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GAME MODELLING THE TOKYO ROUND OF TARIFF NEGOTIATIONS

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ABSTRACT

Using actual trade and tariff data for the United States and the European Community, this paper demonstrates how a trade negotiation such as the Tokyo Round, can be modelled as a game among countries attempting to minimize individual welfare loss functions. Once welfare functions are constructed, we compute both noncooperative and cooperative Nash equilibria. These welfare outcomes are then compared with those arising from the initial tariff structure, as well as the structure actually determined by the negotiation. We find that while the game model may track closely the decisions of the negotiators in the Tokyo Round, later unilateral political decisions resulted in less "optimal" tariffs.

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Executive Summary

GAME MODELLING THE TOKYO ROUND OF TARIFF NEGOTIATIONS

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Negotiations in the Tokyo Round over the tariff-cutting formula to be followed by the participants evolved into a bargaining process between the United States and the European Community in which other industrial countries played the role of mediator seeking a compromise acceptable to the two largest trading powers. The announced goal of U.S. negotiators was to obtain a duty cutting formula that would produce a deep average cut in tariffs. Their intention seemed to be to thereby further reduce the diversionary effect on U.S. exports caused by the formation and expansion of the European Economic Community. In contrast, Community negotiators stated that they sought a duty-cutting rule that would reduce the degree of dispersion of tariff rates around a country's average level of duties. Although the average level of duties in both trading blocs was about the same, the U.S. duty schedule contained many more high (and low) tariff items than the Community's. Negotiators from the E.C. believed that the high rates in the U.S. caused exports from third countries to be diverted from the U.S. into the Community and thus aggravated their import-competition problems. (At the same time they maintained that the middle level E.C. rates were not sufficiently high to cause a sigificant shift of third country exports to the low duty categories in the United States.) Neither trading partner placed much emphasis on the other's prime objective but both wanted to achieve reciprocity in the sense of the average cut in the other's tariffs being about the same as in their own average tariff reduction.

In game-theoretic terms the negotiators from the United States and the European Community can be viewed as each having a welfare function that depends upon the depth of the average cut, the extent to which the dispersion of tariffs around the average level are reduced, and the degree to which the depth of the average cuts are the same. The goal of each negotiating team is to minimize its overall welfare loss resulting from failing to satisfy perfectly its objective with respect to each component in its welfare function.

Using actual pre-Tokoyo Round duty rates (classified on the basis of 22 sectors) for the U.S. and the E.C., we calculate for each trading bloc the average duty cut, the variance in duty rates, and the extent by which the average cut of one diverges from that of the other, first, for the cutting rules proposed by the two trading partners and, then, for the cutting rule proposed by the other participants and accepted by the United States and the European Community. We next select for the two trading partners the relative weights for each of the three components in their welfare functions. In these selections we are guided not only by the announced goals of each trading power but by the supposition

that the initial cutting rules proposed by the U.S. and the E.C. should yield a low welfare loss for the proposing trading power compared to the welfare loss for the other trading partner. The compromise rule proposed by the other pariticipants should produce an intermediate welfare position for each.

After choosing welfare rates that yield these results, we then compute the theoretic Nash noncooperative and cooperative equilibria on the basis of these weights. The overall welfare losses of the U.S. and the E.C. are lower under the noncooperative and the cooperative solutions than under the compromise formula as well as under the rules proposed by each, thereby suggesting that the actual negotiating process was not as efficient as it could have been. It was also found that the cuts actually achieved after taking into account the various exceptions to the formula cuts and the pullbacks thought to be necesary to achieve reciprocity, although better than the initial rates, were inferior in welfare terms for both parties not only to the game-theoretic solutions but to thfe cutting rules proposed by either party. While one would expect that the political necessity of making sector exceptions to the full cuts given by the agreed-upon formula would reduce welfare levels compared to those given just by the negotiators' goals in seeking an acceptable cutting rule, the extent of the welfare differences suggests that this part of the negotiations also was not as beneficial to each partner as it could have been.

1. Introduction

Governments participating in trade-liberalizing negotiations invariably regard reductions of their own import barriers as concessions to other countries, and cuts in foreign import restrictions as gains to their own country. This attitude could conceivably be justified on the economic grounds that decreases in import barriers reduce national welfare due to adverse terms of trade effects, or because existing tariff levels enable a country to capture part of the rents earned by imperfectly competitive foreign firms selling in domestic markets. 1/ However, a political economy explanation of this behavior seems more plausible.

Cheaper imports not only increase consumer welfare but may cause temporary unemployment and losses in particular industries. These latter impacts can significantly reduce the real income of certain groups, while the consumer gains are likely to be spread thinly over many individuals. Because of their small numbers and the large per-person income changes at stake, individuals in the import-impacted sectors are more likely than consumers to overcome the free-rider problem of collective action by organizing the voluntary financial contributions needed for effective lobbying. Even though the aggregate benefits to consumers exceed the aggregate losses to producers, the individual consumer is likely to consider it not rational to contribute to an interest group seeking a liberal trade policy which, if adopted, would benefit that

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1/ For the latter possibility, see J. Brander and B. Spencer, "Trade Warfare: Tariffs and Cartels," Journal of International Economics (May 1984).

individual regardless of whether he or she contributed. Consequently, since initiating a duty-cutting exercise may threaten elected officials with the withdrawal of voting and campaign-funding support, it is quite understandable that government negotiators regard voluntary reductions in their own levels of protection as "concessions."

Yet political leaders representing the nation as a whole also seem to believe that there are significant political and economic advantages associated with reciprocal trade-liberalizing negotiations. Rightly or wrongly, they tend to think that trade liberalization promotes better economic relations among nations, and reduces political tensions. Furthermore, the correlation between economic prosperity and trade liberalization in the post-1945 period appears to have convinced most political leaders that general reductions of trade barriers promote overall prosperity for their nations. Therefore, they are sometimes prepared to accept the political risks of antagonizing organized groups representing import-competing sectors, and engage in multilateral trade negotiations. At the same time, they, of course, try to minimize their political costs by stressing the employment and profit benefits stemming from increased export opportunities due to lower foreign trade barriers, by staging cuts in tariffs and other barriers over an extended period, and by excluding certain industries from the liberalizing process. Understandably, each country's negotiators will attempt to shape the rules and processes followed in the negotiations in ways that enable them, and their political superiors to claim that the employment gains from increased exports exceed the employment losses due to increased imports.

In the first six rounds of multilateral negotiations sponsored by the General Agreement of Tariffs and Trade (GATT) between 1947 and 1962,

bargaining over reciprocal tariff cuts took the form of item-by-item negotiations. However, in the last two multilateral negotiations, i.e., the Kennedy (1962-67) and Tokyo (1974-79) Rounds, the participants dropped this cumbersome bargaining method in favor of a procedure under which the participating countries negotiate a tariff-cutting rule or formula that--with some exceptions--would apply to all dutiable items. 2/ In the Kennedy Round, the American negotiators proposed the rule that all duties be cut by 50 percent and, in effect, informed the other participants that the United States would not participate in the negotiation unless this formula was adopted. However, in the Tokyo Round the negotiations on the duty-cutting rule were more open and flexible. Essentially, the bargaining process evolved into one between the United States and the European Community, with other participants acting as facilitators in reaching a formula acceptable to these two economic superpowers, as well as to themselves.

This framework suggests that multilateral trade negotiations can be modelled as a game between several player-countries with the Tokyo Round serving as an example of a two-country game. Each country has payoffs or levels of welfare that depend on characteristics of the negotiated structure of protection. We examine two different types of tariff equilibria. One, the noncooperative Nash solution, assumes that countries negotiate antagonistically with one another. Each country considers only the direct influence that its proposed tariff schedule has on itself. It is not concerned about the level of welfare the tariff-cutting rule secures for the

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2/ The procedure for determining what items would not be subject to the tariff-cutting rule and what withdrawals would be made in response to other countries' exceptions was similar to traditional item-by-item negotiations.

other participants. Another equilibrium is the Nash bargaining solution. This cooperative equilibrium supposes that countries seek to maximize the joint welfare of the group, hence improvements in a single country's welfare are only sought to the extent that they improve the joint payoff.

In the following section the tariff goals of different countries, in particular the United States and the European Community, are presented and specified as components of an overall welfare function for that country. The consistency of these goals will also be analyzed. Section 3 uses these individual welfare functions to demonstrate the noncooperative Nash and Nash bargaining equilibria. Several theoretical characteristics of these equilibria are examined and related to observed characteristics of the tariff negotiations process. In Section 4, we attempt to estimate the relative weights that the U.S. and E.C. attached to the different components of their welfare functions based upon various statements made by representatives of these countries prior to and during the actual negotiating process. We further refine these weights using the two countries' sequentially suggested tariff-cutting rules as additional data. In Section 5, the welfare weights and theoretical game equilibria are compared with the tariff rates actually negotiated in the Tokyo Round of multilateral negotiations. Concluding remarks are in Section 6.

2. Tariffs and Welfare

At the outset and during the early phases of negotiations, countries indicate to other participants the characteristics of the pattern of tariffs they consider most important in terms of their negotiating goals. These characteristics can be combined into a utility function that cumulates the

welfare effects that a country receives from a particular set of tariff rates. 3/

For convenience, we display a model for two countries with k different product classifications. It is straightforward to extend this analysis to any finite number of country-players. Initially, each country has a k-vector of tariff rates for the set of product classifications:

$$t^0 = (t_1^0, \ldots, t_k^0)' ,$$

$$s^0 = (s_1^0, \ldots, s_k^0)' , \text{ 4/}$$

where t^0 represents country 1's initial tariff vector and s^0 represents country 2's initial tariff vector. Through negotiations, countries seek to establish new tariff vectors:

$$t^1 = (t_1^1, \ldots, t_k^1)' ,$$

$$s^1 = (s_1^1, \ldots, s_k^1)' ,$$

that better satisfy their welfare criteria for a desirable tariff structure.

The relative quantities of goods that each country imports of each product class are given by two additional k-vectors:

$$m = (m_1, \ldots, m_k)' ,$$

$$n = (n_1, \ldots, n_k)' ,$$

where m represents country 1's imports and n represents country 2's imports.

3/ Whether these publicly suggested tariff characteristics are an accurate indicator of a country's true preferences is another subject that will be investigated later. We do this by using numerical examples to evaluate how closely the actual proposed and negotiated tariffs compare to the ones that would be optimally implied by the professed considerations.

4/ A prime indicates a transposed vector.

A vector component m_i is the fraction of country 1's total imports that are in product class i. Similarly for country 2. 5/ While it is quite reasonable that the desired import vector should change as tariffs shift from their initial values to their final values, we assume that each country's import bundle remains fixed. This analysis could be expanded to accommodate different initial and final import vectors, however.

We now examine and quantify several of the characteristics countries may desire for the structure of tariff rates.

A. Some countries, in particular, the members of the European Community, are concerned about the variability of tariff rates across products. Although the average level of industrial tariffs in the Community is about the same as in the United States and in other developed countries such as Japan, the extent of dispersion of the E.C.'s rates about their average level is much less than in the United States and Japan. 6/ According to Community officials, reducing all tariff rates by, say, 50 percent still leaves a group of relatively high tariff items in countries such as the United States that are significantly protected. In other words, they seem to believe that there is overkill in high tariff rates, and that these rates will still have a considerable protective effect even after a uniform percentage cut. They maintain it is necessary to reduce high duties by a greater percentage than low duties in order to eliminate this effect and to achieve reciprocity.

5/ It is also possible to interpret m_i and n_i entries as actual dollar values of imports in product class i--if country 1 and country 2 have equal total amounts of imports.

6/ This lower degree of dispersion is the result of the simple averaging of country rates on tariff items that was performed when the Community was formed.

Community negotiators also believe that higher percentage cuts are needed to correct for the diversion of third countries' trade from the United States to the Community caused by high U.S. rates. 7/

We measure the variability of a country's tariffs by the country's unweighted variance of different product class tariffs around their unweighted mean tariff divided by a measure of the mean squared tariff rate desired for that country. 8/ This measure of country 1's tariff variability is called A_1, and of country 2's tariff variability is A_2:

$$(2.1)\quad A_1 = \frac{1}{(k-1)\bar{t}^{*2}} \sum_{i=1}^{k} (t_i^1 - \frac{1}{k} \sum_{j=1}^{k} t_j^1)^2$$

$$= \frac{1}{(k-1)\bar{t}^{*2}} (t^1 - \frac{1}{k} ee' t^1)' (t^1 - \frac{1}{k} ee' t^1)$$

$$= \frac{1}{(k-1)\bar{t}^{*2}} t^{1\prime} (I - \frac{1}{k} ee')t^1$$

$$(2.2)\quad A_2 = \frac{1}{(k-1)\bar{s}^{*2}} \sum_{i=1}^{k} (s_i^1 - \frac{1}{k} \sum_{j=1}^{k} s_j^1)^2$$

$$= \frac{1}{(k-1)\bar{s}^{*2}} (s^1 - \frac{1}{k} ee' s^1)' (s^1 - \frac{1}{k} ee' s^1)$$

$$= \frac{1}{(k-1)\bar{s}^{*2}} s^{1\prime} (I - \frac{1}{k} ee')s^1$$

7/ Community officials first made these points in the Kennedy Round and repeated them in the Tokyo Round. See Robert E. Baldwin, "Tariff-Cutting Techniques in the Kennedy Round" in R. E. Caves, H. G. Johnson, and P. B. Kenen (eds.) Trade, Growth, and the Balance of Payments. (Chicago: Rand McNally, 1965).

8/ The purpose of this variance normalization is to make the variability measure less sensitive to the absolute level of tariffs.

where e is a k-vector of ones, e = (1, ..., 1)', and $\bar{t}^*$ and $\bar{s}^*$ are the measures of unweighted average tariff rates desired for the U.S. and E.C. respectively. 9/ Note that since A_i increases as country i's tariff variability rises, countries seek to reduce the size of the A_i's. Thus A_i can be considered a component of a negative utility function or a loss function for each country's welfare. A country's goal, then, is to minimize its welfare loss.

B. Countries also have views concerning the optimum average level of tariffs. Government leaders who believe that lower tariffs promote economic efficiency and domestic growth will balance these goals against the greater political pressures import-competing industries bring to bear on them the deeper they cut the average duty. A particular reason why the United States pushed strongly for a deep average duty cut in the Kennedy Round and also in the Tokyo Round was to reduce the margin of preference provided to Community members selling within the Community--compared to United States sales to the Community. Thus, reducing the extent of the trade diversion from imports from the United States brought about by the elimination of duties within the Community has been an important goal of U.S. trade policy.

9/ These measures are computed as follows: $\bar{t}^* = \frac{\delta}{k} \sum_{j=1}^{k} t_i^o$ and $\bar{s}^* = \frac{\delta}{k} \sum_{j=1}^{k} s_i^o$. The desired reduction from average tariff rates δ, is computed as the simple average of the U.S.'s and E.C.'s desired tariff reductions, δ_1 and δ_2. Hence $\delta = \frac{\delta_1 + \delta_2}{2}$. The values of δ_1 and δ_2 are explained in the next paragraph.

We assume that each country has a desired percentage reduction in tariff collections by each country. Country 1 desires a reduction of $1-\delta_1$, and country 2 of $1-\delta_2$. 10/ Thus if tariff collections are initially $\sum_{i=1}^{k} m_i t_i^o$ and $\sum_{i=1}^{k} n_i s_i^o$, country j would prefer these collections to be

$$\delta_j \sum_{i=1}^{k} m_i t_i^o \quad \text{and} \quad \delta_j \sum_{i=1}^{k} n_i s_i^o.$$

Loss of welfare results if actual negotiated tariffs do not yield approximately these desired levels of collection. We assume that the amount of loss is proportional to the square of the divergence between desired and negotiated collections. Country 1's loss from not meeting its target reduction in own tariffs is denoted B_{11}. Its loss from country 2's tariff reduction not equalling country 1's desires is B_{12}. Country 2's loss on country 1's failure is B_{21}, and on its own divergence is B_{22}.

$$(2.3) \quad B_{11} = \left[\sum_{i=1}^{k} m_i t_i^1 - \delta_1 \sum_{i=1}^{k} m_i t_i^o\right]^2$$

$$= [m'(t^1 - \delta_1 t^o)]' [m'(t^1 - \delta_1 t^o)]$$

$$(2.4) \quad B_{12} = \left[\sum_{i=1}^{k} n_i s_i^1 - \delta_1 \sum_{i=1}^{k} n_i s_i^o\right]^2$$

$$= [n'(s^1 - \delta_1 s^o)]' [n'(s^1 - \delta_1 s^o)]$$

10/ Desired percentage increases would be denoted by negative δ_i's.

$$(2.5)\quad B_{21} = \left[\sum_{i=1}^{k} m_i t_i^1 - \delta_2 \sum_{i=1}^{k} m_i t_i^0\right]^2$$

$$= [m'(t^1 - \delta_2 t^0)]' [m'(t^1 - \delta_2 t^0)]$$

$$(2.6)\quad B_{22} = \left[\sum_{i=1}^{k} n_i s_i^1 - \delta_2 \sum_{i=1}^{k} n_i s_i^0\right]^2$$

$$= [n'(s^1 - \delta_2 s^0)]' [n'(s^1 - \delta_2 s^0)]$$

C. For negotiators to be able to gain domestic political support for the tariff rates proposed by the negotiation, they must be able to claim that reciprocity (or better) was achieved with their negotiating partners. A commonly accepted standard for reciprocity is that the average duty cut, as measured by the percentage change in pre-cut and post-cut tariff revenues (based on the pre-cut import values), be the same among the major trading participants. Consequently, we shall assume that each country expects other countries to alter the import-weighted level of their tariffs to the same degree as it does. In our two-country model, we shall measure this difference in tariff cuts by the squared divergence between the percent change in country 1's and country 2's import-weighted tariff levels, and call this C in equation (2.7).

$$(2.7)\quad C = \left[\frac{\sum_{i=1}^{k} m_i(t_i^1 - t_i^0)}{\sum_{i=1}^{k} m_i t_i^0} - \frac{\sum_{i=1}^{k} n_i(s_i^1 - s_i^0)}{\sum_{i=1}^{k} n_i s_i^0}\right]^2$$

$$= \left[\frac{m'(t^1 - t^0)}{m't^0} - \frac{n'(s^1 - s^0)}{n's^0}\right]' \left[\frac{m'(t^1 - t^0)}{m't^0} - \frac{n'(s^1 - s^0)}{n's^0}\right]$$

D. Sometimes negotiators express a desire to have equal protective levels in each sector, thereby creating a so-called "level playing field" in each broad industry grouping. This concept of sectoral negotiations is set forth as an objective in the U.S. Trade Act of 1974. 11/ However, the time-consuming nature of the negotiations on various nontariff trade barriers precluded extensive negotiations along these lines. Only in the civilian aircraft sector were such negotiations successful. The European Community was also not very enthusiastic about sectoral negotiations and specifically stated that harmonization did not require an equalization of customs duties for the same products. However, since this goal is likely to be relevant for future negotiations, we describe it in this outline of negotiating objectives, though we shall not include it when analyzing the Tokyo Round empirically.

The inter-country similarity of product-class tariffs would be measured by the sum of squared deviations between countries' tariffs on individual product classes:

$$(2.8)\quad D = \frac{1}{k-1} \sum_{i=1}^{k} (t_i^1 - s_i^1)^2$$

$$= \frac{1}{k-1} (t^1 - s^1)' (t^1 - s^1).$$

Each country would experience this loss if tariff schedules are not equivalent across products.

11/ See Trade Act of 1974, Public Law 93-618, 93rd Congress, H.R. 10710, Sec. 102.

E. A country's overall welfare loss from failing to perfectly satisfy each of these criteria for a desirable tariff structure is a weighted sum of the individual losses listed above. Since countries may differ in their relative concern for each criterion, we allow the weights attached to different loss sources to vary over countries. Thus we may denote country 1 and country 2's overall welfare loss from a new set of tariffs t^1 and s^1 when initial tariffs are t^0 and s^0 as:

$$(2.9) \quad L_1(t^1,s^1) = a_1A_1 + a_2A_2 + b_1B_{11} + b_2B_{12} + cC + dD,$$

$$(2.10) \quad L_2(t^1,s^1) = \alpha_1A_1 + \alpha_2A_2 + \beta_1B_{21} + \beta_2B_{22} + \gamma C + \delta D.$$

The weights a_1, a_2, b_1, b_2, c, d and α_1, α_2, β_1, β_2, γ, δ for countries 1 and 2, respectively, are nonnegative constants. Their relative values determine the differences in importance of individual criteria to a country and differences in interest across countries.

F. Each country wishes to choose a set of tariffs that minimize its welfare loss, $L_i(t^1,s^1)$. However, it is generally not possible for a country to eliminate completely all loss. This is because minimization of one source of welfare loss may be inconsistent with minimizing another source. Before we examine (in the next section) how countries decide what is the overall most favorable tariff structure, we first look at the compatibility of these several negotiating objectives.

Countries wish to reduce the variance of their tariff rates over different product classes (minimize A_i). This variance can actually be reduced to zero by setting all of a country's individual tariff rates equal to an identical

constant, i.e., $t^1 = \bar{t}^1 = (\bar{t}^1_1, \ldots, \bar{t}^1_k)' = \bar{t}e$ and $s^1 = \bar{s}^1 = (\bar{s}^1_1, \ldots, \bar{s}^1_k)' = \bar{s}e$. Elimination of variance loss also does not conflict with achieving a target cut in own tariff collections. This is because constant tariff rates $\bar{t}$ and $\bar{s}$ can be selected so that each country's total tariff collections equal any desired amount. Suppose country 1 wishes constant tariff rates and desires a tariff cut of $1 - \delta$ from its current level. Then it chooses a constant tariff rate $\bar{t}$ to:

$$\min_{\bar{t}} B_{11} = [m'(\bar{t}e - \delta_1 t^0)]' [m'(\bar{t}e - \delta_1 t^0)]$$

$$\Rightarrow e'mm'(\bar{t}e - \delta_1 t^0) = 0$$

$$\Rightarrow \bar{t} = \frac{\delta_1 e'mm't^0}{e'mm'e} .$$

If this $\bar{t}$ is substituted into B_{11}, then $B_{11} = 0$, hence there is no loss from failing to meet one's own target tariff cut. Substituting s for t and 2 for 1 repeats this proof for country 2. While setting a constant tariff to minimize interproduct-class variance and achieve an own desired cut is feasible, it will generally be infeasible for this policy to provide the foreign country with no loss as well. Unless the foreigner's desired tariff reduction $1 - \delta_2$ equals the domestic country's desired reduction $1 - \delta_1$ exactly, then the $\bar{t}$ selected by country 1 will not set $B_{21} = 0$. 12/ Thus, the first source of conflict between country 1 and country 2 arises.

12/ Note that, similarly, if country 2 selects $\bar{s}$ to minimize interproduct variance and achieve its desired cut of $1-\delta_2$, then if $\delta_1 \neq \delta_2$, $B_{12} \neq 0$ and country 1 will suffer a loss.

Criterion A is completely compatible with criterion C (equiproportional reduction in tariff collections), however. Zero loss can be incurred by both countries if each sets its tariff rates constant at $\bar{t}$ and $\bar{s}$ respectively--so long as $\bar{t}$ and $\bar{s}$ are chosen such that

$$\bar{t}\,\frac{m'e}{m't^0} = \bar{s}\,\frac{n'e}{n's^0} \quad .$$

Likewise, criterion D is also compatible with A. No loss is incurred under criterion D if each country's tariff on a product class equals all other countries' tariffs on that product class, i.e. $t_i^1 = s_i^1$, $i = 1, \ldots, k$. Thus the choice of $\bar{t} = \bar{s}$ will ensure both zero variance on tariffs between product classes and equal tariffs on each product charged by each country.

Criterion B is completely compatible with criterion C. To satisfy B with no loss, we need t^1 and s^1 such that:

$$m't^1 = \delta_1 m't^0 ,$$

$$n's^1 = \delta_2 n's^0 ,$$

$$\delta_1 = \delta_2 = \delta .$$

While satisfying C with no loss requires:

$$\frac{m't^1}{m't^0} = \frac{n's^1}{n's^0} .$$

Substituting from the requirements of B, we get:

$$\frac{\delta_1 m't^0}{m't^0} = \frac{\delta_2 n's^0}{n's^0} ,$$

which is only true if, as B also requires, $\delta_1 = \delta_2 = \delta$. Hence, any specific percentage reduction in tariffs can be reconciled with the need for an equiproportionate reduction in collections across countries.

Condition D requires differences in the tariffs different countries charge on product classes to be eliminated. This is achieved if $t^1 = s^1$. Equalization of tariff schedules is consistent with criterion B, so long as $k \geq 2$. 13/ To see this, note first that satisfying criterion D with zero loss requires a common tariff vector $u = t^1 = s^1$ across countries. To also satisfy B we need:

$$m'u = \delta m't^0$$

$$n'u = \delta n's^0$$

where δ is the common desired tariff depreciation factor needed for B to be internally consistent. The resulting system of equations:

$$\begin{bmatrix} m' \\ n' \end{bmatrix} u = \begin{bmatrix} \delta m't^0 \\ \delta n's^0 \end{bmatrix},$$

has at least one solution for u if dim m = dim n = k equals or exceeds 2.

Criterion C, equiproportional change in countries' tariff collections, and criterion D, equal tariff rates across countries, are similarly consistent, D requires $u = t^1 = s^1$, and C requires:

$$\frac{m't^1}{m't^0} - \frac{n's^1}{n's^0} = 0 .$$

Substituting we get:

$$\left(\frac{m'}{m't^0} - \frac{n'}{n's^0}\right)u = 0 ,$$

which may be solved for u.

13/ Or more generally, the number of individual product class tariffs equals or exceeds the number of countries whose schedules must be equalized.

As is evident, combinations of these criteria taken three at a time or four at a time (as in the case of our full welfare loss function) are less likely to be mutually fulfilled. In the following section we see how equilibria in this mesh of conflicting interests may be identified.

3. Game Equilibria

Each country's trade representative negotiates with other representatives to determine each country's tariff schedule. The institutional structure of these negotiations can vary. Depending on the character of these processes, several different definitions of a tariff equilibrium may be appropriate. In this section we describe two such equilibria, and also demonstrate how the optimal tariffs may be computed for each equilibrium.

We examine both the noncooperative Nash equilibrium and the cooperative Nash equilibrium. These solutions to the tariff negotiation game differ largely in how much common ground is established between the countries prior to negotiation, and how much appreciation each country has for tariff adjustments that improve the welfare of other countries--at the cost of some of their own welfare. We begin with the simpler noncooperative equilibrium.

Nash noncooperative equilibrium characterizes negotiators who are solely concerned with their own country's welfare. They refuse to grant other countries any concessions unless these actions also directly improve their own country's well being--no matter how large the potential welfare improvement to the foreigner. In this process, the only common ground established prior to negotiation is each country announcing its welfare loss function to the other participants. Each negotiator then makes and entertains proposals for new tariff schedules. A country only proposes tariffs that improve its own

welfare (effects on other countries are ignored), and does not embrace another country's proposal unless this proposal also directly improves its welfare. Noncooperative Nash equilibrium is finally reached when no country can make any further unilateral tariff changes that both directly improve its own welfare, and do not harm other countries' welfare so as to incite them to take retaliatory actions that end up reducing the country's welfare.

A more cooperative approach to negotiation results if countries are willing to trade off certain small losses in their own welfare, should other countries receive larger gains in their welfare. This is in contrast to the zero tradeoff characterizing the noncooperative model. Nash cooperative equilibrium permits tradeoffs by establishing a joint welfare criterion function. This welfare function is the product of the differences between each country's individual welfare that results from a proposed set of tariffs and a "security level" of welfare that the country could achieve in the absence of cooperatively determined tariff schedules. This security level might be the welfare level that is achieved in a noncooperative equilibrium--if this is the likely outcome should cooperative negotiations break down. Or, if when countries cannot reach a new cooperative agreement, they agree to maintain their current tariff schedules, security levels would be countries' current welfare levels.

Using this cooperative world welfare function, proposed tariffs are evaluated by the level of joint welfare they generate--subject to the proviso that acceptable tariff schedules must provide each participating country an individual welfare level that equals or exceeds its security level (otherwise, countries may wish to withdraw from the cooperative process). The acceptable tariff schedule that ranks highest in world welfare terms is then selected.

There are several reasons why we have selected these two equilibrium concepts from among the many that have been proposed. One large advantage of these two Nash solutions is that they are easy to compute. The intuitive reasonableness of their assumptions has also made them among the most popular concepts. And finally, as an expository tool, these two solutions sit at widely separate points on the continuum between noncooperative and cooperative behavior.

We now examine how optimal tariffs under these two equilibrium concepts may be computed. Under the noncooperative Nash concept, each country tries simultaneously to choose its tariffs so as to maximize its own welfare by minimizing its welfare loss:

(3.1) Country 1: $\min_{t^1} L_1(t^1,s^1)$,

(3.2) Country 2: $\min_{s^1} L_2(t^1,s^1)$,

where $L_1(t^1,s^1)$ and $L_2(t^1,s^1)$ are given in (2.9) and (2.10). This optimization is carried out by solving the following first order conditions:

$$(3.3)\quad 0 = \frac{\partial L_1}{\partial t^1} = a_1 \frac{\partial A_1}{\partial t^1} + a_2 \frac{\partial A_2}{\partial t^1} + b_1 \frac{\partial B_{11}}{\partial t^1} + b_2 \frac{\partial B_{12}}{\partial t^1} + c \frac{\partial C}{\partial t^1} + d \frac{\partial D}{\partial t^1},$$

$$(3.4)\quad 0 = \frac{\partial L_2}{\partial s^1} = \alpha_1 \frac{\partial A_1}{\partial s^1} + \alpha_2 \frac{\partial A_2}{\partial s^1} + \beta_1 \frac{\partial B_{21}}{\partial s^1} + \beta_2 \frac{\partial B_{22}}{\partial s^1} + \gamma \frac{\partial C}{\partial s^1} + \delta \frac{\partial D}{\partial s^1}.$$

Note that from (2.1), (2.2), (2.4), (2.5), we know that $\frac{\partial A_1}{\partial s^1} = \frac{\partial A_2}{\partial t^1} = \frac{\partial B_{12}}{\partial t^1} = \frac{\partial B_{21}}{\partial s^1} = 0$. Using the derivatives: $\frac{\partial A_1}{\partial t^1}, \frac{\partial A_2}{\partial s^1}, \frac{\partial B_{11}}{\partial t^1}, \frac{\partial B_{22}}{\partial s^1}, \frac{\partial C}{\partial t^1}, \frac{\partial C}{\partial s^1}, \frac{\partial D}{\partial t^1}$, and

$\frac{\partial D}{\partial s^1}$, from (2.1), (2.2), (2.3), (2.6), (2.7), and (2.8); rearranging terms and discarding superfluous constants, we can convert (3.3) and (3.4) to the system

$$\begin{bmatrix} a_1(I-\frac{1}{k}ee')+(b_1+\frac{c}{m't^0m't^0})mm'+d & -cmn'-d \\ -\gamma nm'-\delta & \alpha_2(I-\frac{1}{k}ee')+(\beta_2+\frac{\gamma}{n's^0n's^0})nn'+\delta \end{bmatrix} \begin{bmatrix} t^1 \\ s^1 \end{bmatrix}$$

$$= \begin{bmatrix} \delta_1 b_1 mm't^0 + c(\frac{mm't^0}{m't^0m't^0} - \frac{mn's^0}{m't^0n's^0}) \\ \delta_2\beta_2 nn's^0 + \gamma(\frac{nn's^0}{n's^0n's^0} - \frac{nm't^0}{m't^0n's^0}) \end{bmatrix}$$

Call the left hand matrix Q and the right-hand vector r. Unique non-cooperative Nash equilibrum tariff vectors ${}^nt^1$, ${}^ns^1$ exist if Q is nonsingular:

$$(3.5) \quad \begin{bmatrix} {}^nt^1 \\ {}^ns^1 \end{bmatrix} = Q^{-1}r.$$

Substituting these optimal tariffs into each country's welfare loss function, we can compute the countries' lowest amount of welfare loss under the non-cooperative Nash equilibrium: $L_1({}^nt^1, {}^ns^1)$ and $L_2({}^nt^1, {}^ns^1)$.

To compute the cooperative Nash equilibrium, we first must determine the security levels of welfare loss, J_1 and J_2, that countries and 1 and 2 can assure themselves of should cooperative negotiations fail. One possibility is that countries would revert to noncooperative Nash behavior that provides them with welfare losses of:

(3.6) $J_1 = L_1({}^{n}t^1, {}^{n}s^1)$, and

(3.7) $J_2 = L_2({}^{n}t^1, {}^{n}s^1)$.

A second possibility is that tariffs remain as previously, hence:

(3.8) $J_1 = L_1(t^0, s^0)$, and

(3.9) $J_2 = L_2(t^0, s^0)$.

The joint world welfare loss function that the two countries both seek to minimize is now:

(3.10) $L = [L_1(t^1, s^1) - J_1][L_2(t^1, s^1) - J_2]$,

subject to the additional requirements that:

(3.11) $L_1(t^1, s^1) \leq J_1$, and

(3.12) $L_2(t^1, s^1) \leq J_2$.

Forming the Lagrangian

$$\mathcal{L} = L + \lambda_1(J_1 - L_1) + \lambda_2(J_2 - L_2),$$

and minimizing with respect to t^1 and s^1 yields the first order conditions:

$$\frac{\partial \mathcal{L}}{\partial t^1} = (L_2 - J_2 - \lambda_1) \frac{\partial L_1}{\partial t^1} + (L_1 - J_1 - \lambda_2) \frac{\partial L_2}{\partial t^1} = 0 ,$$

$$\frac{\partial \mathcal{L}}{\partial s^1} = (L_2 - J_2 - \lambda_1) \frac{\partial L_1}{\partial s^1} + (L_1 - J_1 - \lambda_2) \frac{\partial L_2}{\partial s^1} = 0 ,$$

$$J_1 - L_1 \geq 0,\ \lambda_1(J_1 - L_1) = 0\ ,$$

$$J_2 - L_2 \geq 0,\ \lambda_2(J_2 - L_2) = 0\ ,$$

$$\lambda_1,\ \lambda_2 \geq 0.$$

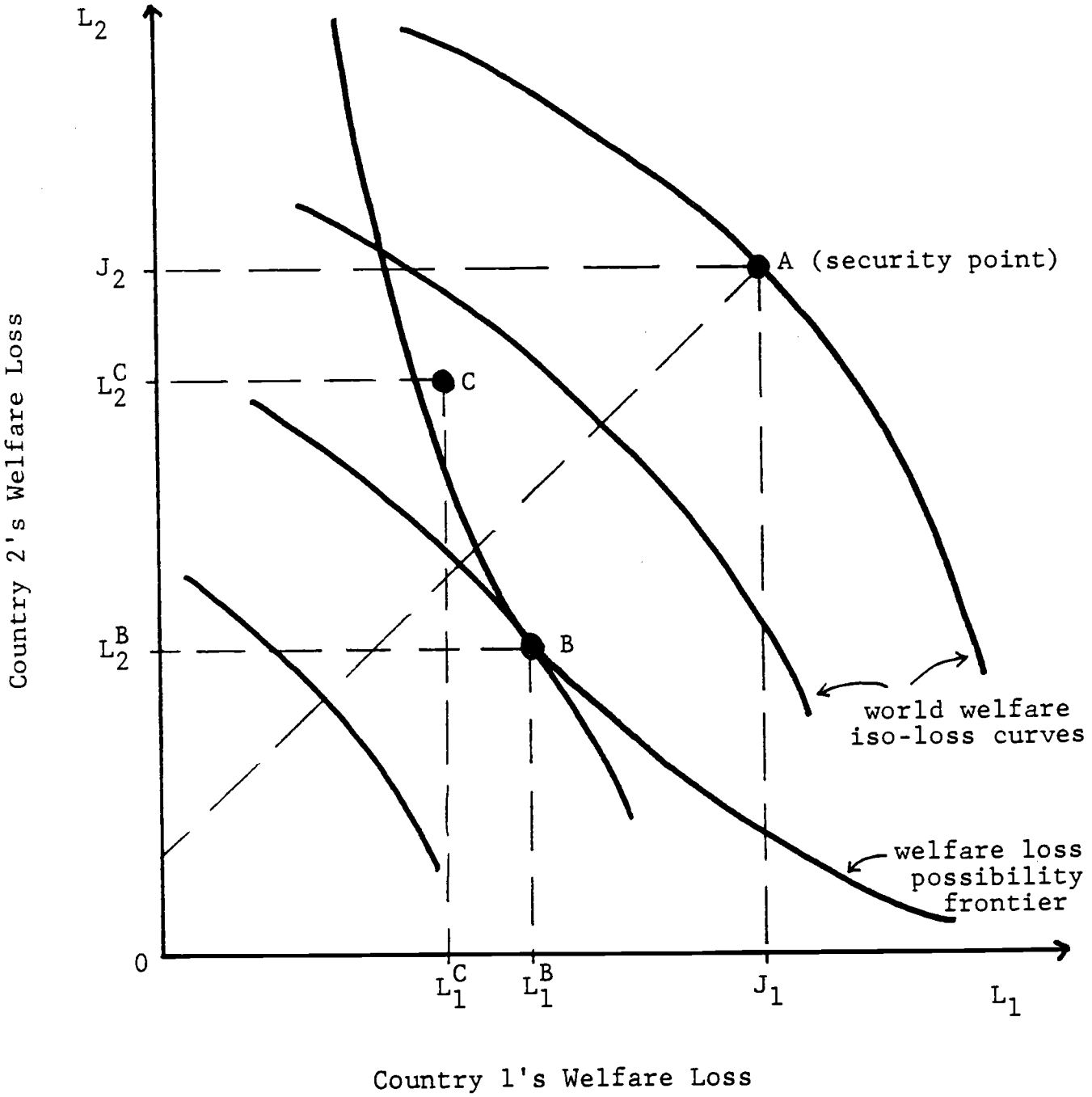
Solving these equations produces the possibly nonunique set of cooperative Nash tariffs ${}^{c}t^{1}$, ${}^{c}s^{1}$. The welfare loss suffered by each country is now $L_1({}^{c}t^{1}, {}^{c}s^{1})$ and $L_2({}^{c}t^{1}, {}^{c}s^{1})$.

Before relating the above theoretical constructs to empirically implied welfare loss functions and their computed optimal tariffs, we make several comparisons between the character of cooperative versus noncooperative tariffs. The first point is that if security levels are the amounts of welfare loss each country would incur from noncooperative tariff setting, then each country gains an equal or lower level of welfare loss by cooperating over not cooperating. This is illustrated in Figure 1. Point A represents the noncooperative security levels of J_1 for country 1 and J_2 for country 2. World iso-welfare loci are the rectangular hyperbolae radiating southwest from the security point A. The welfare loss possibility frontier indicates the minimum levels of loss that each country could achieve in tandem with the other country's given loss. The welfare allocation that minimizes the world welfare loss is indicated by point B: loss of L_1^B to country 1, and loss of L_2^B to country 2. Note that for such a point B to be superior in world welfare to security point A, it must provide both countries with at least as much welfare as their security level, i.e. $L_1^B \leq J_1$, $L_2^B \leq J_2$.

If the countries' security levels are poorer than their noncooperative losses, as might be the case if the original tariffs are retained, then it is

Figure 1

Cooperation versus Noncooperation



possible that one of the countries could do worse under cooperation than noncooperative Nash. Refer back to Figure 1. Suppose C represents the noncooperative welfare loss allocation of L_1^C to country 1 and L_2^C to country 2. Point A represents the security allocation of J_1 and J_2. The cooperative solution with respect to security allocation A is point B. But while point B gives both countries less loss than security level A, it gives country 2 a better level of loss than it would receive under noncooperation, $L_2^B \leq L_2^C$, while giving country 1 a worse level of loss than noncooperation, $L_1^B \geq L_1^C$. Note also that while the iso-loss curves tend to favor equal distributions of loss over unequal ones, it is still quite possible for losses to be more unequally borne under cooperation than noncooperation.

A final contrast between the character of optimal loss under cooperation versus noncooperation is that in the cooperative equilibrium, a greater percentage of a country's total loss will result from losses that the country has complete control over, e.g., interproduct tariff variance loss and target reduction loss (A_1 and B_1 for country 1, A_2 and B_2 for country 2), than will occur in the noncooperative equilibrium. This is because under cooperation, a country is willing to accept more personally avoidable loss if it means that foreign countries are made significantly better off.

In the following two sections we investigate first how well our proposed welfare loss functions match those empirically implied by the statements of U.S. and E.C. officials, then whether either or both of these two theoretically computed equilibria match the observed outcome of the Tokyo Round of tariff negotiations for these two trading blocs.

4. Selecting the Weights for the Welfare Loss Functions

In the preceding section, three characteristics of the tariff-cutting rule to be negotiated in the Tokyo Round were singled out as being important elements in the tariff-reducing goals of the United States and the European Community. They are: the effect of the cutting formula on the degree of dispersion among duty rates in each country; the depth of the average cut produced by the cutting rule; and the relationship between average cuts in the two trading blocs.

At the outset of the Tokyo Round negotiations, the weighted average of U.S. tariff rates over twenty-two ISIC product classes was 4.8 percent, while the E.C.'s weighted average tariff rate over the same sectors was 7.0 percent. 14/ While the average level of U.S. tariff protection was somewhat lower than the level in the European Community, tariff rates in the United States were more variable across product classes. The unweighted variance in the initial rate structures of the United States and the European Community was 33.19 and 13.50, respectively.

The U.S. was strongly in favor of a deep average cut, whereas the E.C. appeared to attach less importance to this feature of a tariff-cutting rule. In contrast, the Community strongly favored a harmonization of tariff rates over different products, while U.S. negotiators did not appear to be particularly concerned about the variation of tariff rates. As in previous

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14/ These averages are calculated by summing the tariff revenue in each sector and dividing by the total value of imports in the twenty-two sectors. The tariff and trade data used in the analysis are taken from Alan V. Deardorff and Robert M. Stern, An Economic Analysis of the Effects of The Tokyo Round of Multilateral Trade Negotiations on the United States and the Other Major Industrialized Countries, MTN Studies 5, Committee on Finance, U.S. Senate, Committee Print, CP 96-15, pp. 26-30 and p. 149.

negotiations, each country expected the average tariff reduction of the other to be approximately the same as its own average cut.

The foregoing suggests that $1-\delta_1$, the U.S.'s desired tariff cut, was greater than $1-\delta_2$, the tariff cut desired by the E.C. Furthermore, it suggests that the sum of the welfare weights that the U.S. attached to interproduct variance, i.e., $a_1 + a_2$, was lower than the sum of the weights that the Community attached to this feature of a cutting rule, i.e., $\alpha_1 + \alpha_2$. Statements by the negotiators representing the two trading powers also indicate that the sum of the weights placed by the U.S. on the target average duty reduction, i.e., $b_1 + b_2$, was high compared to the

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E.C.'s weighting of this characteristic, i.e., $\beta_1 + \beta_2$. Furthermore, given the mercantilistic outlook of the negotiators, one can infer that each country was more interested in reductions in the other country's variance and average cut than in its own, i.e., $a_1 < a_2$, $b_1 < b_2$ and $\alpha_1 > \alpha_2$, $\beta_1 > \beta_2$.

Additional information about the weights on the welfare loss functions should be revealed by the sequence of proposals for a tariff-cutting rule.

One would expect that the rules first proposed by the U.S. and by the E.C. would tend to yield a low welfare loss for the proposing trading power compared to the welfare loss for the other trading partner. However, the rule finally settled upon should represent a compromise between these welfare outcomes.

The first serious discussion of specific formulas occurred at a May 1975 GATT meeting where suggestions for a cutting rule were presented by various delegations. 15/ The United States, for example, proposed a 60 percent across-the-board cut in tariffs, whereas the European Community proposed cutting the tariff on each item by the level of the tariff on the item--and repeating this several times. Japan proposed reducing all duties by a fixed percentage, e.g., 60 percent and then adding a constant number of percentage points, e.g., 3 percentage points, to the result. The Japanese proposal also included a 5 percent floor below which no duties would be cut.

There was little further progress in settling upon a formula until 1976. In March, 1976 the U.S. formally proposed a cutting rule of $y = 1.5x + 50$, where y is the percentage by which the tariff is cut, x is the initial percent tariff rate, and the constant term, 50 percent, is the uniform element in the formula. The U.S. also imposed a 60 percent cut ceiling on all rates currently over 5 percent, since the U.S. law giving authority to reduce tariffs contained such a ceiling. This formula reduced U.S. weighted average

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15/ For a brief history of the Tokyo Round negotiations, see General Agreement on Tariffs and Trade, The Tokyo Round of Multilateral Trade Negotiations, A Report by the Director-General of GATT, Geneva, April 1979. In addition to this source, the following description is based on various other GATT documents and on conversations with some of those who were involved in the negotiations.

rates from 4.8 to 2.0 percent or by 58 percent, and the Community's weighted average rates from 7.0 to 3.4 percent or by 51 percent. The variance in unweighted U.S. rates decreased from 33.18 to 5.41 under this formula, while that of the E.C. declined from 13.50 to 2.02. The reaction of the Community and the other participants was generally negative on the grounds that the formula produced insufficient harmonization of tariffs. They pointed out that it was essentially the old 60 percent cut proposal of the United States, since it became a linear-cut rule of 60 percent for all rates initially above 6.67 percent.

The Community made its proposal for a cutting rule in July, 1976. The formula was y = x repeated four times, where y is the percentage reduction and x is the percentage on an item. Hence if an item initially had a tariff of 20 percent, this figure would be cut by 20 percent down to 16 percent, the 16 percent reduced by 16 percent down to 13.44 percent, the 13.44 percent reduced by 13.44 percent down to 11.63 percent, and finally the 11.63 percent reduced by 11.63 percent down to 10.28 percent. This cutting rule decreased the weighted average tariff levels of the U.S. and the E.C. to 3.4 and 4.7 percent, respectively, or by 29 and 33 percent and their unweighted variance to 4.37 and 3.34, respectively. The reaction of the United States and the other participants was also generally critical, this time on the grounds that the formula produced an insufficiently deep average cut. It was pointed out that, even before any exceptions, the formula gave only a 33 percent average cut in the E.C.'s own tariff schedule. The U.S. formula, in contrast, gave an average cut of 51 percent.

In summing up the accomplishments of the March meetings, the chairman of the negotiating group (the Director-General of the GATT) stated that a

consensus appeared to be emerging that the tariff-cutting plan should contain an important element of harmonization and should aim at a significant reduction in duties.

Japan and Switzerland took on the task of trying to come up with a compromise formula that would meet these objectives, and they both suggested new formulas at the next meeting in October, 1976. The Swiss formula was $y = 100x/(14 + x)$, where y is the percentage cut, and x is the existing percentage duty. A 14 percent tariff, for example, would be reduced 50 percent under this formula. The Japanese formula was $y = 100(.7 - 3.5/x)$, where y is the percentage cut, x is the current percentage tariff, .7 is the uniform element in the cutting formula, and 3.5 is the term that produces the harmonization. An additional part of the Japanese proposal was that no tariffs that were currently 5 percent or less were to be reduced. A 14 percent tariff is cut 45 percent under the Japanese cutting rule.

The Community's initial reaction to both proposals was generally favorable with the E.C. delegation noting in particular that both formulas contained an element of harmonization. The U.S. also expressed interest in the two proposals, but stated that the Japanese formula gave a smaller average reduction for the major trading countries than did the Swiss formula. Besides preferring the Swiss formula because of its deeper average cut, the U.S. delegation objected to the 5 percent floor in the Japanese cutting rule and stated that the U.S. would have great difficulty in accepting a rule which excluded fully 17 percent of all developed country tariffs. The final outcome of the negotiations was that the participants finally agreed on the Swiss

formula. 16/ This rule cut U.S. weighted average tariffs to 3.1 percent or by 35 percent and E.C. weighted average tariffs to 4.3 percent or by 39 percent. The unweighted tariff variance in the two countries was reduced to 4.35 for the U.S. and to 2.55 for the Community. Interestingly, the variance for U.S. rates--the main concern of the E.C.--was reduced slightly more under this formula than under the Community's own suggested formula. But, in agreeing to this cutting rule, the Community had to accept a considerably deeper average cut in its rates than under its own formula. The U.S., for its part, seemed quite willing to trade the deeper reduction in its variance for a deeper average cut in the E.C.'s rates. The means and variances for the two countries under the Swiss formula as well as the other cutting rules are given in Table 1.

Besides satisfying the conditions set forth above concerning the relative magnitude of the weights on the different welfare components, and on the relative size of the weights of foreign versus domestic welfare components, the weights selected should, as also noted above, yield a "reasonable" progression of welfare losses from the actual sequence of negotiating proposals. Specifically, one would expect the welfare loss for the United States to be less under the U.S. formula than under the E.C. formula, and the Community's loss under its proposed rule to be less than under the U.S. formula. Finally, the Swiss formula should give an intermediate loss position for both countries.

A set of weights, that when inserted into the overall welfare loss equations (2.9) and (2.10), fulfills all these conditions is as follows:

16/ Some countries, e.g., the E.C., used 16 as the constant term whereas others, e.g., the U.S., used 14 as the constant term.

(4.1) $L_1(t^1,s^1) = .03\ A_1 + .80\ A_2 + 1000\ B_{11} + 4000\ B_{12} + 50\ C$, and

(4.2) $L_2(t^1,t^1) = .80\ A_1 + .10\ A_2 + 3000\ B_{21} + 500\ B_{22} + 50\ C$,

where $\delta_1 = .40$ and $\delta_2 = .32$.

The resulting losses for the United States and the European Community under the three tariff-cutting rules as well as under the initial set of tariff rates are plotted in Figure 2.

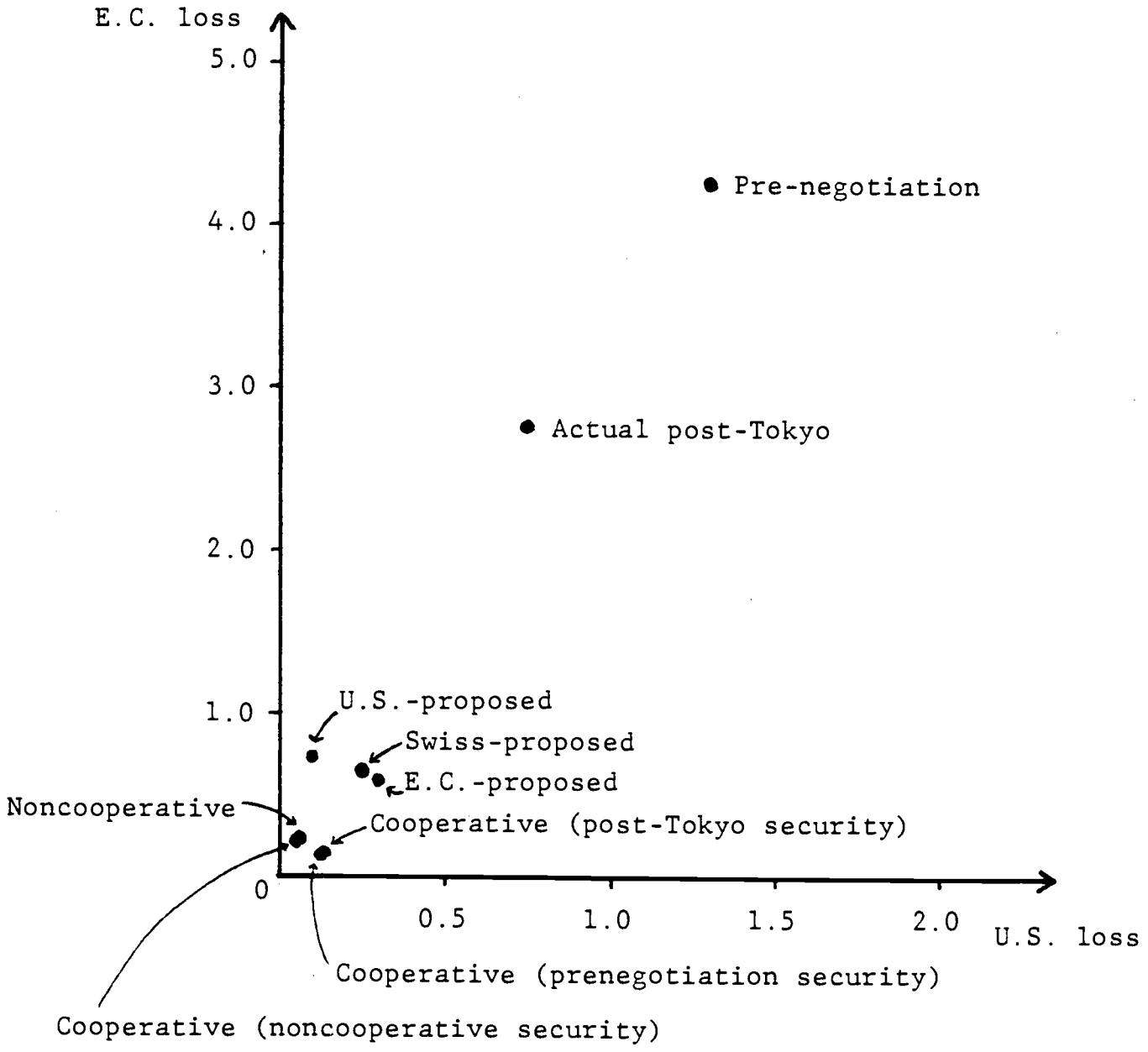
5. Calculated Game Theoretic Equilibria and Their Relationship to Formula and Actual Rates

Using the welfare weights selected in the previous section, we now compute the theoretic Nash noncooperative and cooperative equilibria. To compute the cooperative equilibrium, we alternatively use the initial tariffs, the actual post-Tokyo Round tariffs, and the noncooperative optimum tariffs as security levels. Table 2 lists the home and foreign welfare losses of the United States for the three components of the loss function (together with the overall loss) for these four equilibria as well as for the three proposed cutting formulas, the initial tariffs, and the actual post-Tokyo Round rates. Table 3 gives the same information for the European Community. The four theoretic equilibria and the actual post-Tokyo overall losses for the two countries are also included in Figure 2.

The overall welfare losses of the U.S. and the E.C. are lower under the noncooperative and all the cooperative solutions than under the Swiss formula. The noncooperative and cooperative solutions are also better for the Community than either their own proposed cutting-rule or the rule set forth by

Figure 2

U.S. and E.C. Welfare Losses



the United States. In the case of the United States, the noncooperative solution, and the cooperative one using the noncooperative solution as the security point, are better than all the proposed formulas, but the cutting rule proposed by the U.S. is better for itself than the other two cooperative solutions. The actual post-Tokyo Round rates yield welfare losses for both countries that are less than their losses from the pre-Tokyo rates, but greater than for all the game theoretic solutions as well as all the proposed cutting formulas.

Misspecification of the negotiating model, both in selecting the welfare functions and equilibrium concept, along with incorrect empirical selection of weights may explain the failure of this model to predict precisely the actually negotiated tariffs. There is another possible reason, however. To appreciate why the actual welfare losses for the two trading blocs are greater than what the outcomes would have been if any of the formulas had been implemented or plausible game theoretic behavior had been followed, it is necessary to understand that there were essentially two distinct parts to the negotiations in the Tokyo (and Kennedy) Rounds. The first part, at which the cutting rule was negotiated, was conducted by the chief negotiators of the various countries with comparatively little political pressure from particular economic sectors. Perceived national goals such as achieving a deep average cut in others' tariff rates or a significant reduction in the variance in their rates dominated the negotiating issues. The working hypothesis was that there would be a minimum of tariff item exceptions from the generally agreed cut.

Once the cutting formula was agreed upon, the second stage of the negotiations began, namely, determining the specific items to be excluded from

formula tariff reductions and making sure that overall reciprocity with other major trading partners was achieved. The internal process of determining exceptions involved a much broader group of interests than deciding upon the more general formulas to propose. Particular industries and labor organizations now brought strong political pressure on members of Congress, Cabinet officials, and the President, to exclude their sectors from any cut, or at least from the full formula cut. Governments vary greatly in their ability and willingness to withstand these pressures. In the Kennedy Round, for example, the strong support of President Kennedy for a deep average cut enabled U.S. negotiators to stand up quite successfully to these lobbying pressures and to keep the initial exceptions to a minimum. Community and Japanese negotiators were less successful. In the Tokyo Round, the Community's initial offer list contained no exceptions to the Swiss cutting rule, whereas there were many exceptions in the initial U.S. offer list. In order to produce a significant average cut despite these exceptions, the U.S. actually offered cuts of more than 60 percent on many items with rates of 5 percent or less. (The 1974 Trade Act permitted cuts of up to 100 percent on this group of rates.)

After the initial sets of formal offers in January 1978, the various countries first attempted to improve the offers of others by requesting specific additions to the offer lists. After this stage, which did not appear to be very successful, the process of pulling back to achieve reciprocity began. For example, in April 1978, the Community announced that, in view of the exceptions of the other countries and its unwillingness to give compensation for greater than formula cuts, it would withdraw formula cuts either partially or totally on a specified list of products unless the

exceptions of others were withdrawn. Apparently their announcement produced few tangible results so in July they formally withdrew these items from formula cuts. A rough sampling from their initial and July 1978 offers indicates that about 20 percent of the tariff items were withdrawn from the full formula cut at this time.

In February 1979, the United States announced it would withdraw its greater-than-formula cuts at the end of the month, and this was done. Then, in March 1979 the Community presented its final offer list which involved a further pullback in order to achieve what it regarded as reciprocity. A rough estimate of the extent of this additional pullback is that it involved another 15 percent of all tariff items.

In reading the relevant GATT documents and talking with individuals directly involved in the negotiations, one concludes that there was insufficient effort made by the participants or the GATT Secretariat to minimize the pullbacks designed to achieve reciprocity for the individual participants. Many of the pullbacks in both the Kennedy and Tokyo Rounds were on items on which there was not much domestic political pressure for less-than-formula cuts. It almost seemed as if the negotiators were content to call what had been achieved a great success and to conclude the long process of negotiation as quickly as possible. However, the main point to emphasize is that the process of determining exceptions and achieving reciprocity resulted in a considerably different outcome than what would have occurred if the cutting rules were strictly followed.

6. Conclusions

Using actual trade and tariff data for the United States and the European Community, this paper has attempted to indicate how a trade negotiation such as the Tokyo Round, which in its first stage seeks to achieve agreement upon a general tariff-cutting formula, can be interpreted as an effort by the participants to minimize individual, multidimensonal welfare loss functions--each component weighted differently for the two trading blocs. The different components and specific weights on these components were selected on the basis of statements by the negotiators as to what their objectives were, and also on the basis of what would give a logical sequence of welfare changes as various formulas were proposed. Using these weights, the Nash noncooperative equilibrium and three separate Nash cooperative equilibria (differing only in their security points), were then calculated.

These welfare outcomes were compared with those given by the initial and final tariff rates, using the same weights. While the final set of rates improved the welfare position of both the United States and the European Community as compared to their initial positions, the final outcome was inferior to that given by the various formulas or the different game theoretic outcomes. It was noted that the second stage of a negotiation, where exceptions are determined and pullbacks to achieve perceived reciprocity are made, is likely to result in such an inferior outcome. Various welfare considerations dealing with the weights placed on individual sector that are not included in our model enter at this stage. Of course, an incorrectly specified model could also account for this result. In any event, thinking about trade negotiations in the terms outlined in this paper would seem to be useful for improving the negotiating process in the future, especially with regard to minimizing pullbacks for reciprocity purposes.

Table 1

Characteristics of Weighted Average Tariffs Rates and Unweighted Tariff Variances

(in percent)

	U.S.		E.C.	
	Mean	Variance	Mean	Variance
Pre-negotiation	4.8	33.18	7.0	13.50
U.S. proposed formula	2.0	5.41	2.8	2.02
E.C. proposed formula	3.4	4.37	4.7	3.34
Swiss-proposed formula	3.1	4.35	4.3	2.55
Actual	3.3	22.03	5.2	10.38

Table 2

U.S. Welfare Losses

Tariff Structure	a_1A_1	a_2A_2	b_1B_{11}	b_2B_{12}	cC	Sum
Pre-negotiation	0.1533	0.4250	0.1175	0.6079	0.0000	1.3037
U.S.-proposed	0.0237	0.0630	0.0002	0.0004	0.0044	0.0916
E.C.-proposed	0.0203	0.1040	0.0340	0.1201	0.0198	0.2981
Swiss-proposed	0.0200	0.0793	0.0219	0.0703	0.0680	0.2595
Actual post-Tokyo	0.0972	0.3100	0.0239	0.2013	0.1124	0.7448
Noncooperative optimum	0.0055	0.0267	0.0051	0.0284	0.0000	0.0658
Cooperative optimum (prenegotiation security)	0.0011	0.0461	0.0142	0.0612	0.0001	0.1227
Cooperative optimum (noncooperative security)	0.0010	0.0318	0.0173	0.0154	0.0002	0.0658
Cooperative optimum (post-Tokyo security)	0.0011	0.0464	0.0142	0.0636	0.0001	0.1254

a_1A_1 - U.S. loss from U.S. tariff variability

a_2A_2 - U.S. loss from E.C. tariff variability

b_1B_{11} - U.S. loss from U.S. tariff reduction

b_2B_{12} - U.S. loss from E.C. tariff reduction

cC - U.S. loss from unequal tariff reduction

Sum - Overall U.S. loss

Table 3

E.C. Welfare Losses

Tariff Structure	$\alpha_1 A_1$	$\alpha_2 A_2$	$\beta_1 B_{21}$	$\beta_2 B_{22}$	γC	Sum
Pre-negotiation	4.0868	0.0531	0.1003	0.0216	0.0000	4.2618
U.S.-proposed	0.6327	0.0079	0.0742	0.0163	0.0044	0.7354
E.C.-proposed	0.5402	0.0130	0.0339	0.0016	0.0198	0.6084
Swiss-proposed	0.5343	0.0099	0.0247	0.0031	0.0680	0.6400
Actual post-Tokyo	2.5916	0.0387	0.0211	0.0018	0.1124	2.7656
Noncooperative optimum	0.1470	0.0033	0.0749	0.0086	0.0000	0.2339
Cooperative optimum (prenegotiation security)	0.0283	0.0058	0.0837	0.0056	0.0001	0.1228
Cooperative optimum (noncooperative security)	0.0277	0.0040	0.1893	0.0127	0.0002	0.2339
Cooperative optimum (post-Tokyo security)	0.0306	0.0058	0.0819	0.0055	0.0001	0.1239

$\alpha_1 A_1$ - E.C. loss from U.S. tariff variability

$\alpha_2 A_2$ - E.C. loss from E.C. tariff variability

$\beta_1 B_{21}$ - E.C. loss from U.S. tariff reduction

$\beta_2 B_{22}$ - E.C. loss from E.C. tariff reduction

γC - E.C. loss from unequal tariff reduction

Sum - Overall E.C. loss