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and
Raymond Riezman

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OPTIMAL TARIFF EQUILIBRIA WITH CUSTOMS UNIONS

John Kennan and Raymond Riezman

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February, 1987

We thank Forrest Nelson for valuable comments on an earlier draft.
1. **Introduction**

Since Jacob Viner's pioneering work (1950) customs union research has focused on isolating characteristics of customs unions which affect worldwide economic efficiency. Customs unions are usually analyzed by comparing a particular customs union equilibrium with some arbitrarily given tariff equilibrium (for a recent example see Peter Lloyd (1982)). The choice of the customs union's common external tariff has been extensively discussed using what Max Corden (1984) calls the "non-optimality assumption", which allows customs unions (and also non-member countries) to set non-optimal tariffs.¹

While this line of research has been useful it ignores some interesting questions, such as: (1) what are the nationalistic motivations for customs union membership? (2) will the process of customs union formation lead toward free trade? (3) what determines which countries choose to form a customs union? and (4) how does a customs union choose the common external tariff?

In seeking to answer these kinds of questions the natural assumption is that self-interest dictates what tariffs countries choose and which customs unions they join. We construct a model in which all countries charge optimal tariffs, given tariffs charged by other countries. Members of a customs union have internal free trade and jointly set a common optimal external tariff. Customs union equilibria are compared to a Nash equilibrium in tariffs, and to free trade. This makes the non-member country's reaction to the customs union's tariff policy explicit.

An inevitable difficulty is that the analysis of optimal tariffs is very complicated, even when customs unions are not considered (see, for example,

¹See, for example, Jaroslav Vanek (1965), Akira Takayama (1972), Murray Kemp and Henry Wan (1976), and Earl Grinols (1986).
Yoshihiko Otani, 1980). We simplify the problem by considering a pure exchange economy in which commodity demands in each country are generated by a linear expenditure system. This model delivers explicit formulae for the effects of alternative tariff patterns on world prices, trade volumes and consumption levels, and optimal tariffs can then be calculated by numerical methods for any given specification of preferences and endowments. We use this framework to generate examples with three countries and three goods which illuminate some important strategic issues in customs union theory.

The first issue concerns the circumstances in which a customs union can improve the welfare of its members compared to free trade, even when the non-member country retaliates with its own optimal tariffs. To investigate this we develop an example in which endowments are symmetric and all countries have the same preferences. We find that whenever each country's endowment of its export good is not too large, relative to the total world endowment, any pair of countries can benefit (compared to free trade) by forming a customs union. This stands in sharp contrast to the more familiar results for a symmetric two-country model, where both countries lose a tariff war (see Harry Johnson (1958) and John Kennan and Raymond Riezman (1987)). In the three country case this is still true, but only if countries cannot form customs unions.

This example has some interesting implications. In a symmetric world where any pair of countries can benefit from a customs union it is difficult to see how free trade could be an equilibrium, since each pair of countries has an incentive to defect. Thus the possibility of customs unions may be an additional barrier to free trade rather that a "stepping stone" toward free trade.
In the symmetric example we can compute the set of endowments for which customs unions are beneficial, albeit for a special case. In this context we show that the size of a customs union relative to the excluded country is important in determining whether the customs union can improve its members' welfare. Thus, one motivation for customs union formation is to make the member countries into one larger country for the purposes of trade policy, so that they can compete more effectively with larger countries and with other customs unions.

Our examples also illustrate a pervasive externality associated with tariffs. When one country imposes tariffs on the goods which it imports, the world prices of these goods fall, conferring an uncompensated benefit on all other countries which import the same goods. Customs unions internalize this externality by setting tariffs jointly: this provides another motivation for the formation of customs unions.

Finally, our examples illustrate the effects of customs union formation on prices, tariffs and the volume of trade. Using these results we discuss the effect of trade agreements on global efficiency and the argument that customs unions are a "stepping stone" to free trade.

2. A Linear Expenditure System with Tariffs

We use a model in which \( n \) countries, indexed by the superscript \( i \), trade \( m \) goods, indexed by the subscript \( j \). Each country contains many consumers with identical utility functions

\[
U^i = \sum_{j=1}^{m} \beta_j^i \log X_j^i, \quad \sum_{j=1}^{m} \beta_j^i = 1, \quad i = 1, 2, \ldots, n.
\]

where \( U^i \) is the utility of country \( i \), with taste parameters \( \beta_j^i \), and \( X_j^i \) is the
aggregate consumption of good j in country i, which is divided equally over
individuals within the country.

Define the total world endowment of each commodity as one unit. Country
i's endowment of good j is \( \omega_j \), so that \( \Sigma_i \omega_j = 1 \), for each good j. The
endowments are divided equally between consumers within countries. The
volume of trade in each good is \( Z_j = X_j - \omega_j \), where a negative value of \( Z_j \)
means that country i exports good j, and a positive value denotes an import.
Country i charges a tariff at the rate \( t_j \) on imports of good j.\(^2\) The world
price of good j is denoted by \( P_j \), so the domestic price in i is \( (1+t_j)P_j \).

Consumers in i maximize \( U^i \) subject to the budget constraint

\[
(2) \quad \sum_{j=1}^{m} P_j (1+t_j)X_j - I^i = \sum_{j=1}^{m} \left[ P_j (1+t_j)\omega_j + P_j t_j Z_j \right], \quad i=1,2,...,n.
\]

Income \( I^i \) includes the value of endowments at domestic prices, plus the net
revenue from tariffs,\(^3\) which is divided equally over individuals.\(^4\) We assume
that individual consumers ignore the (small) effect of changes in \( Z_j \) on their
share of tariff revenue. The logarithmic form of \( U^i \) leads to a linear
expenditure system, in which consumers spend a fixed proportion of their
income on each commodity. The demand functions are

\[
(3) \quad (1+t_j)P_j X_j = \beta_j I^i, \quad i=1,2,...,n, \quad j=1,2,...,m.
\]

Expenditure \( E_j^i \) on good j, valued at world prices \( P_j \), and aggregate

\(^2\)We allow export subsidies (i.e. negative tariffs on exports).

\(^3\)In the case of a customs union, we assume that each member country
retains the tariff revenue from its own external trade (i.e. the customs
union does not pool tariff revenues).

\(^4\)It is possible that the tariff system yields negative revenue, in which
case the deficit is covered by lump-sum taxation.
expenditure $E_i^j$, can then be written as $E_i^j = \theta_i^j I_i^j$ and $E_i^j = \theta_i^j I_i^j$, where

$$\theta_i^j = \frac{\theta_i}{1 + t_i^j} \quad \text{and} \quad \theta_i^j = \sum_{j=1}^{m} \theta_i^j$$

The world supply of each good is one unit, so the world price of each good is equal to aggregate world expenditure on that good:

$$\sum_{i=1}^{n} E_j^i = P_j \sum_{i=1}^{n} X_j^i = P_j \sum_{i=1}^{n} \omega_j = P_j, \quad j=1,2,\ldots,m.$$  

Thus prices and also incomes can be written in terms of the expenditure variables $E_j^i$. Let $\lambda_j^i$ denote the fraction of $E_i^i$ allocated to good $j$, so that $E_j^i = \lambda_j^i E_i^i$, and $\sum_j \lambda_j^i = 1$. Then eliminate $P_j$, $X_j^i$ and $I_i^i$ from the demand functions in favor of the expenditure variables $E_j^i$ and $E_i^i$, to obtain

$$E_i = \sum_{j=1}^{n} E_j^i = \theta_i \sum_{k=1}^{m} \left[ \omega_k \sum_{s=1}^{n} \lambda_k E^s + t_k \lambda_k E_i^s \right], \quad i=1,2,\ldots,n.$$  

Define

$$\mu_i^j = \theta_i \sum_{j=1}^{m} t_j^i \lambda_j^i \quad \delta_i^j = \theta_i \sum_{j=1}^{m} \omega_j \lambda_j^i$$

Then equation (6) can be rewritten as

$$(1-\mu_i^j) E_i^i = \sum_{s=1}^{n} \delta_i^j E_i^s, \quad i=1,2,\ldots,n.$$  

This gives a system of $n$ equations in the $n$ expenditure variables $E_i^i$, but these equations are linearly dependent, since the units of expenditure are arbitrary. We normalize by setting aggregate world expenditure to 1, so that equation (8) can be replaced by the matrix equation
The equilibrium expenditure levels can be found from this equation, since the coefficient matrix is determined by preferences, endowments and tariffs. The equilibrium price vector can then be found from (5), since \( E_j = \lambda_j E_i \). Finally, substitution of the demand functions (3) in the utility function (1) gives the utility levels resulting from any arbitrary tariff pattern.

Equation (9) illustrates the complications involved in optimal tariff calculations. We did not consider production, and we assumed a nice functional form for preferences, but the effect of tariff variations on equilibrium consumption and utility levels is still far from transparent. The optimal tariff cannot be determined analytically, except in very special cases (as illustrated in Kennan and Riezman, 1987). Equations (9), (5), (3) and (1) do, however, provide an analytical expression for utility as a function of tariffs, for any given preference and endowment pattern, so that the optimal tariff can be determined numerically.

3. Some Illustrative Examples

We develop four examples using the model described above, with three countries and three goods. In each example the countries' preferences are assumed to be symmetric over goods, in the sense that \( \beta_{ij} = 1/3 \) for all \( i \) and \( j \). In Examples A and B the endowment matrix \( \Omega = (\omega_{ij}) \) is also assumed
symmetric. In Example A each country is dominant in its export market (having 80% of the total world endowment) whereas exporters are not dominant in Example B (each has 50% of the total endowment). In Examples C and D the endowment matrix is symmetric with respect to countries 2 and 3 only, with 1 being dominant in example C, and 2 and 3 dominant in example D.

For each example we compute utility, optimal tariffs, prices, and consumption for the four equilibria of interest; free trade (FT), Nash equilibrium (NE), free trade association (FTA), and customs union (CU). Free trade means that the tariff matrix $T = (t^j_i)$ is identically zero. Nash equilibrium means that no country could gain by changing its tariffs, given the tariffs charged by the other countries. This equilibrium is characterized by a system of six equations in the six off-diagonal elements of $T$, which can be solved, in principle, by a suitable variant of Newton's method. In practice we have found that a cobweb algorithm works well. The first country uses the procedure outlined in Section 2 to find its optimal tariffs, given the tariffs set by 2 and 3. Then the second country chooses $t^2_1$ and $t^2_3$, given the other elements of $T$, and so on until $T$ repeats itself, indicating that no country desires to make further tariff adjustments.

A "Free Trade Association" (FTA) is an agreement between two countries to eliminate tariffs between them, without restricting the tariffs charged to the third country. Here, the equilibrium tariff matrix is computed as in NE except that tariffs within the FTA are set to zero. For example, to compute a FTA between countries 1 and 2 we fix $t^2_1$ and $t^2_2$ at zero and proceed as in the NE case.\(^5\)

\(^5\)In general there is a problem because of the possibility of re-exporting. This does not arise in our examples because the members of the FTA have symmetric endowments and hence always choose the same external tariffs.
In a customs union there is internal free trade (as in the FTA), and in addition the members jointly set a common tariff to the third country. This poses two new problems. First, a tariff externality exists. Second, members of a customs union will not necessarily agree on what the external tariff should be.

The tariff externality arises whenever two large countries import the same good, because a tariff imposed by one country lowers the price paid by both. A CU differs from a FTA in that this externality is internalized by having the members set the external tariff jointly. Although this generally involves a conflict of interest between the member countries we avoid this conflict by considering only symmetric cases, so that members of a customs union always agree on what the external tariff should be.

In practice, we let one CU member choose a single tariff rate for both countries. To compute the tariff equilibrium when countries 2 and 3 form a customs union, for example, we fix $t_2^2$ and $t_3^3$ at zero. Then we compute tariffs as in NE except that country 2 chooses both $t_2^2$ and $t_3^3$, with the constraint that these must be equal.

For each example, Table 1 lists the endowment matrix assumed, and the equilibrium values of utility, tariffs, world prices and consumption. When a customs union or free trade association exists the member countries are 2 and 3, and 1 is the non-member. The utility function used is

$$U = 200 + 100 \sum_{j=1}^{3} \frac{1}{3} \log X_j^i.$$
<table>
<thead>
<tr>
<th>Eqn</th>
<th>Utility</th>
<th>Tariffs</th>
<th>Prices</th>
<th>Endowments, Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Example A</td>
<td></td>
<td></td>
<td></td>
<td>.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.1</td>
</tr>
<tr>
<td>i†</td>
<td>j:→ 1</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>1:</td>
<td>90.14</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>FT 2:</td>
<td>90.14</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3:</td>
<td>90.14</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>NE 1:</td>
<td>79.77</td>
<td>0</td>
<td>1.54</td>
<td>1.54</td>
</tr>
<tr>
<td>2:</td>
<td>79.77</td>
<td>1.54</td>
<td>0</td>
<td>1.54</td>
</tr>
<tr>
<td>3:</td>
<td>79.77</td>
<td>1.54</td>
<td>1.54</td>
<td>0</td>
</tr>
<tr>
<td>FTA 1:</td>
<td>84.95</td>
<td>0</td>
<td>1.67</td>
<td>1.67</td>
</tr>
<tr>
<td>2:</td>
<td>84.95</td>
<td>.42</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3:</td>
<td>84.95</td>
<td>.42</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>CU 1:</td>
<td>68.81</td>
<td>0</td>
<td>1.34</td>
<td>1.34</td>
</tr>
<tr>
<td>2:</td>
<td>88.56</td>
<td>1.56</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3:</td>
<td>88.56</td>
<td>1.56</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

| Example B |          |        |        | 1 | 2 | 3 |
|           |         |         |        | .5 | .25 | .25 |
|           |         |         |        | .25 | .5 | .25 |
|           |         |         |        | .25 | .25 | .5 |
| i†     | j:→ 1   | 2 | 3 |
| 1:     | 90.14   | 0 | 0 | 0 | .333 | .3333 | .3333 | .3333 |
| FT 2:  | 90.14   | 0 | 0 | 0 | .333 | .3333 | .3333 | .3333 |
| 3:     | 90.14   | 0 | 0 | 0 | .333 | .3333 | .3333 | .3333 |
| NE 1:  | 89.34   | 0 | .30 | .30 | .333 | .3944 | .3028 | .3028 |
| 2:     | 89.34   | .30 | 0 | .30 | .333 | .3028 | .3944 | .3028 |
| 3:     | 89.34   | .30 | .30 | 0 | .333 | .3028 | .3028 | .3944 |
| FTA 1: | 89.57   | 0 | .31 | .31 | .337 | .3927 | .3045 | .3045 |
| 2:     | 89.85   | .13 | 0 | 0 | .331 | .3037 | .3477 | .3477 |
| 3:     | 89.85   | .13 | 0 | 0 | .331 | .3037 | .3477 | .3477 |
| CU 1:  | 87.48   | 0 | .24 | .24 | .302 | .4121 | .2881 | .2881 |
| 2:     | 90.33   | .40 | 0 | 0 | .349 | .2940 | .3560 | .3560 |
| 3:     | 90.33   | .40 | 0 | 0 | .349 | .2940 | .3560 | .3560 |

Note: rows refer to countries (indexed by i), and columns refer to goods (indexed by j). For example, in the CU equilibrium in Example A, countries 2 and 3 charge a 156% tariff on good 1. Net trade vectors can be found by subtracting the consumption levels in the last three columns from the endowments at the head of these columns.
TABLE 1: Examples (Continued)

<table>
<thead>
<tr>
<th>Eq\textsuperscript{a}</th>
<th>Utility</th>
<th>Tariffs</th>
<th>Prices</th>
<th>Endowments, Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Example C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>j:→ 1. 2. 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>i†</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1: 116.38</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>.333</td>
</tr>
<tr>
<td>FT 2: 73.89</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>.333</td>
</tr>
<tr>
<td>3: 73.89</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>.333</td>
</tr>
<tr>
<td>1: 117.36</td>
<td>0</td>
<td>1.24</td>
<td>1.24</td>
<td>.397</td>
</tr>
<tr>
<td>NE 2: 67.11</td>
<td>.44</td>
<td>0</td>
<td>.31</td>
<td>.301</td>
</tr>
<tr>
<td>3: 67.11</td>
<td>.44</td>
<td>.31</td>
<td>0</td>
<td>.301</td>
</tr>
<tr>
<td>1: 117.71</td>
<td>0</td>
<td>1.25</td>
<td>1.25</td>
<td>.400</td>
</tr>
<tr>
<td>FTA 2: 67.58</td>
<td>.25</td>
<td>0</td>
<td>0</td>
<td>.300</td>
</tr>
<tr>
<td>3: 67.58</td>
<td>.25</td>
<td>0</td>
<td>0</td>
<td>.300</td>
</tr>
<tr>
<td>1: 112.63</td>
<td>0</td>
<td>1.05</td>
<td>1.05</td>
<td>.351</td>
</tr>
<tr>
<td>CU 2: 69.34</td>
<td>.69</td>
<td>0</td>
<td>0</td>
<td>.324</td>
</tr>
<tr>
<td>3: 69.34</td>
<td>.69</td>
<td>0</td>
<td>0</td>
<td>.324</td>
</tr>
</tbody>
</table>

Example D

| j:→ 1. 2. 3          |         |         |        |                         | \Omega = \begin{bmatrix} .5 & .1 & .1 \\ .25 & .8 & .1 \\ .25 & .1 & .8 \end{bmatrix} |
| i†                    |         |         |        |                         |                          |
| 1: 54.47              | 0       | 0       | 0      | .333                    | .2333 .2333 .2333        |
| FT 2: 104.11          | 0       | 0       | 0      | .333                    | .3833 .3833 .3833        |
| 3: 104.11             | 0       | 0       | 0      | .333                    | .3833 .3833 .3833        |
| 1: 43.33              | 0       | .47     | .47    | .277                    | .3222 .1680 .1680        |
| NE 2: 98.85           | 1.29    | 0       | 1.47   | .362                    | .3389 .5925 .2395        |
| 3: 98.85              | 1.29    | 1.47    | 0      | .362                    | .3389 .2395 .5925        |
| 1: 49.79              | 0       | .53     | .53    | .318                    | .3098 .1888 .1888        |
| FTA 2: 104.38         | .26     | 0       | 0      | .341                    | .3451 .4056 .4056        |
| 3: 104.38             | .26     | 0       | 0      | .341                    | .3451 .4056 .4056        |
| 1: 36.61              | 0       | .39     | .39    | .231                    | .3417 .1475 .1475        |
| CU 2: 106.11          | 1.16    | 0       | 0      | .385                    | .3291 .4262 .4262        |
| 3: 106.11             | 1.16    | 0       | 0      | .385                    | .3291 .4262 .4262        |

Note: rows refer to countries (indexed by i), and columns refer to goods (indexed by j). For example, in the CU equilibrium in Example C, countries 2 and 3 charge a 69% tariff on good 1. Net trade vectors can be found by subtracting the consumption levels in the last three columns from the endowments at the head of these columns.
4. The Tariff Externality

Member countries derive two distinct benefits from a customs union. In this section we discuss examples which illustrate the first of these, which comes from internalizing the tariff externality. In Section 6 we consider the benefit which comes from being part of a larger trading unit.

Examples A-D illustrate the effect of internalizing the tariff externality. The only difference between the FTA and CU equilibria is that CU is computed by letting country 2 choose tariffs for both CU members. In example A, the effect of this is to increase the CU tariff from 42% to 156%. Country 1 responds by lowering its tariff to 134% from 167%. The increased CU tariff and lower non-member tariff is entirely attributable to internalizing the tariff externality. The other examples give similar results.

In all four examples the move from FTA to CU improves the terms of trade for CU members at the non-member's expense. Intra-customs union trade increases and trade between the customs union and the rest of the world decreases. Internalizing the tariff externality results in higher member country welfare and lower non-member welfare.

In examples A and C coordination of tariff policy fails to provide enough benefits for CU members to do better than they would at free trade. The coordination effect is large enough in examples B and D so that CU does better than FT for the member countries. These examples highlight the policy coordination role of customs unions. Next, we consider the effects customs unions have on efficiency.
5. **Resource Allocation Effects**

Our model can be used to address the question of whether customs unions improve the allocation of resources, relative to a Nash equilibrium in tariffs. This is a second best problem with no general answer. A common procedure in analyzing customs unions (see Lloyd (1982) for example) is to compare some arbitrary initial tariff equilibrium to a customs union, assuming that the non-member is passive and that the formation of the customs union does not affect the tariffs that members charge to non-members. This assumption is sensible in models which do not specify how the initial tariffs were set, nor how a customs union sets its tariffs. Since these decisions are the focus of our model we can say more. We require that pre- and post-union tariffs are optimal given the other tariffs. This implies a comparison between Nash equilibrium and customs union equilibrium.

Comparing NE to CU consists of two separable steps, eliminating member tariffs (NE to FTA) and coordinating the external tariff policy of the CU members (FTA to CU). In all four examples moving from NE to FTA decreases the tariffs charged by the FTA members, while increasing the non-member's tariffs. The terms of trade shift in favor of the non-member, but everyone is better off at FTA than at NE, and both inter- and intra-FTA trade increase. In example A the non-member country actually benefits more from the move to FTA from NE than the members; in example B the members benefit more.

These results have an interesting interpretation. Moving from NE to FTA improves the global allocation of resources: this is a "stepping stone" towards freer trade. Investigating the robustness of this result is an important task for future research.

We next consider the second step in the CU process: moving from a FTA to
CU. In all of the examples this leads to an increase in the tariffs charged by the customs union members, and a decrease in the non-member's tariffs. The terms of trade shift in favor of the customs union, there is more intra-CU trade, and less trade between the CU member countries and the non-member. The members experience an increase in utility, while the non-member's utility falls.\(^6\) Thus, the resource allocation effect of the move from FTA to CU is ambiguous.

The two steps have opposing effects on tariffs and on the terms of trade. The net effect on tariffs is ambiguous, but the terms of trade always move in favor of the customs union. Each step increases the welfare of the customs union members, while the non-member gains in the first step (NE to FTA) and loses in the second (FTA to CU). In our examples, the non-member's gains in the first step are outweighed by its losses in the second, so that the customs union benefits its members (relative to NE) at the expense of the non-member country.

6. **Do Big Customs Unions Win Tariff Wars?**

Even if endowments are symmetric and preferences are identical across countries, it may nevertheless be true that each pair of countries has an incentive to defect from free trade and form a customs union. This was shown in Example B. In this case it is difficult to see how free trade could be an equilibrium.

It can also happen, as was shown in Example A, that each country is better

\(^6\)Although we do not specifically analyze unilateral tariff reductions (UTR), the external tariff coordination provided by a customs union is an additional reason why a customs union would be superior to UTR (see Paul Wonnacott and Ronald Wonnacott (1981, 1984) and Eitan Berglas (1983)).
off at free trade than it would be in any customs union. In this section we determine the set of symmetric endowments for which this result holds. We show that a customs union can improve welfare over free trade if the member countries are large enough.

When countries are symmetric the endowment matrix can be written as

\[ \Omega(y) = \begin{bmatrix} y & \frac{1-y}{2} & \frac{1-y}{2} \\ \frac{1-y}{2} & y & \frac{1-y}{2} \\ \frac{1-y}{2} & \frac{1-y}{2} & y \end{bmatrix} \]

where \( y \) is each country's percentage share of the world endowment of their export good.

We let \( y \) vary from .98 to .36 and for each \( y \) we compute NE, CU, and FT, where the CU members are countries 2 and 3. The problem reduces to determining which values of \( y \) imply that customs unions improve members' welfare over free trade.\(^7\) Since reporting the results for each \( y \) would be too cumbersome we report only a summary.

The critical value of \( y \) (computed to five places) is .66919. If each country's endowment of \( y \) (their export good) is less than .66919 then member countries do better at CU than at FT; otherwise they do worse. Of course, the non-member is worse off at CU no matter what the endowment.

This result may seem puzzling since it says that customs unions are beneficial if \( y \) is small. We next show that \( y \) being small is equivalent to the customs union being large. This can be seen by collapsing the three

\(^7\)Following the discussion in section 5 above, it is worth noting that the terms of trade always move in favor of the customs union, for all values of \( y \). In addition, the customs union members are always better off relative to NE, at the expense of the non-member.
country model to two countries, treating the customs union as a single
country. This can be done since the customs union members (countries 2 and
3) decide their tariffs jointly and they are completely symmetric. In
addition, since the relative price of goods 2 and 3 is always unity, these
goods can be aggregated into a composite commodity. Note however that the
customs union's preferences over good 1 and the composite good will not be
symmetric.

We combine countries, aggregate goods, and renormalize so that there is
one unit of both good 1 and the composite good, with the resulting endowment
matrix

\[
\Omega'(y) = \begin{bmatrix}
y & 1-y \\
\frac{1-y}{2} & 1-y & \frac{1+y}{2}
\end{bmatrix}
\]

In a 2 x 2 version of this model with symmetric preferences Kennan and
Riezman (1987) showed that a sufficient condition for a country to win a
tariff war is that it be large in the sense that the sum of its endowments is
greater than some critical number. It can also be shown that this condition
remains approximately valid for a broad range of asymmetric preferences. In
the present context this condition means that the customs union wins a tariff
war if \((1-y) + \frac{1}{4}(1+y) > 1.2\). This is equivalent to \(y < .6\), which is close to
the condition we derived in the 3 x 3 case. The difference is due to the
fact that in the aggregated case the correct preferences would not be
symmetric over goods. Hence, the condition that customs unions gain if
\(y < .66919\) essentially says that customs unions which are big enough gain
compared to free trade. In other words, customs unions can be regarded as a
device to increase country size for the purpose of trade policy.
7. Conclusion

The analysis of optimal tariff equilibria with customs unions presents a formidable theoretical puzzle, and general results in this area do not yet exist. As a first step, we have developed a prototype model which illustrates, by means of examples, some important pieces of the puzzle.

Two distinct motivations for customs union formation were demonstrated. First, a customs union enables its members to internalize the tariff externality that exists whenever two countries import the same good. Second, a customs union can make several countries into one larger one for the purposes of trade policy. If the customs union is big enough it can improve its members' welfare over free trade. One implication of this argument is that even if countries are initially symmetric, it may be difficult to sustain free trade as an equilibrium.

Our model was also be used to separate the tariff reduction aspect of customs unions from the policy coordination aspect. The movement from a Nash equilibrium in tariffs to an equilibrium in which two of the countries form a Free Trade Association with zero internal tariffs improved global resource allocation. Moving from a Free Trade Association to a full customs union in which the member countries agree on a common external tariff had ambiguous resource allocation effects.

There are two obvious directions for further research. First, the robustness of the examples should be investigated, by considering production as well as exchange, and by examining more general preferences. Second, the model can provide a base on which to build a practical framework for empirical applications. For example, it might be used to analyze how the
initial formation and subsequent expansion of the European Community affected tariffs charged on U.S. exports to Europe, and tariffs charged by the U.S. on imports from Europe.

REFERENCES


