Trade as transfers, GATT and the core

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Abstract

We show in our model of international monopoly trade that transfers proposed by Grinols\(^{1}\) support the grand coalition as a core allocation. We compare these transfers to those supporting the Shapley value\(^{2}\) and the core allocation.

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1. Introduction

Individual nations or groups of them may prefer protection to free trade and will then strive to prevent a liberal trading order. We argued in Kowalczyk and Sjöström (1994) that a natural solution concept for analyzing a world-wide trade agreement is the core which is the collection of situations no nation or coalition of nations, whether actual or potential, would block, i.e., prevent from being implemented. We introduced a many-country monopoly trade model where implementing a core allocation may require international income transfers. We derived an explicit formula for such sidepayments which together with the formation of the grand coalition ("free trade") support the Shapley value (Shapley, 1971), a core allocation.

Another transfer scheme has been discussed in the international trade literature. Grinols (1981), in further development of work on compensation by Grandmont and McFadden (1972), and on customs

\(^{1}\)Riezman (1985) and Macho-Stadler et al. (1998) consider the core in non-cooperative trade games but rule out international sidepayments.

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unions by Ohyama (1972) and Kemp and Wan (1976), showed that assigning to each country its pre-change trade vector ensures that no nation loses when joining a customs union which sets its compensating common tariff, i.e., the tariff that leaves trade with non-member nations and hence their welfare unaffected. None of these papers considered the core.

This paper analyzes the Grinols transfer mechanism in our monopoly trade model. We show that Grinols transfers (i) support a core allocation; (ii) go from countries with small to countries with large profit losses; (iii) do not account for differences in recovered deadweight losses; and (iv) constitute minimal compensation necessary to reach the core.

2. The monopoly trade model

We consider the monopoly trade model introduced in our previous paper. The representative consumer in country $i$ ($i = 1, \ldots, n$) consumes $c^i_0$ units of the non-taxed numeraire good, $c^i_j$ units of good $j$ and, with taste parameter $0 < \theta^i_j < 1$, maximizes

$$u^i(c^i) = c^i_0 + \sum_{j=1}^{n} \frac{(c^i_j)^{\theta^i_j}}{\theta^i_j}, \quad i = 1, \ldots, n. \quad (1)$$

Consumer $i$’s endowment of good zero, $l^i_0$, is consumed, sold to the domestic firm, or used for transfers. Letting $l^i$ denote consumer $i$’s full income (equal to $l^i_0$ if no transfers), and $p^i_j$ be the domestic price of good $j$ in country $i$, consumer $i$’s budget constraint becomes

$$c^i_0 + \sum_{j=1}^{n} p^i_j c^i_j = l^i, \quad i = 1, \ldots, n. \quad (2)$$

Demand for good $j$ is

$$c^i_j = (p^i_j)^{1/(\theta^i_j - 1)}, \quad i, j = 1, \ldots, n \quad (3)$$

The budget constraint gives demand for good 0.

Firm $i$ produces $x^i$ units of good $i$ with constant input–output coefficient $\beta^i$. In equilibrium, total cost is

$$l^i_0 = \beta^i x^i, \quad i = 1, \ldots, n. \quad (4)$$

Markets are segmented, with $x^i_j$ being units of good $i$ sold in country $j$. At unit price $(p^i_j)^i_j$, firm $i$ profits are

$$\pi^i = \sum_{j=1}^{n} ((p^i_j)^i_j - \beta^i_j) x^i_j, \quad i = 1, \ldots, n. \quad (5)$$

\(^2\)Vanek (1965).
Expression (3) implies price elasticity of demand \([-1/(\theta_j^{ij} - 1)]\). When governments do not intervene, firm \(i\) sets mark-up price in market \(j\)

\[ (p^*)_{ij} = \frac{\beta^i_j}{\theta^i_j}, \quad i, j = 1, \ldots, n. \]  

(6)

3. Trade agreements and the policy game

A trade agreement between countries \(i\) and \(j\) is an agreement to price at cost to each other.\(^3\)

Country \( i\) gains consumer surplus \(\delta_i^j\) as \((p^*)_{ij}\) is reduced from (6) to cost \(\beta^i_j\), while losing profits \(\pi_j^i\) in market \(j\). The increase in consumer surplus in \(j\) exceeds \(i\)’s profit loss there, i.e. \((\delta_i^j - \pi_j^i)\), and the collective gains \((\delta_i^j - \pi_j^i) + (\delta_j^i - \pi_j^i)\) are positive. However, one country may lose and will require compensation to enter into the agreement.

We view the world economy as a transferable utility game where the set of players is the collection of nations \(N = \{1, \ldots, n\}\), and a coalition \(K\) is a trade agreement with \(|K|\) members, where \(K \subseteq N\). Coalition \(K\) can guarantee itself a payoff given by the characteristic function \(\nu(K)\) which is a mapping from all subsets of \(N\) into a real number. A vector of payoffs \(y\) is said to be blocked by coalition \(K\) if \(\sum_{i \in K} y^i < \nu(K)\). The core is the set of payoff vectors that is blocked by no coalition. We assume that GATT/WTO seeks to establish the grand coalition which in this model is Pareto optimal.

4. Grinols Transfers

Grinols (1981, p. 262) proposes a transfer scheme where “[T]he compensation to each country is given by its pre-union trade vector.”

Lemma. In a model of international monopoly trade, Grinols transfers \(T^i_G\) are

\[ T^i_G = \sum_{j \neq i} (\pi_j^i - \pi_j), \quad i = 1, \ldots, n. \]  

(7)

Proof. If country \(i\) is a member of no trade agreement, \(i\)’s import demand is

\[ c^i_j = \left( \frac{\beta^i_j}{\theta^i_j} \right)^{1/(\theta_j^{ij} - 1)}, \quad i, j = 1, \ldots, n. \]  

(8)

Switching \(i\) and \(j\) gives country \(j\)’s imports from \(i\) and hence \(i\)’s exports to \(j\). Country \(i\) may also be trading good zero to balance trade. At initial prices

\[ m_0^i = \sum_{j \neq i} p^j \left( \frac{\beta^i_j}{\theta^i_j} \right)^{1/(\theta_j^{ij} - 1)} - \sum_{j \neq i} p^j \left( \frac{\beta^i_j}{\theta^i_j} \right)^{1/(\theta_j^{ij} - 1)}, \quad i, j = 1, \ldots, n. \]  

(9)

\(^3\) With constant elasticity import demand, a specific rate import subsidy raises importer’s welfare and exporter’s profits (Kowalczyk and Skeath, 1994). Governments would also unilaterally use import price ceilings. We rule both policies out.
At ‘post-union domestic prices’, i.e., marginal cost, Grinols transfers become

$$T^i_G = \sum_{j \neq i} \beta'(c^i_j - \sum_{j \neq i} \beta'(c^i_j + m^i_j), \ i, j = 1, \ldots, n. \ (10)$$

Substituting (8) and (9) into this yields (7). □

Grinols transfers compensate country i for lost profits abroad but taxes from it foreign firms’ profit losses in i’s market.

Let $S^j_i$ be consumer surplus from good j in country i when paying marginal cost. In the grand coalition without sidepayments, country i’s payoff is

$$\bar{\ell}^i_0 + \sum_{j=1}^n S^j_i, \ i = 1, \ldots, n. \ (11)$$

In the grand coalition with Grinols sidepayments country i’s Grinols payoff is

$$\bar{\ell}^i_0 + \sum_{j=1}^n S^j_i + \sum_{j=1}^n [(\pi'_j - \pi'_i)], \ i = 1, \ldots, n. \ (12)$$

**Proposition.** Forming the grand coalition, and implementing the vector of international sidepayments $T_G(N,v)$ which assigns to country i the net transfer

$$T^i_G = \sum_{j \neq i} (\pi'_j - \pi'_i), \ i = 1, \ldots, n, \ (7)$$

bring GATT/WTO into the core.

**Proof.** Appendix A.

We showed in Kowalczyk and Sjöström (op. cit.) that sidepayments are not needed when countries are similar and that, otherwise, the transfer

$$T^i = \frac{1}{2} \sum_{j \neq i} [(\pi'_j - \delta'_j) - (\pi'_i - \delta'_i)], \ i = 1, \ldots, n, \ (13)$$

supports the Shapley value, another core allocation, with Shapley payoff to country i

$$\bar{\ell}^i_0 + \sum_{j=1}^n S^j_i + \frac{1}{2} \sum_{j=1}^n [(\pi'_j - \delta'_j) - (\pi'_i - \delta'_i)], \ i = 1, \ldots, n. \ (14)$$

Let $\epsilon'_j$ be the deadweight loss given by area II in Fig. 1, where $\delta'_j = \pi'_i + \epsilon'_j$. Substituting into (13), and similarly for country j, and (13) becomes

$$T^i = \sum_{j \neq i} (\pi'_j - \pi'_i) + \frac{1}{2} \sum_{i \neq j} (\epsilon'_i - \epsilon'_j), \ i = 1, \ldots, n. \ (15)$$

Thus, the transfer schemes are equivalent except for a comparison of deadweight losses. Since
Fig. 1. Mark-up versus cost pricing.

$(S'_j - \delta'_j)$ is consumer surplus in $i$ when purchasing good $j$ at mark-up, country $i$’s payoff in the initial situation equals

$$\bar{l}'_i + \sum_{j=1}^{n} [(S'_j - \delta'_j) + \pi'_j], \quad i = 1, \ldots, n. \quad (16)$$

Subtracting (16) from (14) to obtain country $i$’s gains $g'_s$ from moving to Shapley payoffs, and (16) from (12) to obtain its gains $g'_G$ from moving to Grinols payoffs, and substituting for $\delta'_j = \pi'_j + \epsilon'_j$, for all $i$ and $j$, yields

$$g'_s = \frac{1}{2} \sum_{j=1}^{n} (\epsilon'_j + \epsilon'_j), \quad i = 1, \ldots, n. \quad (17)$$

and

$$g'_G = \sum_{j=1}^{n} \epsilon'_j, \quad i = 1, \ldots, n. \quad (18)$$

Shapley payoffs give country $i$ half of each trading partner’s recovered deadweight loss and half of its own recovered loss. Grinols payoffs give country $i$ its own recovered loss but no share in trading partners’ gains. The demand curve for good $j$ and the cost of producing good $j$ determine the magnitude of $\epsilon'_j$. 
5. Discussion

Our earlier paper discussed how the Shapley value is a central point in the core, shares equally the gains from cooperation, and has a non-cooperative foundation. We are not aware of a non-cooperative game yielding the Grinols payoffs. Indeed, Grinols transfers constitute, in general, minimum transfers needed to reach the core: when integrating, a country loses profits in foreign markets while gaining consumer surplus on imports — smaller compensation might not suffice, larger compensation would tax consumer gains more. Relative to the transfers supporting the Shapley value, Grinols transfers (a) favor consumers relative to firms; (b) favor developing relative to developed countries if mark-ups are higher in developing countries; and (c) are informationally efficient since they do not require estimation of demand curves.\(^4\)

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Appendix

Coalition \( K \) prefers Grinols payoffs to an arbitrary alternative situation if

\[
\sum_{i \in K} \delta'_i + \sum_{j=1}^n S'_j + \sum_{i \in K} T'_G \geq v(K), \quad \forall K, K \subseteq N. \quad (A.1)
\]

Substituting

\[
\sum_{i \in K} T'_G = \sum_{i \in K} \sum_{j \in K} (\pi'_j - \pi'_i)
\]

and

\[
v(K) = \sum_{i \in K} \delta'_i + \sum_{j=1}^n S'_j - \sum_{i \in K} \sum_{j \in K} \delta'_j + \sum_{i \in K} \sum_{j \notin K} \pi'_j, \quad \forall K, K \subseteq N,
\]

into this, where \((S'_j - \delta'_j)\) is consumer \( i \) surplus on good \( j \) when firm \( j \) charges mark-up price, yields

\[
\sum_{i \in K} \delta'_i + \sum_{j=1}^n S'_j + \sum_{i \in K} \sum_{j \in K} (\pi'_j - \pi'_i) \geq \sum_{i \in K} \delta'_i + \sum_{j=1}^n S'_j - \sum_{i \in K} \sum_{j \notin K} \delta'_j + \sum_{i \in K} \sum_{j \in K} \pi'_j, \quad \forall K, K \subseteq N, \quad (A.2)
\]

or

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\(^4\)As with the transfers supporting the Shapley value, Grinols transfers could go to high income countries. However, they never exceed the gains from cooperation.
\[
\sum_{i \in K} \sum_{j \notin K} \delta^i_j \geq \sum_{i \in K} \sum_{j \notin K} \pi^i_j, \quad \forall K, K \subseteq N.
\] (A.3)

which holds since \( \delta^i_j \geq \pi^i_j \) for all \( i, j \). Coalition \( K \) will not block the grand coalition with Grinols transfers.

Grinols transfers are feasible if \( B = \sum_i T^i_G \geq 0 \). But \( B = \sum_i \sum_{j \neq i} (\pi^i_j - \pi^i_i) = 0 \), since \( \sum_i \sum_{j \neq i} \pi^i_j = \sum_i \sum_{j \neq i} \pi^i_i \) are profits earned in foreign markets by all the world’s firms. \( \square \)

References


