Abstract: We examine in detail the circumstances under which reciprocity, as defined in Bagwell and Staiger (1999), leads to fixed world prices as a result of a multilateral tariff change in a world with many goods and many countries. Our main result is that a change of tariffs satisfying reciprocity does not necessarily imply constant world prices when the number of goods exceeds the number of countries. Nevertheless, it is true that there exist multilateral tariff reforms that are consistent with both reciprocity and constant world prices. However, these multilateral reforms do not follow directly from the reciprocity condition alone but also from the requirement of unchanged world prices. Moreover, their characterization may be complex. We prove these results rigorously and present a numerical example to help intuition. The paper serves to clarify the nature of the Bagwell-Staiger results on the implication of reciprocity.

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1. Introduction

In an important paper in the *American Economic Review*, Kyle Bagwell and Robert Staiger (1999) propose a general equilibrium theory of GATT that rationalizes the use of reciprocity and non-discrimination as the two main pillars of GATT negotiations. Bagwell and Staiger show that multilateral tariff reforms that are based on the rules of reciprocity and non-discrimination remove the well-known terms-of-trade externalities and allow countries to enjoy the positive efficiency gains of their tariff reforms. The main mechanism that leads to this advantageous situation is based on their result that multilateral tariff reforms that adhere to the rule of reciprocity leave *world prices unchanged*. Clearly, an understanding of this argument is essential in appreciating the Bagwell and Staiger theory of GATT negotiations.

In our minds, an initial understanding of this argument is provided by the following simple figure. Figure 1 depicts the offer curves of two countries (1 and 2) that choose tariffs non-cooperatively. The initial equilibrium point is at the Nash equilibrium point, $N_0$, where the offer curves intersect and each country’s indifference curve is tangential to the other country’s offer curve. The shaded ‘cigar-shaped’ area contained by these indifference curves is the set of trade vectors that yield a Pareto improvement over point $N_0$.

Bagwell and Staiger define a tariff reform satisfying reciprocity as one that keeps value of each country’s trade unchanged, where the evaluation is at the initial world prices. In the figure, the ray passing through the origin and $N_0$ indicates the trade vectors that are consistent with a zero trade balance at the initial world prices, $p_0$. Thus, any expansion of trade along this ray is consistent with the reciprocity rule of Bagwell and Staiger. Thus, it is easy to see in this figure that a negotiated tariff reform that is consistent with reciprocity and market equilibrium expands the trade volumes out along this ray to a point such as $N_1$, at which the equilibrium world prices are unaltered. Moreover, such a tariff change will definitely move the countries within the ‘cigar’ area of Pareto improvements and so both countries gain from the tariff changes.\(^1\) This powerful consequence of reciprocity, viz. that world prices remain unchanged, makes the analysis of the negotiation game between GATT countries more transparent.\(^2\)

\(^1\) The fact that the starting point is a Nash equilibrium is important. If tariffs were not optimally set, the cigar-shaped area of Pareto improvements may be totally to the right or left of the world price ray. For example, if one of the two countries adopted a free trade policy then its indifference curve would be tangential to the ray through the origin and so the Pareto-improving area would be to one side of the ray.

\(^2\)[To text maybe.] Holding world prices fixed has previously appeared as an important insight in the literature of regional trading-clubs. See, for example, Ohyama (1972) and Kemp and Wan (1976) for early contributions, and Panagariya and Krishna (2002), Ohyama (2002), Raimondos-Møller and Woodland (2006) and Grinols and Silva (2007) for more recent uses of this technique. However, none of these papers characterize the tariff reforms
The present paper looks at the conditions needed for this powerful consequence of reciprocity to be extended to a multi-country, multi-good case. Bagwell and Staiger (1999) argue that it does. However, while their rigorous proof of it is based on a $2 \times 2$ version of the model (see p. 224), their footnote 16 on page 225 considers an extension to many goods that left us with some open questions.\(^3\) We hope our way of presenting the Bagwell and Staiger main idea will be helpful in clearing up issues that readers may have when reading such an important paper as "An economic theory of GATT".

We show that, in general, reciprocity by itself does not imply fixed world prices. However, as we also show, there exist some tariff reforms that will be consistent with both reciprocity and fixed world prices. The problem with these reforms is, however, that they are not easy to characterize, i.e. the information needed to derive them is quite substantial. Although

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\(^3\)The same holds for the appendix to chapter 5 in their book (Bagwell and Staiger, 2002), where a more detailed discussion of the many goods case is provided.
reciprocity appears to be a simple policy rule, the determination of the tariff reforms that are consistent with reciprocity is far from simple. When reciprocity does not lead to unchanged world prices, the additional requirement of unchanged world prices provides additional complexity in tariff reform choice.

We put emphasis on these issues because there seems to be a generally acceptance in the literature that Bagwell and Staiger (1999) show that reciprocity fixes the world prices without any qualification. Examples of statements to this effect may be found in Anderson and Neary (2007), Epifani and Vitaloni (2006) and Matoo and Olarreaga (2004). In addition, the language in the writings of Bagwell and Staiger on this topic seem to emphasize the same acceptance of the power of reciprocity. For example, Staiger (2006, p.7) states that "reciprocity describes a fixed-terms-of-trade rule to which mutual tariff changes must conform". The present paper emphasizes that this may be perfectly correct language for the case where the number of products does not exceed the number of countries (subject to a regularity condition on the world trade matrix), but not for the empirically plausible case where the number of products exceeds the number of countries. A numerical example is provided to illustrate our analysis.

2. Model of International Trade

To provide a rigorous analysis of the issue, we consider a perfectly competitive general equilibrium model of the world consisting of $K$ nations trading in $L$ internationally tradeable commodities. Following Turunen-Red and Woodland (1991), the model may be expressed as

$$\sum_{k \in K} S^k_p(p^k, u^k) = 0, \quad (1)$$

$$p^\top S^k_p(p^k, u^k) = 0, \quad k \in K, \quad (2)$$

in terms of the world price vector $p$ ($p^\top$ denotes the transpose of a vector), the domestic price vectors $p^k$ for each country $k \in K$ and the utility levels $u^k$ for each country $k \in K$. In this

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4Quote from p. 187: *Bagwell and Staiger (1999) note that reciprocity, which they interpret as trade policy "concessions" that yield equal increases in market access and so keep world prices constant, is one of the foundational principles of GATT:*

5Quote from p. 428: *A key observation of BS99 (p. 224) is that, as long as changes in import volumes are measured at existing world prices, mutual changes in trade policy that conform to reciprocity leave the relative world price unchanged:*

6Quote from p.1: *In an important recent paper, Bagwell and Staiger (1999) show that reciprocity can be given a more direct positive economic interpretation: it serves to neutralize the adverse terms of trade effects associated with unilateral reductions in protection, and therefore, leads to greater liberalization:*

7The notation $K$ is used to denote the set of countries as well as the number of countries.
specification, \( S^k(p^k, u^k) \equiv G^k(p^k) - E^k(p^k, u^k) \) is the net revenue function, being the difference between the gross domestic product function \( G^k \) and the consumer expenditure function \( E^k \).

Also, \( S^k_p(p^k, u^k) \equiv \nabla_p S^k(p^k, u^k) \equiv x^k \) denotes the gradient of the net revenue function with respect to prices and represents the country-specific vector of compensated net export functions \( x \). The specification of the technologies and preferences is very general. The national production possibilities sets satisfy minimal conditions such as convexity and allow for joint production and intermediate inputs, while the preferences also satisfy minimal conditions.\(^8\) Conditions sufficient for the existence of equilibrium for this tariff-distorted world economy are implicitly assumed.

Equations (1)-(2) consist of the market equilibrium conditions and the budget constraints for each country. The market equilibrium conditions express the requirement that the net exports of countries, \( x^k \equiv S^k_p(p^k, u^k) \), sum to the zero vector, meaning that world markets clear. The national budget constraints state that the value (at world prices) of net exports (the balance of trade) must be zero.

It is implicit in this formulation of the model that there is just one consumer in each country, who receives a transfer from the government and has utility \( u^k \).\(^9\) The model is expressed in terms of domestic and world prices. These are connected by tariffs, which may be expressed in specific terms, whence we may write \( p^k = p^k(p, t^k) = p + t^k \).\(^{10,11}\)

**3. Reciprocity in Trade Negotiations**

Reciprocity in Bagwell and Staiger (1999) is defined in terms of the outcome of tariff negotiations. In particular, it is required that the initial world price value of the change in the net trade vector of each country remains zero. In our notation, this definition can be formally written as follows.

**Definition 1 [Reciprocity].** A set of tariff changes conforms to the principle of reciprocity if

\[
p^1_0(x_1^k - x_0^k) = 0, \quad k \in K,
\]

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\(^8\)Woodland (1982) also spells out these specifications and the properties of the revenue and expenditure functions.

\(^9\)It is relatively straightforward to extend the model, at the cost of added notational complexity, to handle multi-household economies. In the case of multiple households, Pareto improvement may be ensured by assuming the existence of lump sum income transfers between households and the national governments. Alternatively, under appropriate assumptions, commodity taxes may be used to carry out internal Pareto-improving redistributions. See, for example, Diewert, Turunen-Red and Woodland (1989, 1991).

\(^10\)The model may also be specified in terms of ad valorem tariff rates rather than specific (unit) tariff rates.

\(^11\)B&S consider endogenously determined tariffs where governments maximize a utility function (which may or may not be a social welfare function). However, for the purpose of showing that reciprocity leads to unchanged world prices, the setting of tariffs is not essential and thus tariffs are taken to be at an arbitrary level. Clearly, and as it was mentioned in footnote 1, the starting point matters on whether we get a strict Pareto improvement or not.
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where subscripts 0 and 1 denote, respectively, pre- and post-tariff reforms values.

3.1. Does Reciprocity Imply Unchanged World Prices?. Using this definition of Bagwell and Staiger, we wish to determine the conditions under which a tariff reform that satisfies reciprocity ensure that the new world price vector is exactly equal to the initial world price vector. As noted above, such an outcome means that there are no terms-of-trade effects of the tariff reform and this can be exploited in the welfare analysis of the tariff change. To this end, we proceed in several steps.

First, we write the reciprocity condition in an alternative, but equivalent, way. Using balance of trade conditions $p_0^T x_k^0 = 0, k \in K$ (see (2)) at the initial equilibrium, equation (3) implies that $p_1^T x_k^1 = 0, k \in K$. This means that the new trade vectors, evaluated at the initial world prices, also take a value of zero. Combining this last equation with the balance of trade condition $p_1^T x_k^1 = 0, k \in K$ (see again (2)) in the post-reform situation, we can write $(p_0 - p_1)^T x_k^1 = 0, k \in K$. In matrix form, this set of conditions may be written as

$$(p_0 - p_1)^T X_1 = 0,$$  \hspace{1cm} (4)

where $X_1$ is the $L \times K$ matrix of national net exports vectors, $x_k^1$, in the post-reform situation.

Accordingly, we have re-written the reciprocity conditions (3) in the form of equation (4). Thus, the reciprocity condition implies that the product of the $L \times 1$ vector, $p_0 - p_1$, and the $L \times K$ world trade matrix, $X_1$, is the zero vector.

Second, we now focus on (4) and determine the circumstances under which a solution to this set of equations necessarily implies unchanged world prices, i.e. $p_0 = p_1$.

12 Defining $v = p_0 - p_1$, this equation system may be written as $v^T X_1 = 0$ and the question is whether $v = 0$ is the only solution.

To answer this question, we make use of some results from linear algebra that depend upon the properties of the world trade matrix $X_1$. To put the resulting condition in context, it is useful to note the general rank properties of this world trade matrix.

Remark 1. Properties of the world trade matrix. The world trade matrix, $X$, has the following

\footnote{From (4) is straightforward to see that deriving the tariff policy adjustments that preserve world prices will always lead to reciprocity. However, the question that we examine here is the opposite: viz. whether the tariff policy adjustments that satisfy reciprocity imply fixed world prices.}
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rank properties: (i) \( \text{rank}(X) \leq K - 1 \) due to the world market equilibrium conditions,\(^\text{13}\) (ii) \( \text{rank}(X) \leq L - 1 \) due to the balance of trade conditions in the new situation (or the reciprocity conditions)\(^\text{14}\) and (iii) \( \text{rank}(X) \leq \min(L - 1, K - 1) \), since the rank of any matrix must be smaller than or equal to the lower of its dimensions.

Using a result from Hadley (1965, p. 173), a necessary and sufficient condition for the system of \( K \) equations \( v^\top X_1 = 0 \) to have a non-trivial solution \( v \neq 0 \) is that \( \text{rank}(X_1) < L \). Since \( \text{rank}(X_1) \leq L - 1 < L \) from property (ii) above, it follows that a non-trivial solution \( v = p_0 - p_1 \neq 0 \) exists. To illustrate, the reciprocity conditions for situation 1 imply that \( v = p_0 \) is a solution and so \( v = \lambda p_0 \) is also a solution for any \( \lambda > 0 \). Thus, the equilibrium solution for \( p_1 \) can be written as \( p_1 = (1 - \lambda)p_0 \). However, this is uninteresting from an economics viewpoint, since it says that one price vector is a multiple of the other. Normalizing the price of one good to be unity (the numeraire), \( \lambda = 0 \) is required and so the solution for \( v \) becomes trivial. Accordingly, we restrict attention to price systems that contain a numeraire good whose price is set to unity and which is not subject to a tariff in either situation.

Without loss of generality, we choose the first good as the numeraire, normalize the first element of vector \( v = p_0 - p_1 \) to 0 and assume that no tariffs are allowed to be imposed on the numeraire good. Since \( v_1 = 0 \), the equation system \( v^\top X_1 = 0 \) may be written as \( \tilde{v}^\top \tilde{X}_1 = 0 \) where \( \tilde{v} \) is the \((L - 1)\)-dimensional vector of price differences for non-numeraire goods and \( \tilde{X}_1 \) is the \((L - 1) \times K \) dimensional trade matrix for non-numeraire goods. Hadley’s result quoted above now implies that \( \tilde{v}^\top \tilde{X}_1 = 0 \) has a non-trivial solution \( \tilde{v} \neq 0 \) if and only if \( \text{rank}(\tilde{X}_1) < L - 1 \). In words, the necessary and sufficient condition for reciprocity to allow \( p_1 \neq p_0 \) is that the rank of the trade matrix in the new situation is less than the number of traded goods less one (that is, less than the number of non-numeraire goods).

A corollary to Hadley’s theorem quoted above is that a necessary and sufficient condition for \( \tilde{v}^\top \tilde{X}_1 = 0 \) to only have the trivial solution \( \tilde{v} = 0 \) is that \( \text{rank}(\tilde{X}_1) = L \). Applying this result to the problem at hand, we can write that

\[
\tilde{v}^\top \tilde{X}_1 = 0 \Rightarrow \tilde{v}^\top = 0 \quad (p_1 = p_0) \quad \text{if, and only if,} \quad \text{rank}(\tilde{X}_1) = L - 1. \quad (5)
\]

\(^{13}\)With \( X_1 \) being the world net export matrix, the sum of the columns must be the zero vector. Therefore, the maximum rank of this matrix – i.e. the maximum number of independent columns – must be \( K - 1 \).

\(^{14}\)The balance of trade conditions (2) for the new situation may be expressed as \( p_1^\top X_1 = 0 \), meaning that \( X_1 \) has less than full row rank.
Proposition 1. A multilateral change of tariffs satisfying reciprocity implies that world prices remain unchanged if, and only if, the world trade matrix in the post tariff-change situation has maximal row rank, \( L - 1 \) (that is, \( \text{rank}(X_1) = L - 1 \)).

Proposition 1 provides necessary and sufficient conditions for a multilateral tariff reform that is reciprocity-compliant to ensure that world prices remain unchanged as a result of the reform. Examination of special cases of this proposition and of its implications helps cast light on the extent to which reciprocity does, or does not, neutralize the terms-of-trade externalities potentially arising from tariff reforms.

There are just two possibilities regarding the rank condition: (1) \( \text{rank}(X_1) = L - 1 \) and (2) \( \text{rank}(X_1) < L - 1 \).

1. \( \text{rank}(X_1) = L - 1 \). In this case, the Proposition states that a tariff change that obeys the reciprocity conditions ensures that the resulting world price vector is exactly the same as in the initial equilibrium \( (p_1 = p_0) \). This result means that there are no terms of trade externalities arising from the multilateral tariff reform.

2. \( \text{rank}(X_1) < L - 1 \). In this case, the Proposition states that reciprocity is not sufficient to ensure unchanged world prices as a result of the tariff change. In other words, under this rank condition, the equation system \( (p_1 - p_0)^TX_1 = 0 \) always has a solution such that \( p_1 \neq p_0 \). When this situation arises, terms of trade externalities do, indeed, arise from the multilateral tariff reform.

Using the above results, we now consider three possible cases based upon the relative numbers of goods and countries.

a. \( L < K \), i.e. the number of goods is smaller than the number of countries. In this case
\[ \text{rank}(X_1) \leq \min(L - 1, K - 1) \leq L - 1 < K - 1, \] which is consistent with either of cases 1 or 2 above. If the trade matrix \( X_1 \) has maximal row rank \( (\text{rank}(X_1) = L - 1) \) then reciprocity does imply the world prices are unchanged as a result of the tariff reform. However, it is possible that the trade matrix has lower rank \( (\text{rank}(X_1) < L - 1) \), in which case a difference between initial and new world prices may ensue.

\[ \text{rank}(X_1) = \text{rank}(X_1). \]
b. \( L = K \), i.e. number of goods equals the number of countries. Clearly, in this case \( \text{rank}(X_1) \leq \min(L - 1, K - 1) \leq L - 1 \), which also is not in conflict with the rank condition required for reciprocity to generate unchanged world prices. If \( \text{rank}(X_1) = L - 1 \) then reciprocity does imply unchanged world prices, but this outcome is not ensured if \( \text{rank}(X_1) < L - 1 \). Clearly, cases a and b are essentially the same.

c. \( L > K \), i.e. the number of goods is larger than the number of countries. Here \( \text{rank}(X_1) \leq \min(L - 1, K - 1) \leq K - 1 < L - 1 \) and this inequality clearly violates the rank condition in Proposition 1. As a consequence, a multilateral tariff reform that obeys reciprocity does not necessarily imply unchanged world prices.

Cases a and b rely upon the assumption that the trade matrix is of less than maximal row rank \( (L - 1) \) to obtain a difference between initial and new world prices, and this implies some degeneracy. Hence, these cases of exceptions to the B&S result may be regarded as somewhat pathological. However, the same cannot be said about case c. In case c, there are always tariff reforms satisfying reciprocity that yield an equilibrium solution in which world prices are different from the initial world prices: reciprocity is not sufficient to guarantee unchanged world prices.\(^{16}\) This case arises when the number of products exceed the number of countries and this is the empirically relevant case. Accordingly, this is the case that deserves greatest attention.

The above sequence of arguments shows that reciprocity implies (4), but (4) does not always imply zero world prices. More precisely, when the number of goods is larger than the number of countries, reciprocity does not necessarily lead to constant world prices. This result is now recorded as a corollary to Proposition 1 as follows.

**Corollary 2.** Reciprocity in trade negotiations does not necessarily lead to constant world prices for the (empirically relevant) case where the number of goods is larger than the number of countries.

The results above show that reciprocity, by itself, is not sufficient to ensure that world prices remain unchanged as a result of a reciprocity-consistent multilateral tariff reform. They also show that an important rank condition needs to be also satisfied to ensure unchanged prices in the case where the number of countries is at least as great as the number of goods. In the case where the number of goods exceeds the number of countries (the relevant context), this rank

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\(^{16}\) Of course, this does not mean that all tariff reforms satisfying reciprocity imply different world prices.
condition is impossible to satisfy. Our results, therefore, show when reciprocity is not sufficient for unchanged world prices.

The proposition and corollary seem to contradict Bagwell and Staiger (1999), who write (p. 225):

"When governments negotiate tariffs under the rule of reciprocity, however, this terms-of-trade externality is neutralized, as the mutual changes that occur under reciprocity leave the world prices fixed. This feature of reciprocity, which can be seen transparently in our two-country, two-good model but which also extends beyond the 2 × 2 case, will play a central role in our analysis."

This quote suggests that reciprocity implies unchanged world prices generally. Our results clarify Bagwell and Staiger’s results on the role of reciprocity in tariff negotiations.

Bagwell and Staiger are aware of the possibility that reciprocity might not be sufficient to ensure unchanged world prices.

As a proof to that statement, Bagwell and Staiger (1999) provide footnote 16 where they write:

"In the many-good case, however, is also possible that reciprocity can be satisfied even when world prices change. To evaluate this possibility, we note that the restriction of reciprocity can be rewritten as (in our notation) \((p_1 - p_1^k)^T x_1^k = (p_0 - p_1^k)^T x_1^k\). This indicates that any trade-policy adjustment giving rise to the price vectors \(p_1\) and \(p_1^k\) results in the same aggregate tariff revenue as would an alternative tariff-policy adjustment that gave rise to the price vector \(p_0\) and \(p_1^k\), when each adjustment is consistent with the restriction of reciprocity. Since world prices affect welfare only through tariff revenue, we may therefore restrict attention to tariff policy adjustments that preserve the world prices. These properties of reciprocity also extend naturally to a many-country case."

3.2. Is Reciprocity Always Consistent with Unchanged World Prices?. The first sentence in the above quotation clearly recognizes the result in our proposition 1. In what follows we concentrate on the rest of the quotation and attempt to explain it (in a different, and perhaps more informative, way than Bagwell and Staiger).
The balance of trade conditions (2) imply

\[ p_0^k x_0^k(p_0^k, u_0^k) = 0, k \in K, \quad p_0^k = p_0 + t_0^k \quad (6) \]

and

\[ p_1^k x_1^k(p_1^k, u_1^k) = 0, k \in K, \quad p_1^k = p_1 + t_1^k. \quad (7) \]

Reciprocity implies (3), which, together with (7), implies

\[ p_0^k x_1^k(p_1^k, u_1^k) = 0, k \in K, \quad p_1^k = p_1 + t_1^k. \quad (8) \]

However, (8) can be rewritten as

\[ p_0^k x_1^k(p_1^k, u_1^k) = 0, k \in K, \quad p_1^k = p_0 + t_2^k. \quad (9) \]

where now we define another tariff vector \( t_2^k \equiv p_1 + t_1^k - p_0 \) that replicates the same domestic prices \( p_1^k \) and the old world prices \( p_0 \).

Clearly, equations (8) and (9) are equivalent, as the only thing that has changed is the definition of domestic prices and nothing else. Thus, all real economic variables are the same and the only thing that has happened is a re-definition of tariffs in one particular way, viz. replicating the new domestic prices and the old world prices. Clearly, since domestic prices and world prices are connected by tariffs, one can always choose a particular tariff vector that replicates particular values of domestic and world prices (and thereby tariff revenues). The important point here is that it is the imposition the replication of the old world prices, which in a essence becomes an additional constrain that these new tariffs have to meet. In this sense, it is not reciprocity that leads to these new tariffs, but the imposition of the constraint that world prices should remain the same.\(^\text{17}\)

Still, what the above shows is, that there exists a particular trade policy adjustment (identified above as \( t_2 \)) that preserves world prices and at the same time satisfies reciprocity.\(^\text{18}\) Propo-
Proposition 3. There exists a particular trade policy reform that is consistent with both reciprocity and constant world prices.

It is exactly this trade policy reform to which Bagwell and Staiger restrict attention. However, it should be clear from the above that there is little guidance to policy makers (by means of a simple rule) as to how to choose this trade policy reform. As it has been shown above, just imposing reciprocity is not sufficient for leading to that particular tariff reform.

In what follows we provide a computational example that illustrates the discussion above and provides an intuition for the derived results.

4. An example

To illustrate the theoretical results obtained above, we provide a simple example. In this example, there are $K = 2$ countries trading $L = 3$ goods. The countries have fixed endowments of goods and no production. There is a single consumer in each country, each with the same Cobb-Douglas preferences. The endowment matrix is

| Good 1 | 0.50 | 0.25 |
| Good 2 | 0.15 | 0.70 |
| Good 3 | 0.05 | 0.05 |

The utility functions are $U(c_1, c_2) = (c_1 c_2)^{1/3}$. All tariff revenue is distributed to the consumer as a lump sum. Without loss of generality, good 1 is taken as the numeraire with price equal to unity and it is assumed that there are no tariffs imposed on this good by any country.

Table 1 presents the equilibria for several different scenarios. The first column presents the free trade equilibrium as a basis of comparison with the Nash and other equilibria. The second column presents the Nash equilibrium, which we assume is the initial situation prior to the tariff reform. In this equilibrium, country 1 imposes an ad valorem tariff rate of $54.77\%$ ($t_{21} = 0.5477$) on its imports of good 2 and an export subsidy of $25.6\%$ ($t_{31} = 0.2560$) on good 3. Country 2

to be able to replicate the new domestic prices and the old world prices it may be necessary to increase the tariffs on certain goods. However, GATT negotiations do not permit such tariff increases (see the discussion in Raimondos-Møller and Woodland, 2006, on this topic).

19This example is drawn from Table A1 of Kennan and Riezman (1990). Their example has three countries and three goods, so we simply remove the third country to get our example.
taxes its exports of good 2 at the rate 49.34\% \ (t_{22} = -0.4934) and has a subsidy rate of 11.19\% \ (t_{32} = -0.1119) on imports of good 3. Both countries are worse off in the Nash equilibrium than at free trade.

The equilibrium corresponding to a tariff reform that obeys the reciprocity condition is presented in the third column of Table 1 labelled "Reciprocity 1". There are two reciprocity conditions - one for each country - but one of these conditions is redundant in view of the market equilibrium conditions. To obtain the results presented, we keep the tariff rates on good 3 as in the Nash equilibrium, alter the tariff rate imposed on good 2 by country 2 from -0.4934 to -0.4441 (a 10\% change) and solve the equilibrium conditions and one reciprocity condition for the world prices, utility levels and the tariff rate \( t_{21} \). The resulting tariff reform (only involving good 2 by assumption) obeys both reciprocity conditions. In this post-reform equilibrium, both countries are better off than at the Nash equilibrium and there is greater trade in both goods.

However, it is clear from Table 1 that this reciprocity-compliant reform results in world prices that are different from those observed in the Nash equilibrium. The prices of goods 2 and 3 have both increased as a result of the tariff reform. This result is consistent with our Corollary to Proposition 1, since we have that \( K = 2 < 3 = L \) and so a solution with different world prices is assured.

The final column of Table 1 labelled "Reciprocity 2" provides the equilibrium for a second reciprocity-compliant reform. This reform is obtained from the first one using the results of Proposition 2. The new tariff rates are derived from those corresponding to the Reciprocity 1 reform in such a way as to ensure that world prices remain unchanged. That is, the new tariffs are obtained as \( t_{2}^2 = p_{1} + t_{1}^1 - p_0 \), where \( p_0 \) is the Nash world price vector and \( p_1 \) is the world price vector from the Reciprocity 1 reform. This new Reciprocity 2 equilibrium yields the same real variables (e.g. utility levels and trade flows) and the same tariff revenues (last two rows) as the Reciprocity 1 equilibrium.

5. Conclusions

Influenced by the important work of Bagwell and Staiger (1999, 2002) on the economics of GATT, we focus on whether the \( 2 \times 2 \) property of reciprocity, viz. that it implies unchanged world prices, can be extended to a more general model with many goods and many countries. We show that, in the case where the number of goods is larger than the number of countries, reciprocity by itself does not necessarily lead to fixed world prices. The remedy that Bagwell
and Staiger mention in their writings, viz. that there exists a particular tariff reform that is consistent to both reciprocity and fixed world prices, is of course correct, but constitutes by no means a simple rule that policy makers can use in finding this tariff reform. Thus, interpreting the important work of Bagwell and Staiger as saying that "reciprocity fixes the world prices" is not accurate.
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References


