The Redistribution of Efficiency Gains: Transfers or Tariffs?

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1. Introduction

Throughout the post World War II period international trade policy reform has seldom been absent from the mind of policy-makers. The formation of the General Agreement of Tariffs and Trade (GATT) as a forum for the discussion of international trade and policy issues, the resolution of disputes and as a sponsor of regular rounds of multilateral negotiations leading to a substantial drop in the average level of tariff protection has ensured that trade policy issues have retained currency. More recently, there has been considerable focus on bilateral and regional trade agreements with the expansion of the customs union of the European Community and the advent of organizations such as NAFTA, APEC and Mercusor. Nevertheless, cooperative trade policy remains an important part of the international landscape.

This paper is concerned with some theoretical issues in cooperative multilateral trade policy reform.[1] The focus of the paper is on the structure of the policy reform problem, particularly as it applies to piecemeal policy reform, and on the similarity in roles that can be played by income transfers on the one hand and tariffs reforms on the other as redistributive policy instruments. It is shown that the model structure implies a very close connection between these roles played by tariffs and transfers.

The first, preparatory, task of the paper is to set out a simple competitive model of world trade that involves tariff distortions and hence yields an equilibrium that is not Pareto optimal. What is meant by the concept of trade policy reform in the context of this model is a primary concern. For our purposes, the policy reform problem is one of making small changes to the policy parameters (piecemeal policy reform) and the appropriate criteria is that the reforms should generate a strict Pareto improvement in welfare.

The second task, taking up the major part of the paper, is concerned with the mechanism by which efficiency gains arising out of trade policy reforms can be distributed amongst countries to achieve a strict Pareto improvement in welfare. Traditionally, trade theorists have assumed the existence of lump sum income transfers to distribute efficiency gains. Most models have lump sum transfers between countries and between governments and households. Recently, however, some authors have given more serious attention to cases where such transfers are not feasible. Here we focus upon a connection between international income transfers and tariffs. Turunen-Red and Woodland (2000) have shown that, under a mild condition on the world trade matrix, transfer reforms accompanying quota reforms can be replaced by suitable multilateral tariff reforms to achieve the same welfare outcome. In the

[1] For earlier contributions to the literature on multilateral tariff reform see, for example, Hatta and Fukushima (1979), Mayer (1981), Fukushima and Kim (1989), Turunen-Red and Woodland (1991, 1993). More recent analyses of quota reforms have been provided by Anderson and Neary (1996) and Turunen-Red and Woodland (2000).

current paper, we generalize this idea to deal with *discrete* policy reforms. And, we develop several applications to enhance understanding of the connection between tariffs and transfers.

The paper concludes with some remarks about possible future directions of this type of analysis of trade policy reforms.

2. The Multilateral Policy Reform Problem

2.1. General Structure of Policy Reform. Suppose that the equilibrium conditions for the world economy can be written in the form

$$F(u, p, \tau) = 0, \tag{1}$$

where F is a vector of functions, u is a vector of endogenous variables of direct interest to the policy-makers, p is a vector of endogenous variables of no special interest, and τ is a vector of policy variables to be chosen by the policy-makers. These equilibrium conditions for the world economy determine the endogenous variables as functions of the exogenously chosen policy variables. In the context of the current paper, we can think of u as a vector of utility levels for single-consumer national economies, p as the world price vector for goods, and τ as the vector of tariffs for all countries. However, such an assignment is not necessary for what follows; models can differ, but the basic policy reform problem may be viewed in a common way.

The policy reform problem concerns the relationship between the policy instruments, given by vector τ, and the endogenous variables of special interest, given by vector u. Starting from an initial equilibrium (solution to the model), the policy maker wishes to change the values of the policy instruments to generate a change in u that is regarded by the policy maker as beneficial. The policy reform problem is to come up with changes in policy that are beneficial. The well-known theorem of the second best indicates that this is generally a non-trivial task. The issue of tax policy reform in a closed economy has been well surveyed by Myles (1995, 167-195). In this paper we concentrate on open economies in a multilateral context.

2.2. A Specific Trade Model. To make our discussion more concrete, we now consider a particular model of world trade. In this competitive equilibrium model, K nations engage in international trade in N goods that are subject to a set of trade taxes by each nation. The world price vector for goods is denoted as p and the trade tax ("tariff") vector imposed by country k on net imports is given by τ^k. Hence, the domestic price vector in country k is $p^k = p + \tau^k$. The production sector in country k is characterized by a revenue or GDP function $G^k(p^k)$, while the single household has an expenditure function $E^k(p^k, u^k)$, where u^k denotes the level of utility. The net revenue function $S^k(p^k, u^k) \equiv G^k(p^k) - E^k(p^k, u^k)$ provides a convenient summary characterization of the price-taking behaviour of the household and production sectors.

Following Turunen-Red and Woodland (1991), the model may be expressed as:

$$\sum_{k \in K} S_p^k(p + \tau^k, u^k) \quad = \quad 0 \tag{2}$$

$$p^{\intercal} S_p^k(p+\tau^k, u^k) = b^k,\ k \in K \quad (3)$$

$$\sum_{k\in K} b^k = 0. \quad (4)$$

These are the market equilibrium conditions, the budget constraints for each country and the world budget constraint. The market equilibrium conditions express the requirement that the net exports of countries, $x^k \equiv S_p^k(p+\tau^k, u^k) \equiv \partial S^k/\partial p$, sum to the zero vector, meaning that world markets clear. The budget constraints state that the value (at world prices) of net exports (the balance of trade) must be matched by a transfer of income abroad, b^k. In our atemporal world, the national budget constraints are simply the requirements of zero current account balances. The world budget constraint required these transfers abroad to sum to zero over all countries.[2]

It is implicit in this formulation of the model that there is just one consumer in each country, who gets or receives a transfer from the government. To see this, the national budget constraints may be written as

$$E^k(p+\tau^k, u^k) = G^k(p+\tau^k) + \tau^{k\intercal}\left(E_p^k(p+\tau^k, u^k) - G_p^k(p+\tau^k)\right) - b^k,\ k \in K, \quad (5)$$

which states that expenditure by the household equals income from production, plus net tariff revenue, minus transfers abroad. The latter two terms constitute the government's net receipts (net budget surplus), assumed to be passed on to the household in a lump sum.

It is assumed that, for given policy variables $b = (b^1, ..., b^K)$ and $\tau = (\tau^1, ..., \tau^K)$, the market equilibrium and national budget constraint equations determine the endogenous variables of the model, namely the world price vector $p \gg 0$ and the vector of national utilities $u = (u^1, ..., u^K)$.[3]

2.3. Piecemeal Policy Reform. The multilateral policy reform problem is to find changes in the policy variables that yield a strict increase in the level of utility for each national household. Several points of clarification are in order. First, while the initial tariff-distorted equilibrium may be the consequence of a non-cooperative strategic policy game, it is implicitly assumed that the policy reform itself is cooperative; the national governments are not engaged in non-cooperative, strategic policy games during the reform process. This, of course, raises the question of whether the solution to the policy reform problem will be incentive compatible, that is whether each participant will continue to honour the cooperative agreement. This issue is not addressed here and is ignored by assuming a reversion to the initial equilibrium, should any country deviate from the agreement. Second, the requirement that all national households experience a strict increase in welfare is the definition of a *strict Pareto improvement in welfare (SPI)*. Countries will not agree to a multilateral policy change unless they benefit. Accordingly, it is implicitly assumed that unanimous support is required for a cooperative agreement to proceed. While a weak Pareto improvement (no household loses and some gain) could be contemplated, this

[2] Throughout the paper, we use the symbol K to denote the set of countries (as well as the number) of countries in the world.

[3] The notational convention used regarding vector inequalities is as follows: $x = (x_1, ..., x_n) \geq 0$ means $x_i \geq 0, i = 1, ..., n$; $x \gg 0$ means $x_i > 0, i = 1, ..., n$; and $x > 0$ means $x \geq 0$ and $x \neq 0$.

raises technical issues for differential policy changes, as explained by Diewert (1978).[4] Third, it is assumed that it is not feasible to move directly from a distorted equilibrium to a Pareto optimal equilibrium. Accordingly, policy changes are assumed to be "small" in some sense. We can contemplate differential or small discrete policy changes, most of the literature being devoted to the former since it allows analysis by differential calculus methods. One reason for greater interest in differential policy reforms is that they have less stringent informational requirements than discrete policy reforms; differential reforms simply require knowledge of the values of variables and all responses at the initial equilibrium, whereas discrete reforms demand knowledge of the response surfaces at the initial and final equilibrium.

3. Redistribution of Efficiency Gains

One of the major issues in trade policy reform concerns the way by which efficiency gains can be distributed to ensure a SPI. To obtain a SPI, we need an increase in economic efficiency created by reducing the distortions in the world economy, but we also need some mechanism of distributing these gains. An assumption that there exists the possibility of employing lump sum transfers between countries allows the separation of these two objectives, since lump sum transfers can always be used to successfully distribute the gains. If lump sum transfers are not allowed, however, distortionary taxes and tariffs have to accomplish both tasks and this can be difficult.

In this section, we present some results that establish a clear relationship between tariff reforms and lump sum transfers. This relationship allows us to demonstrate that tariffs can sometimes be used to redistribute efficiency gains in lieu of lump sum transfers.

3.1. Propositions Regarding Discrete Policy Choice. The model used in this demonstration may be expressed as:

$$\sum_{k\in K} S_p^k(p+\tau^k,\theta,u^k) = 0 \tag{6}$$

$$p^\intercal S_p^k(p+\tau^k,\theta,u^k) = b^k,\ k\in K \tag{7}$$

$$\sum_{k\in K} b^k = 0. \tag{8}$$

This is an extension of the model discussed above to include a vector of policy parameters other than tariffs. This vector is denoted by θ, which can be given a variety of interpretations depending upon the particular model under discussion. Examples include θ being a vector of quota restrictions on trade (a case dealt with below) and domestic commodity taxes. Of course, we can get back to the original model (given by equations (2)-(4)) by simply ignoring the existence of θ.

[4] If each household's utility is increasing in a particular direction of policy change, then there is a, possibly small, discrete policy change that will yield higher utility. On the other hand, if a household's utility is stationary with respect to a policy change (derivative is zero), there is no guarantee that a small discrete policy change will raise that household's utility.

In the initial equilibrium, the policy parameters (τ^0, θ^0, b^0) determine the endogenous variables (p^0, u^0). Now consider a new situation that involves a *discrete change in policy* to (τ^1, θ^1, b^1) with a solution for the endogenous variables given by (p^1, u^1).

The question posed is: can we choose the new tariffs so that the initial utility vector is attained, but without any transfers? That is, given that there is a solution $(\tau^0, \theta^0, b^0, p^0, u^0)$ to the equilibrium conditions (6)-(8), is there also a solution of the form $(\tau^1, \theta^0, 0, p^1, u^0)$? Specifically, this new solution $(\tau^1, \theta^1, b^1, p^1, u^1)$ proposed involves $\theta^1 = \theta^0$, $u^1 = u^0$ and $b^1 = 0$. This new solution therefore involves the same θ policy and yields the same utility vector as the first solution, but there are no transfers. However, the tariff policy and world price outcomes are different. The answer to the question of whether such a solution is possible is "yes", under suitable conditions.[5]

The strategy for the proof is, first, to postulate a new solution involving tariffs chosen carefully to keep domestic prices unchanged by "neutralizing" the domestic price effects of any new world price vector and, second, to demonstrate that the world price vector can be determined such that all of the equilibrium conditions are satisfied. The existence of a world price vector that is consistent with our multilateral choice of tariffs depends upon a mild condition on the world trade matrix.

To prove this proposition, therefore, we choose the new tariffs so that initial domestic prices in each country are retained, that is, $p^1 + \tau^{k1} = p^0 + \tau^{k0}$. Since domestic prices, the θ policy vector, and utility levels are unchanged, consumers and producers make the same choices as they did initially. Accordingly, the market equilibrium conditions (6) remain satisfied since

$$\sum_{k \in K} S_p^k(p^1 + \tau^{k1}, \theta^1, u^{k0}) = \sum_{k \in K} S_p^k(p^0 + \tau^{k0}, \theta^0, u^{k0}) = 0. \tag{9}$$

The world balance of trade conditions (8) hold trivially, since transfers are zero.

Will the individual country balance of trade conditions (7) hold? This requires the new world price vector p^1 to satisfy the equations

$$p^{1\intercal} S_p^k(p^0 + \tau^{k0}, \theta^0, u^{k0}) = b^{k1} \equiv 0,\ k \in K. \tag{10}$$

Defining the initial equilibrium world trade matrix as $X \equiv \left[x^1, ..., x^K\right]$, where $x^k = S_p^k$ is the net export vector for country k, these equations may be written compactly in matrix form as

$$p^{1\intercal} X = 0. \tag{11}$$

Since the world trade matrix has dimension $N \times K$, this is a set of K linear equations in N unknowns given by the elements of vector p^1.

What is required in order to complete our demonstration is that this set of homogeneous linear equations has a positive solution for the world price vector, since market clearing is assumed. By a version of Motzkin's theorem of the alternative, such a solution is assured under the following assumption.[6]

[5] We are grateful to Kala Krishna for raising the question of whether our previous results on the equivalence of differential changes in tariffs and transfers could be extended to discrete changes.

[6] See Mangasarian (1969, 34) for a general statement of Motzkin's Theorem of the Alternative and Diewert, Turunen-Red and Woodland (1989, 212) for a statement in the context of policy reform.

Assumption A: *There is no solution λ to the inequality system $X\lambda > 0$.*

This system may be expressed as $\sum_{k \in K} x^k \lambda^k > 0$. If this system does have a solution, it is possible to expand or contract each economy (multiply its trade vector by some number) such that no good is in excess demand and at least one good is in excess supply. Such a solution exists, for example, if there is some country k for which $x^k > 0$, meaning that country k exports every good (or has zero trade in some goods).[7] In this case, it will clearly not be possible to find a positive price vector p^1 such that $p^{1\intercal} x^k = 0$. Assumption A rules out such cases and therefore guarantees that we *can* find a vector of positive prices that satisfy the national budget constraints (11).

Given this solution, we find the appropriate tariffs vectors from the required relation $p^1 + \tau^{k1} = p^0 + \tau^{k0}$. Thus

$$\tau^{k1} = p^0 + \tau^{k0} - p^1, \tag{12}$$

where p^1 is any positive solution to the equation system (11). This completes our demonstration. The result may be conveniently recorded in the following proposition.

Proposition 1. *If $(\tau^0, \theta^0, b^0, p^0, u^0)$ solves the equilibrium conditions (6)-(8) and Assumption A holds, then we can construct another solution of the form $(\tau^1, \theta^0, 0, p^1, u^0)$. That is, any equilibrium involving income transfers can be replaced by an equilibrium without transfers, but with the same welfare outcome, by an appropriate choice of tariffs. Appropriate tariffs are given by (12), where p^1 is any positive solution to the equation system (11).*

While we have chosen $b^1 = 0$ in this proposition, there is no need to do so. If we choose the transfers in the new situation arbitrarily, the same argument follows except that now the requirement for satisfaction of the budget constraints is that p^1 is a positive solution to the equation system:

$$p^{1\intercal} X = b^{1\intercal}. \tag{13}$$

The assumption that guarantees a positive solution to these equations for the world price vector is the following.

Assumption B: *There is no solution λ to the inequality system* $\lambda^\intercal \begin{pmatrix} X^\intercal & -b^1 \end{pmatrix} > 0$.[8]

The solution to this set of linear equations determines the new world price vector and then the required tariffs in the new situation are given by (12). Thus, we get the following slightly more general proposition.

[7] This could happen if that country has a positive trade balance, $b^k > 0$.

[8] The inequality system in Assumption B may be expressed as

$$\sum_{k \in K} \begin{pmatrix} x^k \\ -b^{1k} \end{pmatrix} \lambda^k > 0.$$

A solution to this system means that it is possible to expand or contract each economy (multiply its trade vector and trade deficit by some number) so that no good is in excess demand and there is no world payments surplus, and that either some good is in excess supply or there is a world payments deficit. The existence of a positive solution for prices to the national budget constraints requires that such anomalies do not exist.

Proposition 2. *If $(\tau^0, \theta^0, b^0, p^0, u^0)$ solves the equilibrium conditions (6)-(8) and Assumption B holds, then we can construct another solution of the form $(\tau^1, \theta^0, b^1, p^1, u^0)$. That is, any equilibrium involving income transfers can be replaced by an equilibrium with a different set of transfers, but with the same welfare outcome, by an appropriate choice of tariffs. Appropriate tariffs are given by (12), where p^1 is any positive solution to the equation system (13).*

3.2. Discussion. What these propositions establish is an "equivalence" between transfers and tariffs. Specifically, the utility vector that arises from any equilibrium involving a set of international income transfers can be attained from another equilibrium that does not involve any such transfers (Proposition 1). This new equilibrium is achieved by the imposition of a carefully selected set of tariffs for each country. In this sense, a set of transfers can be replaced by a suitably chosen set of tariffs; transfers are redundant policy instruments. In the case of Proposition 2, what we have shown is that any new set of income transfers can be "neutralized" by a careful choice of tariffs in the sense that the initial utility vector will remain the equilibrium outcome.

While these propositions show that any transfer can be replaced by tariffs to get the same welfare outcome, the reverse is not true in general. Thus, we cannot change all tariffs arbitrarily and replace them by a set of transfers to get the same welfare outcome, in general. The exception is where the change in tariffs is the same for each country. Thus, transfers can be replaced by suitable tariffs, but a general structure of tariffs cannot be replaced by transfers.

It is noteworthy that the tariff reforms required to go from one equilibrium to the other are the *same* for every country. This follows from our requirement that domestic prices remain the same under the two policy regimes. Accordingly, the *change* in each country's tariff vector is given by $\tau^{k1} - \tau^{k0} = p^0 - p^1$, which is clearly the same for every country. Also noteworthy is the fact that the net export vectors for each country are unchanged by the change in policy from transfers to tariffs, so the volume and pattern of trade is unaffected. Thus, all real variables in the model are unchanged by this change of policy, as are domestic prices. The only differences in the two scenarios are in the tariff and transfer policy instruments and the world price vector. This arises from a dependency that exists between these variables of the model.

Figure 1 contains an offer curve diagram to illustrate Proposition 2. The figure shows offer curves for two countries (in net export space for one country). These offer curves have their origin at point T, which represents the initial transfer in terms of good 2. The initial equilibrium is at E. The initial world price vector is p^0, which is normal to the line TE, the domestic price vector for country 1 is $p^0 + \tau^{10}$ and the trade vector for country 1 is OE. The same trade vector can be supported with the same utilities and the same domestic price vectors, but with no transfers, if the new world price vector is p^1, which is normal to the trade vector OE. In the new equilibrium, the tariff vectors adjust to ensure that the domestic prices are unchanged and the new trade balances are zero, implying zero transfers.

3.3. Two Special Cases. The development above is reasonably general. Understanding of the general result will be enhanced by considering two interesting special

cases.

Tariffs Replace Transfers. Here we consider that scenario 0 has no tariff reform; a θ reform, accompanied by transfers, yields a SPI. Thus we have $\Delta\tau^0 = 0$, while $\Delta\theta^0$ and Δb^0 are non-zero and generate a SPI given by $\Delta u^0 \gg 0$. The new equilibrium is therefore $(\tau^0, \theta^0, b^0, p^0, u^0)$. In scenario 1 there are no transfers and no change in transfers ($b^1 = \Delta b^1 = 0$) but a tariff reform $\Delta\tau^1$ is now permitted to accompany the same θ reform $\Delta\theta^0$. By Proposition 2, we know that the new tariff structure can support the same utility vector as in scenario 0. The new scenario 1 equilibrium is therefore $(\tau^1, \theta^0, 0, p^1, u^0)$. A comparison of the two equilibria reveals that the difference in tariffs in the two equilibria, given by $\tau^1 - \tau^0$, has simply replaced transfers as a means of achieving utility vector u^0 when policy reform $\Delta\theta^0$ is undertaken.[9] That we can get the same change in utility means that the tariff reform effectively replaces the transfer reform as a redistributive device.

Tariffs Replace Tariffs and Transfer. In this second special case, we do not allow a θ reform in either policy scenario and hence consider only a tariff reform with (in scenario 0) and without (in scenario 1) transfers.

Now consider two policy reforms $(\Delta\tau^0, \Delta\theta^0 = 0, \Delta b^0, \Delta p^0, \Delta u^0)$ and $(\Delta\tau^1, \Delta\theta^1 = 0, \Delta b^1 = 0, \Delta p^1, \Delta u^0)$ leading to equilibria $(\tau^0, \theta^0, b^0, p^0, u^0)$ and $(\tau^1, \theta^0, b^1 = 0, p^1, u^0)$ with $\Delta u^1 = \Delta u^0 \gg 0$. Thus, both reforms yield the same welfare outcome but with different policy settings. Given that $(\tau^0, \theta^0, b^0, p^0, u^0)$ is an equilibrium for the model, Proposition 2 can be used to demonstrate that $(\tau^1, \theta^0, b^1 = 0, p^1, u^0)$ is also a viable equilibrium. Scenario 0 involves a reform of tariffs and transfers that leads to a SPI in welfare. Scenario 1 also involves a tariff reform and leads to the same SPI in welfare, but does not involve any income transfers.

Accordingly, we have able to show that the transfer reform accompanying the tariff reform in scenario 0 can be dispensed with, provided the tariff reform is altered appropriately from $\Delta\tau^0$ to $\Delta\tau^1$. The difference between this result and that obtained for the previous special case discussed above is that in this second special case there is no reform of the policy parameter vector θ. Thus, the second special case applies to a model where the focus is completely on tariff reform.

The result yielded by this second special case is rather strong. Suppose that we have a discrete tariff and transfer policy reform that yields a strict Pareto improvement in welfare. Then our result tells us that we can dispense totally with the income transfers and can construct another tariff reform that provides for exactly the same SPI welfare change. In other words, there is an equivalence between transfers and tariffs in the sense that transfers can be replaced by a suitable multilateral reform of tariffs. The reason for this result is that there are sufficient tariffs in the world described by our assumptions to replicate and welfare outcome that transfers are able to achieve.[10]

[9] This is made even clearer if there are no tariffs in the inital equilibrium, in which case $\tau^0 = 0$. Then (τ, b) is $(0, b^0)$ in scenario 0 equilibium and $(\tau^1, 0)$ in scenario 1 equilibrium.

[10] In an extension of scenario 1, we can simply contemplate a *different* transfer reform $\Delta b^1 \neq 0$ that involves $b^1 \neq 0$. Then, for any such arbitrary change of transfers, we can construct another tariff reform that provides for exactly the same welfare change. Thus, the change in transfers from b^0 to b^1 can be accomodated by the change in tariffs from τ^0 to τ^1.

This suggests a two-step approach to tariff reform. The first step involves finding a tariff reform that, alone with a suitable set of multilateral transfers, is able to generate a strict welfare gain. This problem has been addressed by several authors and various suggested tariff reforms are available. Step two involves the use of the first solution to the tariff reform problem to create a new tariff reform, from the same initial equilibrium, that involves no transfers (the special case of $\Delta b^1 = 0$). This new reform could be the one implemented if transfers are not permitted. This two-step procedure is, of course, a purely analytical device that helps to understand the anatomy of tariff reform; it is not put forward as a procedure to be followed in the actual practice of multilateral negotiations for tariff reform.

3.4. Some Applications. Here some applications of the propositions are discussed.

Transfer Problem. In the context of the model of trade under discussion here, Turunen-Red and Woodland (1988) showed that it was possible to establish a SPI by a pure redistribution of income via international lump sum transfers, provided that some country exhibits a consumption inferiority. While their analysis is for a SPI arising from a differential change in transfers, it obviously implies the existence of a SPI arising from a (possibly small) discrete change in transfers. Assume that the required conditions hold for such a SPI to occur and that the equilibrium following a discrete change in transfers is (τ^0, b^0, p^0, u^0), in which we ignore policy vector θ.[11] Thus, the change in the equilibrium is $(\Delta\tau^0, \Delta b^0, \Delta p^0, \Delta u^0) = (0, \Delta b^0, \Delta p^0, \Delta u^0)$ with $\Delta u^0 \gg 0$.

Now consider an alternative discrete policy change (from the original initial equilibrium) that achieves the same welfare change as the pure transfer reform just described. The change is to be $(\Delta\tau^1, 0, \Delta p^1, \Delta u^0)$, which involves a tariff reform (but no change in transfers) and the same welfare change $\Delta u^0 \gg 0$. The new equilibrium is therefore (τ^1, b^0, p^1, u^0). By Proposition 2, we know that such an equilibrium is possible, provided that Assumption B on the world trade matrix is satisfied.

Thus, it has been shown that, instead of using a pure transfer reform to obtain a SPI as did Turunen-Red and Woodland (1988), we can use a carefully chosen multilateral tariff reform to achieve exactly the same welfare outcome. Of course, the equilibrium is not the same since, for example, the world price vector will be different under the two different policies. Nevertheless, tariffs can be used to achieve the same welfare outcome that transfers were able to achieve. Thus, we have been able to extend the Turunen-Red and Woodland result on the existence of SPI transfer reforms to the existence of equivalent SPI uniform tariff reforms.

This result occurs because each country has a full set of tariffs at its disposal to ensure that domestic prices are kept unchanged even though the world prices are affected. By a "full set of tariffs" we mean $N - 1$ tariffs, since the tariff on any one of the N goods can be set to zero without any loss of generality (as discussed above). If we choose this good conveniently to be the numeraire (whose world price can be set to unity, again without loss of generality), the $N - 1$ tariffs can be used to

[11] The model used by Turunen-Red and Woodland (1988) is that of (2)-(4), which corresponds to (6)-(8) if the policy parameter vector θ is ignored.

neutralize any change the world price vector would otherwise have upon the domestic price vector.

Commodity Taxes. Next, we consider the consequences for the above propositions if some countries have a set of domestic commodity taxes in place. In this case there is a distinction between consumer and producer prices and the net export functions depend separately upon these two sets of prices. Accordingly, for the above argument to proceed in the same way, both consumer and producer prices have to be maintained at their initial values even though world prices change. This is possible, since producer prices can be maintained at the initial levels by an adjustment of tariffs, while consumer prices can be maintained by an adjustment of commodity taxes. Then the market equilibrium conditions will hold and the appropriate choice for the world price vector comes from solving the balance of trade conditions as described above. Thus, the propositions can be readily extended to handle domestic taxes.

Quota Reforms. Turunen-Red and Woodland (2000) develop results concerning the "equivalence" between differential quota and transfer reforms on the one hand and differential quota and tariff reforms on the other. Here we show that this equivalence, established in the differential policy reform context, also applies to discrete policy reforms.

The model of Turunen-Red and Woodland (2000) may be expressed in compact form as:

$$\sum_{k\in K^1} S_p^k(p_t+\tau_t^k, p_q+\tau_q^k, u^k) + \sum_{k\in K^2} S_p^k(p_t+\tau_t^k, x_q^k, u^k) = 0 \quad (14)$$

$$p^{\intercal} S_p^k(p_t+\tau_t^k, v_q^k, u^k) = b^k,\ k\in K \quad (15)$$

$$\sum_{k\in K} b^k = 0. \quad (16)$$

where $v_q^k \equiv (p_q+\tau_q^k), k\in K^1$ and $v_q^k \equiv x_q^k, k\in K^2$. In this model, net exports of traded goods are given by $x^k = S_p^k(p_t+\tau_t^k, p_q+\tau_q^k, u^k)$ for countries $k\in K^1$ without any quota restrictions; for countries $k\in K^2$ that have quota restrictions on net trades of the subset of goods labeled by the subscript q, net exports are given by $x^k = S_p^k(p_t+\tau_t^k, x_q^k, u^k)$, where x_q^k is the vector of quotas. As previously, the equations of the model are the market equilibrium conditions, the budget constraints for each country, and the world budget constraint.

Turunen-Red and Woodland (2000) showed that a differential reform of quotas and transfers that yields a SPI can be replaced by the same differential reform of quotas and an appropriate multilateral, differential reform of tariffs that yields exactly the same welfare improvement. Here we show that the same results obtains when we consider discrete policy reforms. The demonstration of this result follows from observing that the model (14)-(16) correspond exactly to the general model given by (6)-(8) above, where $\theta = x$ is the vector of all quotas on trade. Accordingly, the propositions established above apply to the current model of quotas. Therefore, assuming that there is a solution $(\tau^0, x^0, b^0, p^0, u^0)$ to the equilibrium conditions (14)-(16), there is another solution of the form $(\tau^1, x^0, 0, p^1, u^0)$ that has no transfers but

the same set of quotas and utility levels. The tariffs that achieve this outcome are chosen (in the same way as done above) to keep domestic prices unchanged.

3.5. The Differential Policy Reform Case. The discussion above has focused on a comparison of discrete policy reforms. Here the case of small or differential policy reforms is briefly discussed and compared to the discrete policy reform case.

The Main Proposition. For concreteness, we present the ideas in the context of the extended model dealt with above for the discrete reform case. The proposition and proof follow those provided by Turunen-Red and Woodland (2000) for the specific model of trade (given above) in which both tariff and quota distortions occur. However, the proposition stated below is more general in that it allows for tariff reforms in both policy scenarios.

The total differential of system (6)-(8) may be written as:

$$\sum_{k\in K} dS_p^k(p_t+\tau_t^k,\theta,u^k) = 0 \tag{17}$$

$$p^{\intercal}\,dS_p^k(p_t+\tau_t^k,\theta,u^k)+S_p^{k\intercal}(p_t+\tau_t^k,\theta,u^k)\,dp = db^k,\ k\in K \tag{18}$$

$$\sum_{k\in K} db^k = 0. \tag{19}$$

Consider two alternative policy reforms enacted at a common initial equilibrium. We assume a solution for policy 0 of the form $(d\tau^0, d\theta^0, db^0, dp^0, du^0)$ with $du^0 \gg 0$. We now propose a solution of the form $(d\tau^1, d\theta^1, db^1, dp^1, du^1) = (d\tau^1, d\theta^0, 0, dp^1, du^0)$ with $db^1 = 0$ and $du^0 \gg 0$. In this new solution, the same θ policy change is enacted and the same welfare outcome is required as in the original policy reform, there are no transfers, and the tariff policy and world price changes are different. We wish to show that such a policy change is indeed possible under a particular rank condition on the world trade matrix.

The demonstration that the new solution to the comparative statics equations is feasible proceeds by choosing a tariff reform that ensures that the *changes* in domestic prices are the same under the two policy scenarios, that is, that $dp^1+d\tau^{k1} = dp^0+d\tau^{k0}$. By ensuring that the differential changes in domestic prices are the same under both policy scenarios, along with the same θ reform and the same change in utilities, it is easy to see that the changes in the net export vectors are also the same in both scenarios. Hence, market equilibrium is preserved under policy 1. Since changes in the transfers are zero by assumption, the world budget constraints are satisfied.

Therefore, it remains to be checked whether the national budget constraints will be satisfied. The total differentials of the national budget constraints under the two scenarios are

$$p^{\intercal}\,dS_p^{k0}+S_p^{k\intercal}dp^0 = db^{k0},\ k\in K \tag{20}$$

$$p^{\intercal}\,dS_p^{k1}+S_p^{k\intercal}dp^1 = db^{k1}=0,\ k\in K, \tag{21}$$

where initial values of variable have no indicator and changes in variables for the two policies are indicated by superscripts 0 and 1. Since $dS_p^{k1} = dS_p^{k0}$, it follows that

policy 1 is viable if, and only if, the change in world prices satisfies the equations

$$S_p^{k\intercal}\left(dp^0 - dp^1\right) = db^{k0},\ k \in K. \tag{22}$$

This set of K linear equations in N unknowns given by $\left(dp^0 - dp^1\right)$ may be written in matrix form as

$$X^{\intercal}\left(dp^0 - dp^1\right) = db^0. \tag{23}$$

Let us assume a suitable condition that ensures a non-trivial solution to these equations.

Assumption C: *The world trade matrix* $X \equiv \left[x^1, ..., x^K\right]$ *has rank equal to* $K - 1 \leq N - 1$.

Under this assumption, a non-trivial solution to (23) for $\left(dp^0 - dp^1\right)$ is assured.[12] Once determined, this solution yields the required tariff reform given by

$$d\tau^{k1} = dp^0 - dp^1 + d\tau^{k0}. \tag{24}$$

Thus, we obtain the following result.

Proposition 3. *Let the world trade matrix at the initial equilibrium,* X*, satisfy Assumption C (Rank Condition) below. If* $(d\tau^0 = 0, d\theta^0, db^0, dp^0, du^0)$ *solves the comparative statics equations (17)-(19) then we can construct another solution of the form* $(d\tau^1, d\theta^0, db^1 = 0, dp^1, du^0)$*. That is, if there exists a differential reform of policy parameters* θ *and transfers* $(d\theta^0, db^0)$ *that yields a SPI in welfare, then there also exists a differential reform of policy parameters* θ *and tariffs* $(d\theta^0, d\tau^0)$ *with no accompanying transfer reform, that yields the same SPI in welfare. That is, the reform of transfers accompanying the reform of* θ *can be replaced by a suitable multilateral reform of tariffs. The appropriate tariff reform is given by* $d\tau^{k1} = dp^0 - dp^1 + d\tau^{k0}$*, where* $dp^0 - dp^1$ *is any solution to the equation system* $X^{\intercal}\left(dp^0 - dp^1\right) = db^0$*.*

This proposition is a generalization of a result developed in Turunen-Red and Woodland (2000) for the case where θ is a vector of quotas on trade. In their Theorem 1, the scenario 0 reform does not involve a reform of tariffs, whence $d\tau^0 = 0$. The present proposition is a generalization by allowing a tariff reform to be part of scenario 0. Apart from this, the outline of the proof provided above follows that in Turunen-Red and Woodland (2000).

In the special case where the $d\tau^0 = 0$, this proposition shows that an accompanying differential transfer reform can be dispensed with and replaced by a suitable multilateral differential tariff reform; the differential welfare gain is the same under either policy. In the more general case, when scenario 0 involves a tariff reform, a further suitable multilateral change in tariffs can compensate for the differential removal of transfers.

It is clear from the above demonstration that the differential reform case is very similar to the discrete reform case. While the differential case has been discussed in

[12] The solution allows us to set $dp_1^i = 0$, as required by the assumption that the price of the numeaire is fixed at unity , and hence to have the tariffs on the numeraire equal to zero in every country.

detail by Turunen-Red and Woodland (2000), it has been presented above in order to show a difference that relates to the conditions on the world trade matrix required for the appropriate propositions to hold. It is to this difference that attention is now turned.

Comparison of Discrete and Differential Reforms Conditions. The question arises as to why the condition on the world trade matrix is apparently different depending on whether we are dealing with discrete policies or differential policy changes. Assumption C, our rank condition required to solve (23), is weaker (more easily satisfied) than Assumption A made further above to ensure a positive solution to (13). The reason lies in the fact that the discrete case requires a solution for the new world price vector, which has to be positive to be consistent with the market clearing conditions. By contrast, the differential analysis is undertaken at the initial price vector, which is positive. The differential comparative statics results are valid in a sufficiently small neighbourhood of the initial positive price vector and so the new price vector will be positive in this neighbourhood.

In short, the differential analysis demands less than the discrete analysis and so the required conditions for the validity of our results are less stringent in the differential policy reform case.

4. Concluding Remarks

Multilateral policy reforms have particular importance because of the role of the GATT (now the WTO) in the international trade negotiations over the post-war period. This paper has concentrated on some particular aspects of the multilateral policy reform problem. In particular, attention has focused on the structure of the competitive trade model used to analyze the problem, the structure of the solutions and the implications for tariff and transfers policies designed to accompany other trade policy reforms to achieve Pareto improvements in welfare.

The paper has demonstrated that the model structure has significant implications for the important theoretical and practical question of how efficiency gains arising from trade policy reform can be distributed to countries to ensure that all countries benefit in a welfare sense. If lump sum transfers (employed by most trade analysts) are not available policy instruments, the achievement of a strict Pareto improvement must depend on changes in distortionary taxes, such as domestic taxes or tariffs on trade. Our results developed in this paper (extending the ideas presented previously in Turunen-Red and Woodland (2000)) show that, under a mild condition on the world trade matrix, it does not matter whether lump sum transfers are available. An equilibrium with transfers can be replaced by an equilibrium with no transfers if tariffs are appropriately adjusted. This ability to replace transfers by tariffs is a result of the structure or anatomy of the model of international trade, whereby the terms of trade effects for a country and a lump sum transfers are equivalent and whereby there are sufficient tariff instruments to enable countries to neutralize the domestic price effects of terms of trade movements.

While many possible extensions to the multilateral trade reform literature can be contemplated, two particular ones come to mind. First, rather than starting from an arbitrary initial competitive equilibrium, it would be potentially productive to start

from a Nash equilibrium for a trade policy game. This would provide added structure to the initial equilibrium that could be profitably exploited. A second extension would be to consider a restricted set of policy reforms. For example, following the ideas in Bagwell and Staiger (1999) concerning the reciprocity rules of the WTO, tariff reforms that are world price preserving as well as welfare increasing may constitute interesting research.

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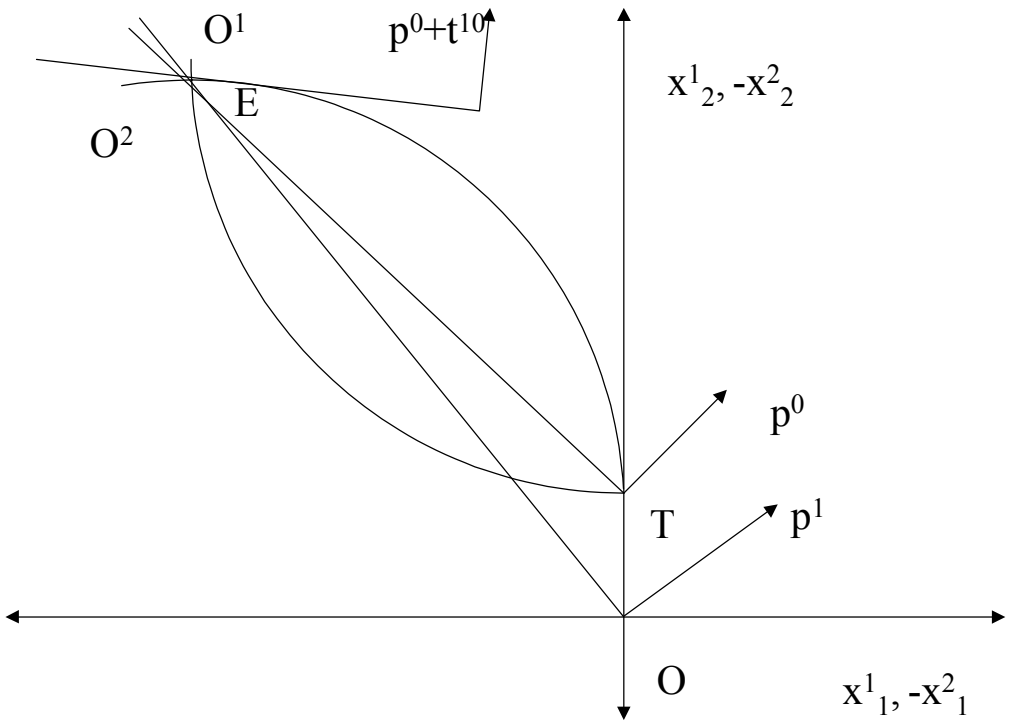

Figure 1: Offer Curve Illustration

Figure 1: