

Free Trade: What Are the Terms-of-Trade Effects?

Carsten Kowalczyk* Raymond Riezman[†]

First Draft: June 2007[‡]

This Draft: November 2007

JEL Classification Numbers: F00, F02, F10, F11, F13, F15

Keywords: WTO, Multilateralism, Free Trade, Customs Unions, Free Trade Areas, Transfers

*The Fletcher School, Tufts University, MA 02155; Telephone: 617.627.5603; Email: carsten.kowalczyk@tufts.edu. (Corresponding author.)

[†]Department of Economics, University of Iowa, IA 52242; Telephone: 319.335.0832; Email: raymond-riezman@uiowa.edu.

[‡]Prepared for the conference "New Directions in International Trade Theory" at the University of Nottingham's Leverhulme Center. We are grateful to our discussant, Eric Bond, and to conference participants for comments. We appreciate also comments at Vanderbilt, Buffalo, and the Midwest Trade Meetings. This paper is part of the Globalization Project at the University of Aarhus.

Free Trade: What Are the Terms-of-Trade Effects?

Abstract

Changes in trade policy affect a nation's economic welfare through terms-of-trade and volume-of-trade effects. A move to global free trade would imply higher world economic welfare equal to the sum of all nations' volume-of-trade, or efficiency, effects. Since the sum of the terms-of-trade effects across all nations is zero, terms-of-trade effects are contentious. Konishi, Kowalczyk, and Sjöström (2003) have shown that if customs unions do not affect trade with non-member countries, immediate global free could be achieved if free trade were proposed together with international sidepayments equal to the terms of trade effects. How large would these terms of trade effects, and hence transfers, be? This paper presents estimates from a simple computable general equilibrium model of a world economy of perfect competition. We show

that, in some cases, terms-of-trade effects are small compared to efficiency gains, and transfers are not necessary for free trade. In other cases, terms-of-trade gains may account for more than 50% of a country's gains from free trade and transfers could be large.

(168 words)

1 Introduction

Even as the Doha Round multilateral negotiations, which were launched in 2001, have been ongoing, many WTO member countries have continued to establish new free trade areas or customs unions.

Free trade areas and customs unions reduce trade barriers, but they also pose potential problems: Surprisingly, they may reduce the economic welfare of the participants, and, indeed, of the world by making world trade more distorted.¹ They may also affect adversely non-member countries. Finally, they may discourage further liberalization, and hence prevent global free trade, if they imply a situation where some member countries would prefer to stay in a world of preferential trading areas because a move to free trade would imply losing existing valuable preferential access to some markets.

Is it possible to get global free trade in a world of trading blocs? Until recently, the strongest theoretical result on free trade in a world of preferential trade was due to Michihiro Ohyama (1972) and Murray Kemp and Henry Wan (1976) who showed that if the members of a customs union are required to set their common external tariff such that trade with non-members remains constant, then there exist income transfers between members such that no

¹This was the insight of Jacob Viner (1950).

country loses. It follows that global free trade can be achieved through a sequence, or through parallel sequences, of continual expansions of such Ohyama-Kemp-Wan customs unions.

Hideo Konishi, Kowalczyk, and Tomas Sjöström (2003) have identified a more direct approach to global free trade: Recognizing that the long-standing negotiating principle in GATT/WTO for a multilateral agreement to be reached is that no group of members object, and maintaining the Ohyama-Kemp-Wan requirement that customs unions cause no change in trade with non-members, they show that there exists a proposal for immediate global free trade with international income transfers that would be blocked by no group of countries. They show, in particular, that free trade with international income transfers equal to any terms-of-trade effects is not blocked. In other words, free trade with international income transfers equal to the terms of trade effects is in the core of the customs union trade policy game.

One line of research has considered the possibility of global free trade without international income transfers and has found that if important asymmetries between countries exist, in particular with respect to differences in ability to affect own terms of trade, global free trade may be impeded by

nations who have an ability to obtain better terms of trade with protection. In a two-country world, Harry Johnson (1953-54) showed that the larger country may obtain higher economic welfare from levying its optimal tariff rather than from free trade even if its smaller trading partner retaliates. John Kennan and Riezman (1988) considered, further, how differences in preferences or in endowments would upset the balance between countries required for both to desire free trade. In a world of three countries, Riezman (1985), in an early application of the core in international trade, and Kennan and Riezman (1990), Eric Bond and Costas Syropoulos (1996), and Riezman (2000) explore how the ability of countries to form customs unions or free trade areas may affect the incentives of countries to agree to free trade.

Once international sidepayments are possible then, as shown by Kowalczyk and Sjöström (1994) in a model of international monopoly trade, there exist income transfers such that no country objects to a multilateral agreement to eliminate all distortions. And they show, in Kowalczyk and Sjöström (2000), that transfers equal to terms-of-trade changes, originally discussed by Earl Grinols (1981) as between-member transfers that would make a Ohyama-Kemp-Wan customs union beneficial for all its members, would prevent any blocking of a proposal to eliminate all trade distortions. Konishi,

Kowalczyk and Sjöström (op. cit.) extend that work to the standard model of international trade in a competitive world economy.

In this paper, we explore, in a world of perfect competition, how large the transfers to support global free trade, and hence how large the terms-of-trade effects, might be. While the theoretical rationale for the possible benefits from the use of sidepayments does not depend on the answer to this question – a country never pays more than it gains from free trade – the size of transfers could matter if the notion of international income transfers were to be brought from theory to a world of practical policy: First, some countries may find it difficult in practice to raise through taxation of domestic producers and consumers the revenue that would correspond to the terms of trade gains from free trade. And it would, presumably, be harder to raise a large than a small revenue. Secondly, while the notion of paying trading partners for market access is not entirely unknown in the context of negotiating free trade areas or customs unions – witness, for example, the EU’s agricultural, regional, and structural funds – international income transfers would be a somewhat novel tool for facilitating multilateral trade liberalization where negotiations have traditionally involved exchanges of market access. Thirdly, since, in theoretical work, transfers would tend to go from

countries with relatively small domestic markets to countries with relatively large domestic markets, it is possible – although not a certainty – that the transfers be regressive if they were to go from lower-income countries to higher-income countries.² In short, governments might find it difficult to obtain domestic political support for engaging in international income transfers addressing terms-of-trade effects.

We consider, in this paper, a three-country model of international trade in which key economic variables such as consumption, prices, and utility, can be calculated both before and after changes in trade policy. Assuming an initial situation where countries apply their non-cooperative Nash optimal tariffs, we calculate the change in each nation’s real income from global free trade. Decomposing this change into a terms-of-trade effect and an efficiency effect, and quantifying these effects, we then have estimates for the transfers discussed above that would support global free trade. We conduct these calculations for varying distributions of world endowments, and find that transfers for free trade vary considerably depending on the economic environment: For countries that are not too dissimilar we find, in our simu-

²Undoubtedly, many would find it difficult to accept the implications for world income distribution of such transfers. On the other hand, it should be stressed that the sidepayments discussed here are not inconsistent with foreign aid which nations might still wish to undertake for reasons not considered in this work.

lations, terms-of-trade effects of about ten percent of gains from trade, while for very dissimilar countries with large initial trade, terms-of-trade gains may account for almost 60% of a nation's total gains from free trade, and almost nine percent of GDP. In the latter case, the international sidepayments discussed in this research would be large, and it could be politically difficult to raise the associated revenue.³

Section 2 states an expression for evaluating the change in national economic welfare from a change in trade policy in a competitive world economy. Section 3 introduces the roles of terms-of-trade effects and international income transfers in obtaining global free trade. Section 4 offers calculations of how large terms-of-trade effects from free trade might be in a three-country, three-good general equilibrium model. Section 5 concludes and offers suggestions for further research.

³Of course, without such sidepayments, the same countries might not experience these larger gains as other countries might block the very trade that would induce them.

2 National Economic Welfare in Perfect Competition

Consider a country i ($i = 1, \dots, n$) where price-taking consumers and producers trade a finite number of goods with price-taking producers and consumers in other countries. Assuming that preferences can be expressed by the utility function of a representative consumer, that international trade is initially subject to tariffs the revenue of which is redistributed lump-sum to domestic households, and that trade is balanced, it is possible to express the change in country i 's national income, $\Delta\eta^i$, from a change in tariffs, whether own or trading partners', as:⁴

$$\Delta\eta^i = -\Delta(p^e)^i m_A^i + (p_B^i - (p_B^e)^i) \Delta m^i + S^i. \quad (1)$$

With subscript A denoting pre-change values and subscript B post-change values, and Δ denoting a change, equation (1) states that the change in real income, $\Delta\eta^i = \eta_B^i - \eta_A^i$, measured in units of some numéraire good, can be

⁴See Ohyama (1972) or Earl Grinols and Kar-yiu Wong (1976) for a derivation of this expression. For small changes this expression becomes the terms-of-trade and volume-of-trade effects formalized by Ronald Jones (1969). Kowalczyk (2000) demonstrates that this is a better approach to analyzing the welfare effects of free trade areas or customs unions than is Viner's trade diversion and trade creation approach.

expressed as the sum of three terms: A terms-of-trade effect, $-\Delta(p^e)^i m_A^i$, where m_A^i is country i 's pre-change trade vector and $\Delta(p^e)^i = (p_B^e)^i - (p_A^e)^i$ is the vector of changes in country i 's tariff-exclusive trade prices. A tariff-revenue effect, $(p_B^i - (p_B^e)^i) \Delta m^i$, where $\Delta m^i = m_B^i - m_A^i$, and p_B^i is the vector of domestic, tariff-inclusive, prices in country i , and hence $p_B^i - (p_B^e)^i$ is the vector of post-change specific tariffs, t_B^i , or the vector $\tau_B^i (p_B^e)^i$, where τ_B^i is a matrix of *ad valorem* tariffs. The final term, S^i , is the non-negative sum of production and consumption effects due to substitution by domestic producers and consumers as they face changed domestic prices. If y_A^i and y_B^i are profit-maximizing pre- and post-change production respectively, the production efficiency effect is $p_B^i (y_B^i - y_A^i) \geq 0$, and if c_A^i is initial consumption, and if $c^i(p_B^i, u_A^i)$ would be consumption at the new domestic price vector p_B^i that preserves the initial level of utility u_A^i , the consumption efficiency effect is $p_B^i (c_A^i - c^i(p_B^i, u_A^i)) \geq 0$.

This approach allows for a comparison of a nation's real income from different policy strategies and, in particular, for a comparison of national welfare from free trade versus from customs unions or free trade areas.

While GATT/WTO emphasizes non-discrimination between its members, GATT Article XXIV allows WTO members to form free trade areas, which

eliminate the barriers on mutual trade between the free trade area members while leaving each member's tariffs on its trade with non-members to that member country to decide, or customs unions, which eliminate the barriers to mutual trade on the union members while setting common external tariffs on trade with non-members.⁵

As mentioned in the Introduction, Ohyama (op. cit.) and Kemp and Wan (op. cit.) consider a variation of the Article XXIV customs union, namely a union where the common external tariffs be such that aggregate trade of members with non-members not be affected, and they show the existence of intra-union sidepayments such that no member country would be hurt from the formation of such a customs union. Konishi, Kowalczyk and Sjöström (op. cit.) prove that if customs unions are required to satisfy that trade with non-members not be affected then there exist sidepayments such that a proposal for immediate free trade with such sidepayments will not be blocked by any nation or by any Ohyama-Kemp-Wan customs union. They show, specifically, that international sidepayments that off-set countries' terms-of-trade losses or gains, together with global free trade, constitute an outcome

⁵Additional requirements are that internal barriers must be eliminated on "substantially all trade" and that the average rate of protection on trade with non-members must not increase.

in the core of the customs union game.⁶ Thus, if T_B^i is the (aggregate) net transfer to country i associated with moving from the initial situation A to global free trade in B , the sidepayment mechanism that transfers to country i the amount

$$T_B^i = (p_B^e - p_A^e)m_A^i \quad (2)$$

supports global free trade as an outcome in the core.

How large would these transfers be? This is the question we consider next.

3 Computing the Terms-of-Trade Effects

We construct a general equilibrium model where three endowment economies trade three goods. Since we wish to derive the transfers that would compensate for terms-of-trade effects, we calculate the terms of trade effects from global free trade assuming that transfers do not take place.

We assume that countries set their individually non-cooperative optimal

⁶Grinols (1981) showed that giving each member country of an Ohyama-Kemp-Wan customs union its initial trade vector would make every member better off. If the alternative under consideration is not a customs union but free trade, then Grinols's recommended transfers amount to off-setting countries' terms of trade effects.

tariffs initially, and that they consider as alternatives whether to join a free trade area (FTA) or a customs union (CU), or whether to establish global free trade (FT).

We assume that each country i is endowed with a fixed amount of commodity j , ω_j^i . We assume also that the utility function of the representative consumer in country i is given by

$$U^i = \sum_{j=1}^3 \beta_j^i \ln c_j^i \quad (3)$$

where U^i is the utility of the country i consumer, and β_j^i is the weight this consumer puts on consumption of good j , c_j^i . This preference formulation results in a linear expenditure system which allows us to employ numerical methods to solve the model. Further, with this structure we do not have to specify elasticities, and can state our results in terms of fundamental endowment parameters.

The net imports of good j into country i are $m_j^i = c_j^i - \omega_j^i$. When acting individually, countries charge optimal tariffs on imports. Tariffs are assumed to be *ad valorem* with τ_j^i denoting the rate charged by country i on imports of good j . If the world price for good j is p_j^e , the domestic price of good j in country i is $p_j^i = (1 + \tau_j^i) p_j^e$.

Given that each country consists of identical individuals, aggregate demand is obtained from maximizing the utility subject to the budget constraint where I^i is income of the representative consumer in country i which consists of income from the endowment $(1 + \tau_j^i)p_j^e\omega_j^i$ plus any tariff revenue which is rebated to consumers lump-sum.

At world market prices, balanced trade implies that aggregate expenditure in each country i must equal the value of country i 's endowment in equilibrium. Thus

$$W^i = \sum_{j=1}^3 p_j^e c_j^i = \sum_{j=1}^3 p_j^e \omega_j^i \quad (4)$$

where W^i is the aggregate expenditure of country i . In addition, in equilibrium, world demand for each good equals world supply:

$$\sum_{i=1}^3 c_j^i = \sum_{i=1}^3 \omega_j^i \quad (5)$$

This system of equations allows us to solve for p_j^e , c_j^i , and U^i .

Treating the Nash equilibrium as the benchmark, we are interested in seeing how large the terms of trade effects are relative to the change in real income from a move to global free trade.

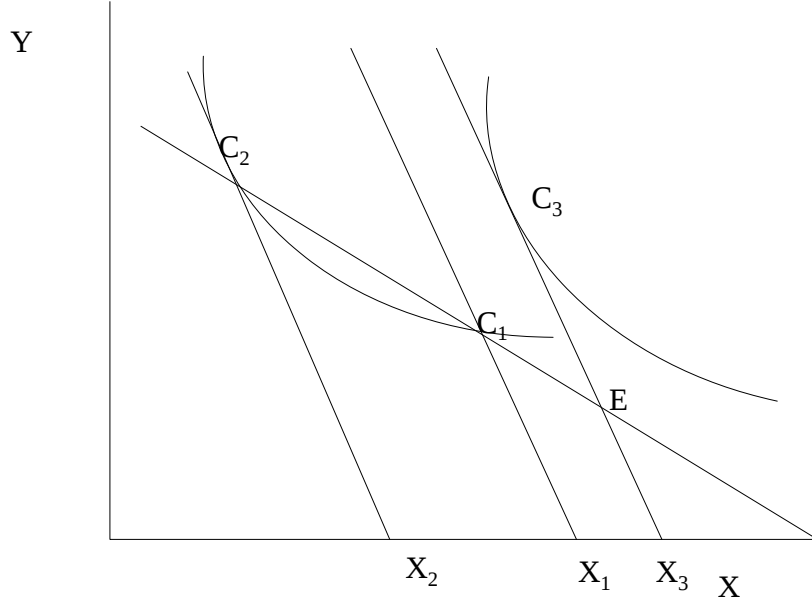


Figure 1: Nash equilibrium to Free Trade

With free trade there is no revenue effect, and expression (1) simplifies to:

$$\Delta\eta^i = -\Delta(p^e)^i m_A^i + S^i. \quad (6)$$

We illustrate how the terms-of-trade and consumption effects impact real income in figure 1 where we assume that only two goods, X and Y , are consumed:

Let E be the endowment point, C_1 the initial consumption bundle with Nash tariffs, and C_3 the free trade consumption bundle. The point C_2 is the consumption bundle that has equal utility with the Nash equilibrium consumption and that would be chosen at post-change free trade prices if utility were to be constant. In Section 1 of this paper, we wrote C_2 as $c^i(p_B^i, u_A^i)$ when introducing the consumption effect from a price change. Evaluating changes at post-change prices, and assuming good X is the numéraire, we then have that the distance X_2X_3 represents the total increase in real income associated with a move from Nash equilibrium to free trade. We can decompose this change into a change due to a substitution effect, X_2X_1 , which is the consumption effect, and a change due to a terms of trade effect, X_1X_3 .

If we call the terms-of-trade effect ΔTOT and the substitution effect S , then the total effect on real income caused by the move from the benchmark to free trade, $\Delta\eta$, is

$$\Delta\eta = \Delta TOT + S \tag{7}$$

We are particularly interested in seeing how much of the welfare change, $\Delta\eta$, is explained by terms of trade changes, ΔTOT . For that purpose, we consider four examples that differ in assumptions regarding country sizes and

in how (dis-)similar countries are, and hence how much they trade.

4 Examples

4.1 Country 1 Is Large

The endowment matrix is given by:

	Good 1	Good 2	Good 3
Country 1	0.8	0.25	0.25
Country 2	0.1	0.5	0.25
Country 3	0.1	0.25	0.5

Letting τ_j^* denote the optimal tariff on good j ($j = 1, 2, 3$) by the country indicated by the row entry, key endogenous variables in the Nash equilibrium are:

	τ_1^*	τ_2^*	τ_3^*	c_1	c_2	c_3	Utility
Country 1	0	1.2358	1.2358	0.6226	0.3669	0.3669	117.36
Country 2	0.4453	0	0.3133	0.1887	0.3594	0.2737	67.11
Country 3	0.4453	0.3133	0	0.1887	0.2737	0.3594	67.11

We normalize prices so that their product is unity. In all examples in this paper we also assume that the world endowment of each good is one, and that preferences are identical and symmetric across countries and goods.

It follows that in all examples in this paper free trade world market prices will be the same and equal to $1/3$. World market prices in Nash equilibrium will, however, differ in the examples. In this first case, they are:

World market Nash prices:

Good 1 Good 2 Good 3

0.3971 0.3014 0.3014

In free trade we have the following consumption, utility and value of income:

	c_1	c_2	c_3	Utility	GDP (value of endowment) at free trade price
Country 1	0.4333	0.4333	0.4333	116.38	0.43329
Country 2	0.2833	0.2833	0.2833	73.89	0.283305
Country 3	0.2833	0.2833	0.2833	73.89	0.283305

The changes in economic welfare and its components are hence:

	$\Delta\eta$	ΔTOT	S
Country 1	-0.004321461	-0.01883145	0.014509989
Country 2	0.0185298	0.00936573	0.00916407
Country 3	0.0185298	0.00936573	0.00916407

Or, in relative terms:

	$\Delta TOT/\Delta\eta$	$S/\Delta\eta$	$\Delta TOT/GDP$	S/GDP	$\Delta\eta/GDP$
Country 1	435.77%	-335.77%	-4.35%	3.35%	-0.09%
Country 2	50.54%	49.46%	3.31%	3.23%	6.54%
Country 3	50.54%	49.46%	3.31%	3.23%	6.54%

By moving to free trade the large country would forego the terms of trade gains from applying its optimal tariff, and it would require a substantial transfer to agree to free trade. The smaller countries experience terms of trade improvements that are about the same size as their consumption gains.

If transfers were implemented, the smaller countries would surrender about half of their gains from free trade as payments to the large country. We note also that, in this example, terms-of-trade effects, and hence any transfers, would be less than one percent of GDP for the paying countries, and less than two percent of GDP for the receiving country.

We note that the gains from free trade relative to income, $\Delta\eta/GDP$, are quite large for the smaller countries: If no transfers take place, they are over 6% of GDP, with transfers, they are about 3%, still a substantial gain.

4.2 Countries 2 and 3 Are Large

The endowment matrix is assumed to be:

	Good 1	Good 2	Good 3
Country 1	0.5	0.1	0.1
Country 2	0.25	0.8	0.1
Country 3	0.25	0.1	0.8

Nash equilibrium yields:

	τ_1^*	τ_2^*	τ_3^*	c_1	c_2	c_3	Utility
Country 1	0	0.4665	0.4665	0.3222	0.168	0.168	43.33
Country 2	1.2857	0	1.474	0.3389	0.5925	0.2395	98.85
Country 3	1.2857	1.474	0	0.3389	0.2395	0.5925	98.85

World market Nash prices:

Good 1	Good 2	Good 3
0.2766	0.3616	0.3616

At free trade:

	c_1	c_2	c_3	Utility	GDP (value of endowment) at free trade price
Country 1	0.2333	0.2333	0.2333	54.47	0.23331
Country 2	0.3833	0.3833	0.3833	104.11	0.383295
Country 3	0.3833	0.3833	0.3833	104.11	0.383295

Estimates of changes in welfare and terms of trade and consumption ef-

fects are:

	$\Delta\eta$	ΔTOT	S
Country 1	0.024564678	0.01389861	0.010666068
Country 2	0.019624977	-0.0069993	0.026624277
Country 3	0.019624977	-0.0069993	0.026624277

implying:

	$\Delta TOT/\Delta\eta$	$S/\Delta\eta$	$\Delta TOT/GDP$	S/GDP	$\Delta\eta/GDP$
Country 1	56.58%	43.42%	5.96%	4.57%	10.53%
Country 2	-35.67%	135.67%	-1.83%	6.96%	-5.12%
Country 3	-35.67%	135.67%	-1.83%	6.96%	-5.12%

In this example, two countries, 2 and 3, are relatively large due to a skewed world endowment that makes each country almost a monopoly seller of its export good. While both countries would experience terms of trade losses from global free trade as compared to the Nash equilibrium both countries would gain from free trade since their consumption effects are larger than their terms of trade losses.

In this case, transfers would not be necessary for countries to agree to free trade. If, nevertheless, transfers equal to the terms-of-trade changes were implemented, country 1 would surrender about 57% of its gains from free trade. This transfer would be about the same relative magnitude as in example 1. When viewed as a fraction of income, the donor country would

pay almost six percent of GDP, a substantial transfer, while the receiving countries would receive less than two percent of their GDP as transfers. In this example too, the gains to the small country from free trade relative to GDP if transfers take place are about 5% and almost 7% for each of the two larger countries who gain primarily due to liberalization relative each other.

4.3 Countries 1, 2, and 3 Are of Different Size

The endowment matrix is given by:

	Good 1	Good 2	Good 3
Country 1	0.5	0.15	0.05
Country 2	0.25	0.7	0.05
Country 3	0.25	0.15	0.9

Nash equilibrium yields:

	τ_1^*	τ_2^*	τ_3^*	c_1	c_2	c_3	Utility
Country 1	0	0.4203	0.5044	0.3196	0.1984	0.122	37.96
Country 2	0.8142	0	1.012	0.3043	0.4868	0.1575	74.76
Country 3	2.3359	2.5167	0	0.376	0.3146	0.7204	117.92

World market Nash prices:

Good 1	Good 2	Good 3
0.258	0.2925	0.4493

At free trade:

	c_1	c_2	c_3	Utility	GDP (value of endowment) at free trade price
Country 1	0.2333	0.2333	0.2333	54.47	0.23331
Country 2	0.3333	0.3333	0.3333	90.14	0.3333
Country 3	0.4333	0.4333	0.4333	116.38	0.43329

Estimates of changes in welfare and terms of trade and consumption ef-

fects are:

	$\Delta\eta$	ΔTOT	S
Country 1	0.035476897	0.01996467	0.015512227
Country 2	0.047477242	0.01709829	0.030378952
Country 3	-0.006778772	-0.03702963	0.030250858

implying:

	$\Delta TOT/\Delta\eta$	$S/\Delta\eta$	$\Delta TOT/GDP$	S/GDP	$\Delta\eta/GDP$
Country 1	56.58%	43.42%	8.56%	6.65%	15.21%
Country 2	36.01%	63.99%	5.13%	9.11%	14.24%
Country 3	546.26%	-446.26%	-8.55%	6.98%	-1.57%

In this example, no two countries are of equal size. Global free trade hurts the largest of the countries, country 3, and benefits the smaller ones, with the smallest, country 1, gaining most. The smallest country would surrender about 56% of its gains from free trade as a transfer, while the mid-sized country would surrender only about 36% of its gains from free

trade.

Transfers are almost nine percent and about five percent of GDP for both of the potentially paying countries, 1 and 2, and almost nine percent for the receiving country 3. Gains from free trade relative to GDP even after transfers are about 6% for smallest country 1, and a substantial 9% for next smallest country 2.

4.4 Countries' Size More Similar

The endowment matrix is:

	Good 1	Good 2	Good 3
Country 1	0.5	0.2	0.2
Country 2	0.25	0.6	0.2
Country 3	0.25	0.2	0.6

Nash equilibrium yields:

	τ_1^*	τ_2^*	τ_3^*	c_1	c_2	c_3	Utility
Country 1	0	0.4203	0.5044	0.3196	0.1984	0.122	37.96
Country 2	0.8142	0	1.012	0.3043	0.4868	0.1575	74.76
Country 3	2.3359	2.5167	0	0.376	0.3146	0.7204	117.92

World market Nash prices:

	Good 1	Good 2	Good 3		
Nash prices	0.258	0.2925	0.4493		
At free trade:					
	c_1	c_2	c_3	Utility	GDP (value of endowment) at free trade prices
Country 1	0.3	0.3	0.3	54.47	0.29997
Country 2	0.35	0.35	0.35	90.14	0.349965
Country 3	0.35	0.35	0.35	116.38	0.349965
Changes in real income, and terms of trade and consumption effects are:					

	$\Delta\eta$	ΔTOT	S
Country 1	0.01776175	0.0019998	0.01576195
Country 2	0.005602365	-0.0009999	0.006602265
Country 3	0.005602365	-0.0009999	0.006602265

Hence:

	$\Delta TOT/\Delta\eta$	$S/\Delta\eta$	$\Delta TOT/GDP$	S/GDP	$\Delta\eta/GDP$
Country 1	11.26%	88.74%	0.67%	5.25%	5.92%
Country 2	-17.85%	117.85%	-0.29%	1.89%	1.60%
Country 3	-17.85%	117.85%	-0.29%	1.89%	1.60%

In this, final, example, countries are made more symmetric, and terms-of-trade effects become relatively less important.⁷ Every country gains from

⁷In a completely symmetric world economy, there would be no terms-of-trade effects from moving from Nash tariffs to global free trade.

free trade and no sidepayments would be necessary for countries to agree to free trade.

If, however, transfers were implemented, they would only be about 11% of the gains of the country whose terms-of-trade improve. When calculated as a fraction of GDP, terms-of-trade effects, and hence potential transfers, are about zero for both paying and receiving countries. The smallest country has the largest gains relative to GDP at about 5% if transfers are enacted.

5 Conclusion and Further Research

We have presented estimates of terms-of-trade effects from moving from a non-cooperative tariff equilibrium to global free trade in a world trade model of perfect competition, and we have found that these terms-of-trade effects can be large. For countries whose real income falls from free trade, the terms-of-trade effects are so large that they dominate any positive contribution from the consumption effects. For countries whose terms-of-trade improve, they may constitute more than half of their total gains from free trade. When calculated as a fraction of a nation's GDP, terms-of-trade effects do not

exceed nine percent in our examples.⁸

It would be a useful extension to explore the robustness of the findings in this paper by undertaking a grid search over all possible parameter values, and calculating the corresponding terms-of-trade effects and associated income transfers.

Our analysis assumes no substitution in production allowing only for consumption effects to play a role. It would be an interesting extension to consider whether introducing substitution in production would make terms-of-trade effects from free trade, and hence international sidepayments, larger or smaller relative to any total income change. On the one hand, added substitution would tend to imply that adjustments between equilibria are more in quantities than in prices, suggesting smaller terms-of-trade effects. On the other hand, additional substitution might raise the initial trade volume in the non-cooperative Nash equilibrium, and thereby imply that terms-of-trade effects relative to free trade would be larger. Sorting these out would be useful.

Finally, it is an interesting question how transport cost would affect our

⁸These payments are larger than those under monopoly trade where Kowalczyk and Sjöström (1994) find that transfers account for about 14 percent of the payees' gains from trade, and less than one percent of their GDP.

findings. For given endowments and preferences, introducing transport costs would presumably reduce trade flows in the optimal tariff equilibrium, and hence reduce one of the components of any terms-of-trade effects from free trade while, at the same time, reducing the responsiveness of import-demand and export-supply functions and hence reducing the relative magnitudes of volume responses but raising those of price responses. Thus transport costs could have ambiguous overall effects for the size of terms-of-trade effects and thus of any transfers. A quantitative investigation of these would be necessary to determine whether transport costs would raise the importance of international sidepayments.

We conclude by suggesting that since terms-of-trade effects may constitute a significant cause for some nations' resistance to free trade, exploring these effects further may prove to be a productive approach to a further unlocking of the gains that could be earned from trade.

References

- [1] Bond, Eric and Costas Syropoulos, 1996, "The Size of Trading Blocs: Market Power and World Welfare Effects," *Journal of International Eco-*

nomics, 40, 411-438.

- [2] Grinols, Earl L., 1981, "An Extension of the Kemp-Wan Theorem on the Formation of Customs Unions," *Journal of International Economics* 6, 95-97.
- [3] Grinols, Earl L., and Kar-yiu Wong, 1991, "An Exact Measure of Welfare Change," *Canadian Journal of Economics* 24, 61-64.
- [4] Johnson, Harry G., 1953-54, "Optimum Tariffs and Retaliation," *Review of Economic Studies* XXI, 2, 142-153.
- [5] Jones, Ronald W., 1969, "Tariffs and Trade in General Equilibrium: Comment," *American Economic Review* 59, 418-424.
- [6] Kemp, Murray C., and Henry Y. Wan, Jr., 1976, "An Elementary Proposition Concerning the Formation of Customs Union," *Journal of International Economics* 6, 95-97.
- [7] Kennan, John, and Raymond Riezman, 1988, "Do Big Countries Win Tariff Wars?" *International Economic Review* 29, 81-85.
- [8] Kennan, John, and Raymond Riezman, 1990, "Optimal Tariff Equilibria with Customs Unions," *Canadian Journal of Economics* 23, 70-83.

- [9] Konishi, Hideo, Carsten Kowalczyk, and Tomas Sjöström, 2003, "Free Trade, Customs Unions, and Transfers," Social Science Research Network, July; <http://ssrn.com/abstract=428346>.
- [10] Kowalczyk, Carsten, 2000, "Welfare and Integration," *International Economic Review* 41, 483-494.
- [11] Kowalczyk, Carsten, and Tomas Sjöström, 1994, "Bringing GATT into the Core," *Economica* 61, 301-17.
- [12] Kowalczyk, Carsten, and Tomas Sjöström, 2000, "Trade as Transfers, GATT and the Core," *Economics Letters* 66, 163-169.
- [13] Ohyama, Michihiro, 1972, "Trade and Welfare in General Equilibrium," *Keio Economic Studies* 9, 73-73.
- [14] Riezman, Raymond, 1985, "Customs Unions and the Core," *Journal of International Economics* 19, 355-365.
- [15] Riezman, Raymond, 2000, "Can Bilateral Trade Agreements Help Induce Free Trade?" *Review of International Economics*, November, 8, 4, 619-633.

- [16] Viner, Jacob, 1950, *The Customs Union Issue*, New York: Carnegie Endowment for International Peace.