_{us}^{86}$  is negative.

At tariff levels between zero and forty percent  $V_{us}^{86}$  is positive. At tariff levels between seven and seventy three percent  $V_{oc}^{86}$  is positive. These results imply that tariffication in animal feeds is likely to be politically acceptable if it occurs within the seven to forty percent range, all else constant. By comparison with game two, the gains from tariffication are small compared to those which result from decoupling.

#### EC Harmonization - US liberalization Trade-Offs

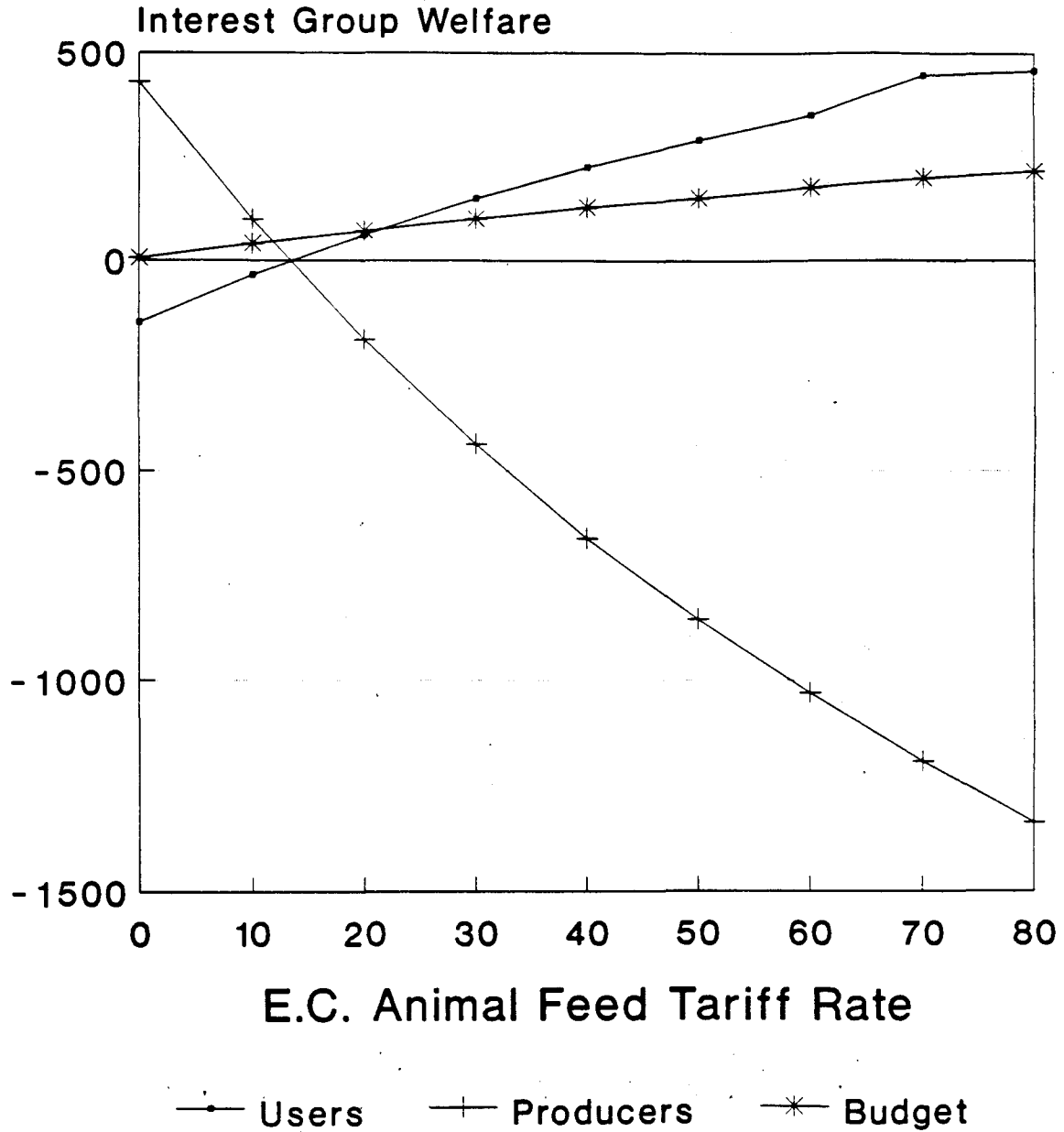
An important component of the EC's position at the current GATT round is the harmonization or rebalancing of the prices of imported animal feeds with the domestic prices of grain (EEC). In essence, since a significant portion of EC grain production supplies feed to animals, the EC wishes to trade cuts in the support price of grains and cakes for tariffs on cakes and FGS (National Center). These tariffs are currently prohibited by previous GATT agreements.

Insights into these trade offs are obtained by performing simulations for a set of tariffs on animal feeds in the EC, cuts in the EC price



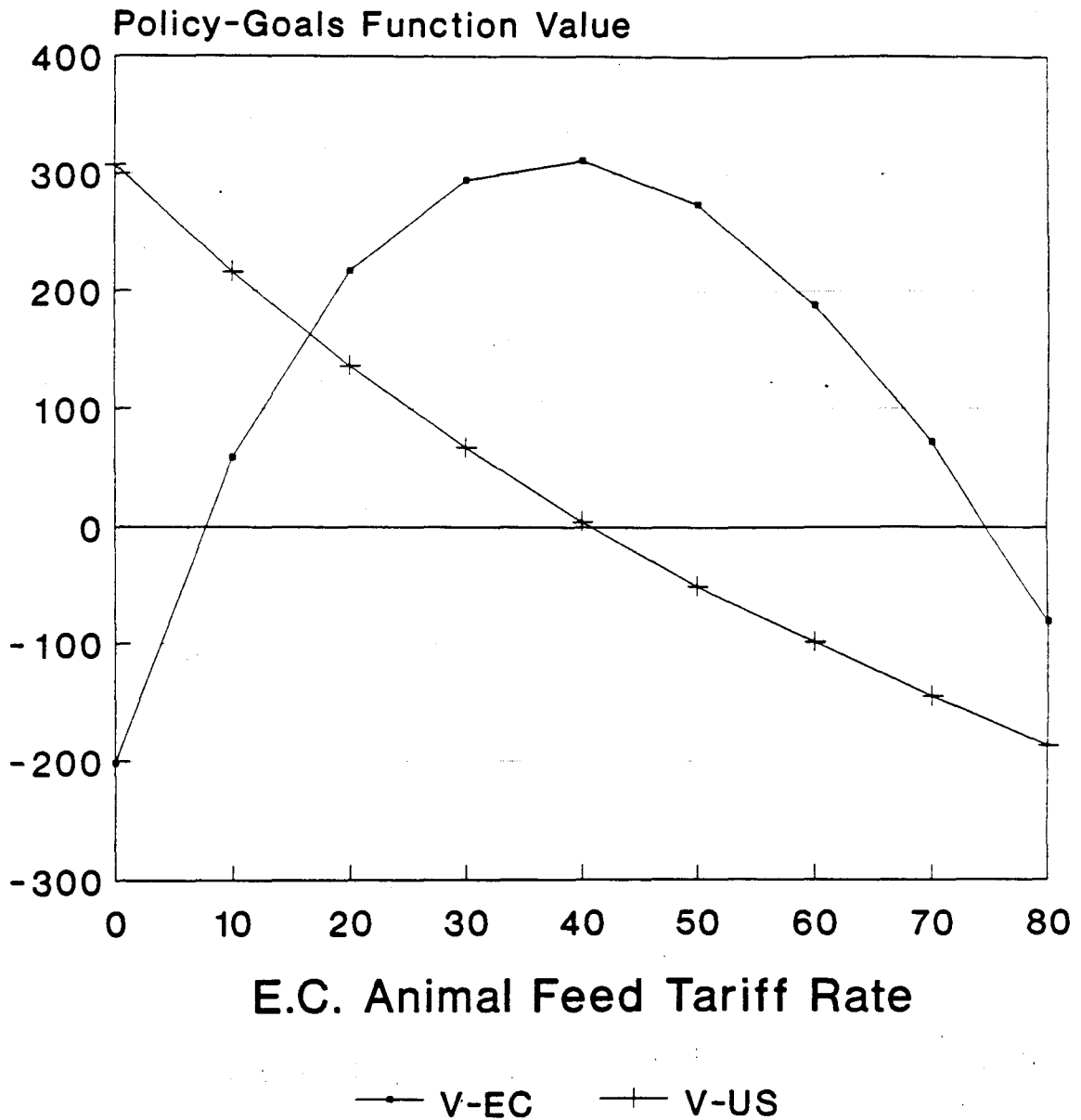
# FIGURE TWO

## Tariffication Effects on U.S. Welfare



# FIGURE THREE

## Policy-Goals Function Values

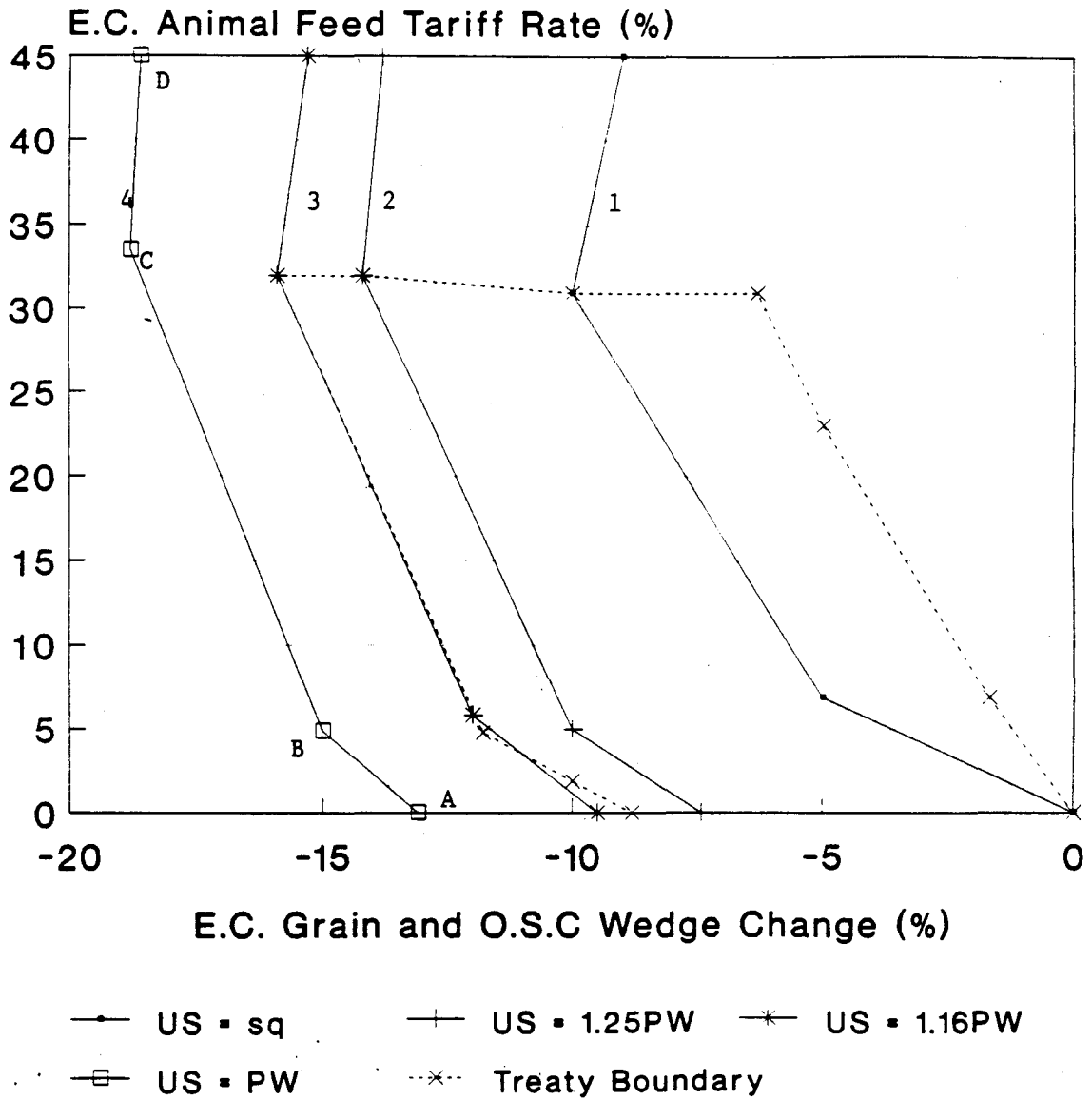


supports of grains and oil seed cakes, and liberalizing policies in grains and animal feeds in the US. A treaty action space is found to exist where the harmonization - liberalization trade offs yield non-negative values of the EC and US PGFs. All other policies remain unchanged from the status quo of 1986. Yet the improvements in the PGFs of the US and the EC for actions in this space are modest compared to gains from decoupled payments.

The estimation proceeds in two steps. First, simulations are performed to find combinations of EC harmonizations for given US actions that leave the EC no worse off than the status quo. For a given US action, a coordinate point is obtained for each EC harmonization. To illustrate, consider curve 4, coordinate A, Figure 4. The US pursues free trade in grains and oil seed cakes which leaves  $V_{ec}^{86}$  positive. To reduce  $V_{ec}^{86}$  to zero (its status quo value), the EC wedges between the consumer - producer prices of grains and the world grain price, and the EC wedge between the producer and world price of oil seed cakes are reduced until  $V_{ec}^{86}$  is zero. The needed decrease in the price wedge is 13.1 percent. At coordinate B, these price wedges are cut by 15 percent; since this leaves the  $V_{ec}^{86}$  negative, it is necessary to levy a tariff of 5.8 percent on oil seed cakes and FGS to restore  $V_{ec}^{86}$  to zero. At coordinate D, a tariff rate of 40 percent on these commodities requires a price wedge cut of 9.5 percent to attain a  $V_{ec}^{86}$  of zero. Connecting A, B, C, and D defines the EC's indifference curve for the given US action. Their coordinate values also appear in the bottom panel of Table 4.

Note that if the US "buys" wedge cuts with tariffs, the cheaper "purchases" occur at tariff rates no greater than the point of inflection, C. Finally, for each of these coordinate points, the value of the US's PGF is recorded. These values are negative for the mentioned points. The other US policy actions are: curve 1 (first panel, Table 4), the status quo of

### Figure 4: E.C. Harmonization Indifference Curves



1986; curve 2 (second panel), abolish the export enhancement program, no Commodity Credit Corporation support of animal feeds, and set the price of grain at 1.25 of the world price; curve 3 (third panel), same as curve 2 except reduce the price of grain to 1.16 of the world price; curve 4 (fourth panel), free trade. US animal product and sugar policies are unchanged from the status quo.

The indifference curves and their respective US policies identify the top and bottom boundaries of a treaty action space in EC harmonization and US liberalization of the grain and animal feeds sectors. The second step finds the left and right hand boundaries of the treaty action space. The left hand boundary traces those EC harmonizations which set  $V_{ec}^{86}$  and  $V_{us}^{86}$  equal to zero for a given US liberalization. On the right hand boundary, the US pursues the status quo (it smallest liberalization). The coordinate points on the right hand boundary depict EC harmonizations where  $V_{us}^{86}$  is zero and  $V_{ec}^{86}$  is positive<sup>4</sup>. Further movement to the right leads to negative values of  $V_{us}^{86}$ . Hence, this boundary identifies those points of smallest harmonization in the EC and smallest liberalization in the US.

Within these four boundaries is the treaty action space of harmonization and liberalization such that for any harmonization (liberalization) in the space, there is at least one liberalization (harmonization) in the space such that the PGFs of the US and the EC are at least zero. As shown in Figure 4, the treaty action space suggests that considerable latitude exists for trading EC tariffs and price cuts in grain and oil seed prices for US liberalization in grains and animal feeds.

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<sup>4</sup>In other words, beginning with curve 1 where the US is following the status quo, movement toward the right hand boundary traces a locus of EC harmonizations. Since the US action is fixed, movement toward the boundary results in an increase in the EC's PGF and a decrease in the US's PGF. At the boundary, the US's PGF is zero, beyond the boundary, it is negative.

Table 4: In Search of Harmonization: E.C. Tariffs on Animal Feeds and Cuts in Grain and Oil Seed Cakes Support for U.S. Cuts in Grain and Animal Feed Support.

E.C. Grain and Oil Seed Cakes: Change in Dom- estic to World Price Wedge (%)	E.C Ad Valorem Tariff on Animal Feeds (%)	U.S Value of Policy Goals Function ( $V_{us}^{86}$ ) <sup>a/</sup>
Panel 1: US Action: Status Quo		
0	0	0
-5	6.7	75
-10	31	88
-9	45	32
Panel 2: US action: No CCC support, $P_{fg} = 1.25 * P_{wg}$		
-7.4	0	48
-10	5	87
-14.2	32	88
-13.8	45	38
Panel 3: US action: No CCC support, $P_{fg} = 1.16 P_{wg}$		
-9.5	0	-36
-12	5.8	-1
-15.9	32	0
-15.3	45	-47
Panel 4: US action: No CCC support, $P_{fg} = P_{wg}$		
-13.1	0	-377
15	5.8	-350
-18.8	33.5	-350
-18.6	45	-388

<sup>a/</sup> EC policy-goal function values equal zero for all simulations.

However, as noted in more detail below, the political and social gains are small relative to those obtained from decoupling.

Finally, Table 4 reveals two important results which are not easily seen from Figure 4:

(1) As the US liberalizes, the intercepts of the indifference curves on the wedge cut axis increase (in absolute terms), but the difference between the largest and smallest wedge cut on an indifference curve decreases. Hence, the greatest cut in the EC support price of grain and cakes which the US could obtain through harmonization and, which the EC is willing to trade, decreases with the degree of US liberalization.

(2) By inspection of Figure 4, below the inflection point, the slope of each indifference curve becomes steeper with greater tariffs. By Table 4, the slope is always less than -1. Thus, at the margin, the US gives up a greater tariff for a smaller cut in the price wedge. Furthermore, the marginal trade off decreases with each greater tariff. For example, for curve 2, the trade offs are a tariff increase of 5 percent for a wedge cut of 2.6 percent (from 7.4 to 10 percent) and a tariff increase of 27 percent (from 5 to 32 percent) for a cut of 4.2 percent (from 10 to 14.2 percent). Hence, for a given US policy, additional wedge cuts are obtained at the price of larger increases in tariffs until the point of inflection is reached.

Two points in the treaty action space, one each on curve 1 and 2, are chosen to discuss the economic and welfare consequences of harmonization. These are the first two interior harmonizations for the first two US policies: the status quo; and no CCC support of oils seed cakes, no EEP for grains and target price equals 1.25 times world price. Call these the first and second harmonizations, respectively.

Both harmonizations lead to increases in the world price of grain. In

the first, the EC cut in the price wedge for grain and oil seed cakes decreases its excess supply inducing a corresponding increase in world grain price by 1.1 percent. In the second, excess supplies are reduced further by the US support cut and the abolition of the EEP and the additional EC cuts in price wedges causing the world grain price to increase by 6.4 percent relative to the status quo. The world price of feed grain substitutes declines for both scenarios. The decline is greater in the first harmonization because the tariff on EC imports is larger than in the second. The price of oil seed cakes decreases by 1.1 percent in the first harmonization as a result of the EC tariff on cakes and the feed grain substitution effect. It rises in the second case by 0.6 percent because of the US abolition of the CCC support which decreases US production enough to raise its world price despite EC tariffs.

In the EC, the groups most affected by harmonization are the producers of grains and animal feeds, consumers and the budget. This affect is consistent with the EC intention to restructure input prices to affect animal sector incomes minimally. This accomplished, the important political trade off is between the budget savings and the welfare losses of producers of grains and oil seed cakes. Producers lose about 1.02 billion ECU in the first harmonization and about 1.2 billion ECU in the second. For the first and second harmonization, EC budget savings of 1.13 and 1.22 billion ECU accrue from tariff revenues and from diminished outlays for grain restitutions and oil seed cake subsidies. Increases in consumer surplus of 0.37 and 0.48 billion ECU are then sufficient to overcome the lose to producers and, hence, push  $V_{ec}^{86}$  to zero.

In the first harmonization, US producer losses (0.34 billion ECU) are small, slightly less than the budget savings, evenly distributed across all sectors except for the grains and sugar whose output prices are unchanged at



the status quo. Consumer gains are negligible. In the second harmonization, the major trade off is between producer surplus in grains and oil seed cakes and the budget. In contrast to the EC, although the values of the US PGF do not change much from one harmonization to the other (see Panel 1 and 2, Table 4), the magnitude of budget savings and producer surplus losses increase dramatically relative to the first harmonization. US producer losses are 6.96 billion ECU while budget savings and consumer gains are 7.78 and 0.36 billion ECU, respectively.

The social gain to the EC is about 0.5 billion ECU for both harmonizations. For the US, the social gain increases from 0.02 in the first to 1.18 billion ECU in the second. This change reflects the effects of the large target price reduction for grains in the US.

#### CONCLUSIONS

The previous section presented results of three groups of simulations to test whether the game theoretic model is consistent with the respective negotiating positions of the US and the EC by finding sets of policies within those negotiating positions which lead to mutually advantageous outcomes for the US and the EC.

In the games section, the estimated model seemed consistent with the US negotiating position of free trade with decoupling. It was shown that for the US and the EC, the introduction of decoupled payments to producers could lead to unilateral liberalization. Freer trade, not free trade, results because it remains politically optimal for consumers to bear part of the cost of agricultural policies. By extension, recent instrument innovations of the US and the EC have occurred out of self interest because they implicitly decouple a portion of the support payment from production decisions.

In the tariffication section, the US proposal to transform domestic support policies on oil seed cakes into equivalent tariffs on cakes and feed

grain substitutes was evaluated. Tariffs on cakes and FGS between seven and forty percent are mutually advantageous for the US and the EC. The harmonization section addressed the EC proposal to trade cuts in support prices of oil seed cakes and in domestic prices of grains for the introduction of tariffs on cakes and feed grain substitutes. Mutually advantageous actions of EC harmonization and US liberalization were found. However, the political and social gains of harmonization and tariffication are small compared to the political and social gains from trade liberalization that introduces decoupled payments and abolishes export subsidies and production subsidies on exported commodities.

As mentioned, the strict application of the model requires stability in the political process and the economic environment. When these change weights and instruments may change. For example, the 1986 policies led to unusually high budget outlays in the US and the EC. These outlays may have induced countervailing lobbying by those adversely affected with the result that the weights of producers could have declined since 1986. Thus the treaty action spaces may understate the loss in producer incomes that the US and the EC may be willing to trade for lower budget costs of agricultural policies.

Reconciling the special status of agriculture with trade liberalization has been a major <sup>o</sup>bstacle in obtaining an agricultural trade agreement during the Uruguay Round of the GATT negotiations. To quantify this special status, the model presented characterizes the 1986 agricultural policies of the US and the EC as rational outcomes of their respective political processes. The model suggests that such a reconciliation is possible. Of course it is only a necessary condition for a GATT treaty -should one be agreed to at the current Uruguay Round- that it is acceptable to the US and the EC; other parties to the GATT must also agree to the

treaty. If multilateral liberalization increases world prices more than bilateral EC/US liberalization then US and EC producer losses will be less and their budget savings greater. The treaty action spaces of the US and the EC will consequently expand over other liberal alternatives making more liberal outcomes more likely.

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