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Abstract

This paper constructs a three-country, many-good and many-factor trade-theoretic model in which two of the countries are in conflict and where war effort is determined endogenously in a Nash equilibrium. The third country does not take part in the war, but trades with the warring countries. In the framework, we examine, *inter alia*, how war and welfare are affected by globalization and by two instruments available to the third country — one carrot and one stick. Our overall conclusion is that the third parties do have the incentives for, and can play an effective role in, conflict resolution.

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1 Introduction

There is too little trade in the world and too much war. By some estimates, the costs of war are at least 8% of worldwide per capita consumption (Hess, 2002), excluding the cost of lost lives. And the costs of insufficient trade are comparable, with estimates around 10% of national income (Anderson and van Wincoop, 2004).[1] These costs are, however, not evenly distributed with developing countries, which are more likely to be engaged in conflict, bearing a disproportionate share of both types of costs. Are the two phenomena related? This question has received a lot of attention in the literature on international relations. The literature offers many different possibilities. Conflict may disrupt trade, then again it may foster innovation that leads to trade. Trade in defense-related goods and services of course thrives on conflicts. Trade on the other hand may lower conflict (the classic liberal position) or it may intensify conflict (the 'modern realist' position).[2]

For the most part, the recent theoretical literature on trade and conflict has considered bilateral relations.[3,4] But bilateral relations do not usually occur in a vacuum and are directly or indirectly influenced by the rest of the world. Moreover, third parties may not be indifferent to the outcomes of bilateral conflicts and may indeed have strategic and economic

[1] Even ardent anti-globalization activists do not object to increased trade *per se*, but their complaints are against the manner in which trade liberalization is being pursued by the international institutions such as the World Trade Organization, the World Bank, and the International Monetary Fund.

[2] Trade reduces conflict in the liberal paradigm by increasing the opportunity costs of conflict. By contrast, trade increases conflict in the realist paradigm by increasing the costs of trade through creation of vulnerabilities and loss of status. Conflict reduces trade in both paradigms, but for different reasons. Liberals argue that wealth losses lower the opportunities for trade, while realists argue that the fear of dependency causes nations to reduce trade. Neither paradigm discusses the possibility that conflict fosters innovation. But the history of warfare is full of examples where innovations in war technology eventually found peaceful uses.

For reviews of the traditional theoretical arguments see Barbieri (1996) and Reuveny (1999). As is evident from the analysis in Barbieri (1996), there are theoretical arguments for all possible interactions between conflict and trade. On the empirical front, Reuveny (1999) shows that support can be found for the various theoretical arguments. For the more specific topic on the effect of globalization on conflict see, for example, Oneal and Russett (1999) and Polachek *et al.* (1999).

[3] A growing literature follows the seminal work of Hirshleifer (1988) and develops game-theoretic models where two rival groups allocate resources between productive and appropriative activities (see, for example, Brito and Intriligator (1985), Hirshleifer (1989, 1991, 1995) Grossman and Kim (1996) Skaperdas (1992), and Neary (1997)). Recent contributions by Anderton *et al.* (1999), and Skaperdas and Syropoulos (1996, 2001) emphasize trade and conflict in two-country frameworks. Anderson and Marcouiller (2004) examine the consequences of endogenous transaction costs in trade in the form of predation on international trade.

[4] An exception is Haaparanta and Kuisma (2004) which will be discussed later.

interests in such conflicts. Actions by the rest of the world may also have significant bearing on bilateral conflicts. Understanding the role of third parties in bilateral conflicts is also important because solutions to conflicts usually involve outsiders with their own set of priorities and incentives. And unless these incentives are properly understood, it may be difficult to achieve conflict resolution. To understand conflict resolution in a multilateral world, we attempt to address (among others) questions about the effect of third party actions. For instance, can the third party help resolve conflicts by using carrots such as foreign aid and sticks such as trade sanctions? Which of the two instruments is likely to be more effective in the resolution of conflicts?

We explore these issues in a general many-good many-factor trade-theoretic model. Our framework has three countries that trade with each other and actions by any of the three countries affect the relative price of one of the traded goods, the three countries being small open economies with respect to the other goods. While previous work on trade and conflict usually assumes a very special structure often with complete specialization, we consider a general model that allows for incomplete specialization. Two of the three countries may choose to direct resources from productive activity to war, while the third country may choose tariffs and foreign aid to influence trade with the warring countries and also to affect conflicts themselves. The conflict equilibrium is specified as a Nash one where each warring country decides on the level of its war activity taking that of the other country and the prices as given, and the conflict is over a factor of production. Our analysis shows that the relationship between trade and conflict depends on relative factor intensities in the warring countries and on the pattern of trade. Factor intensities and the pattern of trade are also important in the choice for the rest of the world between carrot and stick policies. In particular, we find that trade liberalization and adjustments by the rest of the world of the policy instruments under its control can promote peace and enhance welfare for some realistic and policy-relevant configurations.

Compared to previous work on conflict in general-equilibrium trade models, our work

broadens the theoretical framework and focuses on conflict resolution efforts by the rest of the world.[5] Skaperdas and Syropoulos (1996, 2001) consider multinational conflict in a two-country trade model with complete factor specialization, and, in a related paper, Garfinkel *et al.* (2004) consider domestic conflict with external trade. Comparing the competitive equilibrium under autarky and free trade, they show that whether the combatants gain or lose from trade depends on whether they are exporters or importers of the contested good and whether the relative price under trade is higher or lower than the autarkic price. Syropoulos (2004) also compares autarky with free trade in a Heckscher-Ohlin framework with incomplete specialization where the terms of trade is exogenous under free trade. The paper by Haaparanta and Kuisma (2004) considers, like the present paper, a three-country model where two of the countries are involved in a conflict. However, the two papers are quite different from each other both in terms of the model structure and the substantive issues considered. In terms of the model structure, whereas Haaparanta and Kuisma (2004) consider a pure exchange economy in which the conflict equilibrium takes into account the effect of war activity on commodity prices, in the present model, the production side of the economy plays an important role, and, as mentioned before, the warring countries decide on the level of war activities taking prices — some which are determined in the general equilibrium — as given. In terms of the substantive issues considered, they examine effects of income in the three countries, and of trade with the third country, on the intensity of conflict. In contrast, the focus of the present paper is on policy options for the third country when its trading partners are involved in a conflict.

The layout of the paper is as follows. Section 2 sets up the model and carries out the initial analysis. In this section the effect of globalization on the level of conflict is examined. In section 3, after examining the possible effects of conflict on the third country in subsection 3.1, three policy options for the third country are analyzed in sections 3.2-3.4. Whereas sections 3.2 and 3.3 consider tariffs and foreign aid respectively one at a time, in

[5]Other types of multi-country models have also been used by Gowa (1994), Werner (1997), Dorussen (1999), Dorussen and Hegreto (2004) to analyze international security issues.

section 3.4 the third country is assumed to apply them simultaneously. In the simultaneous application of the two instruments, we consider two different rules that tie down variations in the instruments. Specifically, changes in tariffs and foreign aid are restricted to be revenue-neutral for the third country in section 4.3.1 and welfare-neutral for the third country in section 4.3.2. A conclusion summarizes our main results.

2 Model and Initial Analysis

We develop a three-country, many-good, many-factor model with two of the countries — called country a and country b — engaged in a war with each other and a third country — called country c — that does not take part in the war but trades with the warring countries. All product and factor markets are perfectly competitive and country c imposes tariffs on imports from country a and b. There are many inelastically supplied factors of production; however, two of the factors play important roles in our analysis. For expositional ease, we shall call these factors labor and land although one could interpret them differently. Labor is used to fight the war and land is what they fight for. We define $f(L_s^a, L_s^b)$ as the net gain of land by country a from war,[6] where L_s^a and L_s^b are respectively the amount of 'soldiers' employed by country a and b.[7] For this net-gain function we make the following assumptions.

ASSUMPTION **1** *$f(\cdot)$ is homogeneous of degree zero in the two arguments and satisfies: $f_1 > 0,\ f_2 < 0,\ f_{11} < 0,\ f_{22} > 0,$ and $f_{12} < 0$.*

The production side of the economies indexed by $i = a, b, c$ is described the three revenue functions $R^a(p, \bar{L}^a - L_s^a, \bar{V}^a + f(L_s^a, L_s^b))$, $R^b(p, \bar{L}^b - L_s^b, \bar{V}^b - f(L_s^a, L_s^b))$ and $R^c(p + t, \bar{L}^c, \bar{V}^c)$ where $\bar{L}^i$ and $\bar{V}^i$ are the endowments of labor and land respectively in country i, p is the international price vector of the non-numeraire goods, and t is the vector of specific

[6] This can be viewed as the reduced form of a 'contest' payoff function.

[7] The net gain function takes negative values when country b 'wins' the war.

tariff rates imposed by country c.[8] We assume that the two factors are complements, i.e., $R^i_{23} > 0,\ i = a, b, c.$

The consumption side of the economies is represented by the expenditure functions $E^a(p, u^a)$, $E^b(p, u^b)$ and$E^c(p+t, u^c)$, where u_i is the utility level of a representative consumer in country i $(i = a, b, c)$.[9]

The income-expenditure balance equations of consumers in the three countries are given by:

$$E^a\left(p, u^a\right) = R^a\left(p, \bar{L}^a - L^a_s, \bar{V}^a + f\left(L^a_s, L^b_s\right)\right) + \lambda F, \tag{1}$$

$$E^b\left(p, u^b\right) = R^b\left(p, \bar{L}^b - L^b_s, \bar{V}^b - f\left(L^a_s, L^b_s\right)\right) + (1-\lambda)F, \tag{2}$$

$$E^c\left(p+t, u^c\right) = R^c\left(p+t, \bar{L}^c, \bar{V}^c\right) + t(E^c_1 - R^c_1) - F, \tag{3}$$

where F is the amount of aid given out by country c and λ is the proportion of it going to country a. It is assumed that aid is financed by lump-sum taxation of the consumers in the donor country.

We assume that the three countries are small open economies with respect to all the except one the price of which is determined endogenously in the model. Since the exogenous prices do not vary in our analysis, the price vector p is redefined as the scalar price of the good that is endogenous in the model. henceforth, this good will be referred to as the non-numeraire good. Market clearing condition for this good is

$$m^a + m^b + m^c = 0, \tag{4}$$

[8]All factors other than land and labor are suppressed in the revenue functions as they do not change in our analysis. As is well known, the partial derivative of a revenue function with respect to the price of a good gives the output supply function of that good. Similarly, the partial derivative of a revenue function with respect to a factor endowment gives the price of that factor. The revenue functions are positive semi-definite in prices and negative semi-definite in the endowments of the factors of production. In particular, they satisfy $R^i_{jj} \leq 0$, for $i = a, b, c$ and $j = 2, 3$. For these and other properties of revenue functions see Dixit and Norman (1980).

[9]The partial derivative of an expenditure function with respect to the price of a good gives the compensated demand function of that good, and that with respect to the utility level is the reciprocal of the marginal utility of income.

where the excess demand function m^i ($\equiv E_1^i - R_1^i$) is the import of the non-numeraire good in country i ($i = a, b, c$).

It only remains to explain how war efforts in the two warring countries, L_s^a and L_s^b, are determined. Following Skaperdas and Syropoulos (2001), we assume that each warring country decides on the levels of its own war effort by maximizing its welfare level, taking war efforts in the other country and the international prices of the non-numeraire good as given. The first order conditions are given by:

$$E_2^a \frac{\partial u^a}{\partial L_s^a} = -R_2^a + R_3^a f_1 = 0, \tag{5}$$

$$E_2^b \frac{\partial u^b}{\partial L_s^b} = -R_2^b - R_3^b f_2 = 0. \tag{6}$$

An increase in L_s^i, *ceteris paribus*, increases income in country i ($i = a, b$) by increasing the amount of land, but it also has a cost in the sense that it reduces the amount of labor than can be used for producing goods and services. The first term in (5) and (6) is the marginal cost of warfare and the second term is the marginal benefit. Equating marginal costs and benefits yields two reaction functions in the warring countries that are simultaneously solved.

This completes the description of the basic model. There are six endogenous variables, u^a, u^b, u^c, L_s^a, L_s^b, p, and these six variables are solved for simultaneously using the six equations (1)-(6).

We conclude this section by deriving our basic welfare equation. Differentiating equations (1), (2), (3) and (4), we obtain

$$E_2^a \; du^a = -m^a dp + R_3^a f_2 dL_s^b + \lambda dF, \tag{7}$$

$$E_2^b \; du^b = -m^b dp - R_3^b f_1 dL_s^a + (1-\lambda) dF, \tag{8}$$

$$(E_2^c - tE_{12}^c) \; du^c = -\left(m^c - t\left(E_{11}^c - R_{11}^c\right)\right) dp + t\left(E_{11}^c - R_{11}^c\right) dt - dF, \tag{9}$$

and

$$\begin{aligned}\Delta\ dp &= \beta^a\ dL_s^a + \beta^b\ dL_s^b + \frac{R_{11}^c - E_{11}^c}{1 - tc_y^c}\ dt \\ &\quad + \left[-\lambda c_y^a - (1-\lambda)c_y^b + \frac{c_y^c}{1 - tc_y^c}\right] dF,\end{aligned} \tag{10}$$

where

$$\begin{aligned}\beta^a &= -R_{12}^a + f_1\left(R_{13}^a - R_{13}^b\right) + c_y^b R_3^b f_1, \\ \beta^b &= -R_{12}^b + f_2\left(R_{13}^a - R_{13}^b\right) - c_y^a R_3^a f_2, \\ \Delta &= S - c_y^a m^a - c_y^b m^b - \left\{m^c - t\left(E_{11}^c - R_{11}^c\right)\right\} \cdot \frac{c_y^c}{1 - tc_y^c}, \\ S &= \sum_{i=a}^{c}\left(E_{11}^i - R_{11}^i\right), \\ c_y^i &= \frac{E_{12}^i}{E_2^i}, \quad i = a, b, c.\end{aligned}$$

The term $S < 0$ is the slope of the compensated excess demand function, and the term Δ is the slope of the uncompensated excess demand function of the non-numeraire good, which has to be negative for Walrasian stability. The term c_y^i is the marginal propensity to consume the non-numeraire good in country i.

The first term on the right hand side of (7)-(9) captures the well-known terms-of-trade effect on utility: an exporter (importer) of the non-numeraire good is better off, if the international price of the good increases (decreases). The second term in (7) and (8) gives the international conflict externality from war effort on the two warring countries. Higher war effort by one country, *ceteris paribus*, reduces utility in the other warring country by reducing the endowment of land in the latter. However, higher war effort in a country has no effect on its own welfare as war effort in optimally chosen. Note that war effort affects the utility in the donor country only through changes in the international terms of trade. The direct effect of foreign aid is to reduce welfare in the donor country and increase that

in the recipient countries, and these effects are given by the last term in (7)-(9). Finally, the second term on the right hand side of (9) is the effect of a change in tariffs in the donor country on tariff revenue; an increase in tariffs reduces the volume of imports and thus tariff revenue.

The last term on the right hand side of (10) captures the effect of foreign aid on the international terms of trade. This effect can be explained as follows. An increase in aid reduces income in the donor country and reduces those in the recipient countries; the former reducing the demand for the non-numeraire good and the latter increasing it. The net effect on the world demand for the non-numeraire good depends on the relative magnitudes of the marginal propensities to consume in the three countries.[10] The next-to-last term on the right hand side of (10) captures the revenue effect of an increase in tariffs. An increase in t reduces tariff revenue and thus demand in the donor country as mentioned before, and thus its effect on p is negative. Finally, from the first two terms in (10), we see that the effect of an increase in war efforts in the two countries on p is ambiguous. We shall only explain the effect of an increase in L_s^a on p and the effect of L_s^b can be similarly explained. An increase in the employment of soldiers reduces the supply of workers for the private sector and this reduces output of the non-numeraire good if and only if $R_{12}^a > 0$. This reduction in output will increase p by reducing the world supply of the non-numeraire good. The first term in β^a captures this effect. The second term in β^a gives the effect via changes in the endowment of land in the two countries. An increase in L_s^a increases the supply of land in country a and reduces that in country b, and the effect of the world supply of the non-numeraire good is given by $R_{13}^a - R_{13}^b$. An increase in L_s^a also has two income effects on p that come from capturing more of the land endowment. The own-income effect disappears because of the envelope property, and the third term in β^a gives the effect from changes in income in country b: an increase in L_s^a reduces income in country b and thus the world demand and the price of the non-numeraire good.

[10] These effects of an aid have been discussed extensively in the literature on the Transfer Paradox (see, for example, Bhagwati et al. (1983)).

3 Globalization and war with two small open economies

In this section, we examine the effect of globalization on the war efforts of two countries engaged in conflict, assuming that they are small open economies that face an exogenous terms of trade. In other words, the price of the non-numeraire good, p, is taken as exogenous and we ignore equations (4) and (10). It is to be noted that in this case, globalization or a reduction in trade costs in a country is equivalent to an improvement in its international terms of trade (see Copeland and Taylor (2003)) and so we analyze the effect of a change in p on the equilibrium.

Differentiating the reaction functions of the warring countries (5) and (6) results in:

$$\alpha_1 dL_s^a + \alpha_2 dL_s^b = \alpha_3 dp, \tag{11}$$

$$\alpha_4 dL_s^a + \alpha_5 dL_s^b = \alpha_6 dp, \tag{12}$$

where

$$\begin{aligned}
\alpha_1 &= R_{22}^a - 2f_1 R_{23}^a + R_3^a f_{11} + (f_1)^2 R_{33}^a < 0, \\
\alpha_2 &= -R_{23}^a f_2 + R_3^a f_{12} + f_1 f_2 R_{33}^a, \\
\alpha_3 &= R_{21}^a - f_1 R_{31}^a, \\
\alpha_4 &= R_{23}^b f_1 - R_3^b f_{21} + f_1 f_2 R_{33}^b > 0, \\
\alpha_5 &= R_{22}^b + 2f_2 R_{23}^b - R_3^b f_{22} + (f_2)^2 R_{33}^b < 0, \\
\alpha_6 &= R_{21}^b + f_2 R_{31}^b.
\end{aligned}$$

Note that $\alpha_1 < 0$ and $\alpha_5 < 0$ because of the second order conditions in the determination of L_s^a and L_s^b respectively. Also, α_4 is positive since we assumed that $f_{12} < 0$. Thus, the reaction function in country a is upward sloping. We also assume that $\alpha_2 > 0$ so that the the reaction function in country b is also upward sloping. That is, employment of soldiers is a strategic complement in both countries. If the non-numeraire good is more

labor intensive in both countries, then $R^i_{21} > 0$ and $R^i_{31} < 0$ for $i = a, b$ and thus $\alpha_3 > 0$ and $\alpha_6 > 0$.[11]

Solving (11) and (12), we obtain

$$\Delta_s \cdot \frac{dL^a_s}{dp} = \alpha_3\alpha_5 - \alpha_6\alpha_2, \tag{13}$$

$$\Delta_s \cdot \frac{dL^b_s}{dp} = \alpha_1\alpha_6 - \alpha_3\alpha_4, \tag{14}$$

where $\Delta_s = \alpha_1\alpha_5 - \alpha_2\alpha_4 > 0$ for the stability of the Nash equilibrium.

From (13) and (14) it follows that if the non-numeraire good is labor intensive in both countries, we have $dL^a_s/dp < 0$ and $dL^b_s/dp < 0$. In other words, an increase in p will reduce the equilibrium number of soldiers in both countries. The intuition for these results is quite straightforward. An increase in p increases wage rates, and reduces rental rates on land, in the two warring countries if the non-numeraire good is labor intensive (the Stolper-Samuelson theorem). Thus, when the non-numeraire good is labor intensive, an increase in p raises the marginal cost and reduces the marginal benefit of warfare in both countries, and thus reduces their equilibrium war efforts. By similar arguments it can be shown that $dL^a_s/dp > 0$ and $dL^b_s/dp > 0$ if the non-numeraire good is land intensive in the two countries.

As for the welfare of the warring countries, from (7) and (8) we get

$$E^a_2\ du^a = -m^a dp + R^a_3 f_2 dL^b_s, \tag{15}$$

$$E^b_2\ du^b = -m^b dp - R^b_3 f_1 dL^a_s. \tag{16}$$

If both countries are exporters of the labor-intensive non-numeraire good, we have $m^a < 0$, $m^b < 0$ and $R^i_{21} > 0$, $R^i_{31} < 0$, $i = a, b$. In this case, improvements in the terms of trade of the two countries imply $dp > 0$, and a terms-of-trade improvement will reduce the employment of soldiers in both countries. Thus, a terms-of-trade improvement

[11] In a many-good, many-factor model, the terminology labor intensive can be misleading. In this paper, we call the non-numeraire good more labor intensive in country i if $R^i_{12} > 0 > R^i_{13}$, $i = a, b$. By contrast, if the non-numeraire good more land intensive in country i, $R^i_{21} < 0 < R^i_{31}$ which implies $\alpha_3 < 0$ and $\alpha_6 < 0$.

has two positive effects on welfare in the two countries: (i) a rise in welfare due to a terms-of-trade improvement (the first term in (15) and (16)), and (ii) a positive indirect effect via reductions in war efforts (the second term in (15) and (16)). In other words, a terms-of-trade improvement enhances welfare by encouraging exports and freeing up manpower from war production for export production. This result is summarized in the following proposition.

PROPOSITION **1** *Suppose that two small open economies export the labor-intensive good. Then trade liberalization in the two countries reduces war efforts in both countries and is strictly Pareto improving.*

The above result has an important implication for developing countries, where the incidence of warfare is much higher than elsewhere . Given that most developing countries typically export labor-intensive *basic* goods, the process of globalization is likely to reduce incentives for them to engage in conflicts with their neighbors. By contrast, exporters of a land-intensive good will reduce war effort only when its international price falls. If we follow Skaperdas and Syropolous (2001) and interpret the land-intensive good as oil or some other valuable natural resource, then our model suggests that for exporters of resource-intensive goods, trade liberalization actually encourages war, although the terms-of-trade effect continues to exert a positive effect on welfare. The net effect of globalization on the welfare of a country that exports a land-intensive good depends on the relative magnitudes of the terms-of-trade effect and the conflict externality.

4 The case of large open economies

In this section we assume, as in section 3, that countries a and b decide on the levels of its soldiers — L_s^a and L_s^b respectively — in a non-cooperative manner taking the terms of trade as given. However, the terms of trade is endogenous in the present case. The reaction functions of the two countries are given, as before, by equations (5) and (6) respectively, and

equations (13) and (14) still hold in the present case. Substituting (13) and (14) into (10), we get

$$\Delta_1 \, dp = \frac{R_{11}^c - E_{11}^c}{1 - tc_y^c} \, dt + \left[-\lambda c_y^a - (1-\lambda) c_y^b + \frac{c_y^c}{1 - tc_y^c} \right] dF, \tag{17}$$

where

$$\Delta_1 = \Delta - \frac{\beta^a(\alpha_3\alpha_5 - \alpha_6\alpha_2) + \beta^b(\alpha_1\alpha_6 - \alpha_3\alpha_4)}{\Delta_s}$$

is negative for Walrasian stability.[12]

Comparing (17) with (10), we see that internalizing the effect of war efforts on p does not alter the qualitative nature of the effects of aid and tariffs on p. This is because aid and tariffs have no direct effect on war efforts and because aid and tariffs affect war efforts only through induced changes in p.

Having derived the terms-of-trade equation in (17), we now consider four scenarios that are of interest for conflict reduction. In the first scenario we examine the effect of a coordinated reduction in war efforts on the welfare levels in the three countries, starting from the war equilibrium described above. In the last three scenarios we examine how actions by the third country affect the level of conflict and welfare. We consider three possible actions: (i) the amount of foreign aid is increased ('carrots'), (ii) the level of tariffs on imports from the warring countries is increased ('sticks'), and (ii) both the carrot and the stick instruments are used at the same time. These exercises are taken up in turn in the following four subsections.

For all of the scenarios below, for simplicity, we shall assume that the two warring countries are identical.[13] The symmetry assumption implies $f_1 = -f_2$. We shall also assume that the changes in war efforts are also the same, i.e., $dL_a^a = dL_s^b$.

[12]The term Δ_1 is the slope of the uncompensated excess world demand function of the non-numeraire good, taking into account the price effects produced by changes in war effort.

[13]Strictly speaking, we do not need the two countries to be identical. All we need is preferences and technologies to be the same in the two countries, and endowments to lie in the same cone of diversification, so that factor-price equalization occurs.

4.1 The effect of war on the third country

In this subsection we shall examine the effect of a bilateral, concerted and piecemeal reduction in war efforts in the two warring countries from their equilibrium levels on the welfare level in the third country (country c) which does not take part in the war, but trades with the two warring countries.

From (9) and (10) it follows that increases in war efforts will increase welfare if and only if these actions improve the terms of trade of the third country. The terms-of-trade effect under symmetry is derived from (10) as

$$p\Delta \ dp = 2R_2^a(pc_y^a - \epsilon^a)dL_s^a, \tag{18}$$

where ϵ^a $(= R_{12}^a p/R_2^a)$ is the elasticity of wage rate of labor with respect to the price of the non-numeraire good.

As discussed before, a change in war effort has three effects. War effort induces changes in (i) the supply of labor for the private sectors, (ii) the supply of land, and (iii) income effects on the demand for the non-numeraire good. Because the gain of land by one country i is a loss to the other, effect (ii) disappears under the assumption of symmetry because $f(x,x) = 0$, $\forall x$, and we are left with effects (i) and (iii). If $pc_y^a < \epsilon^a$, — i.e., if the marginal propensity to spend on the non-numeraire good (pc_y^a) in the warring countries is less than the price elasticity of wage rate of labor in these countries — the income effect is dominated by the effect through changes in labor supply and the net effect of reduction in war efforts on price is a negative one. In other words, a decrease in L_s^a and L_s^b will reduce p if and only if $pc_y^a < \epsilon^a$. Thus, under the same necessary and sufficient condition, decreased war efforts in the warring countries will increase the welfare level in country c if it is an importer of the non-numeraire good. If country c is an exporter of the non-numeraire good, then decreased war efforts in the warring countries will decrease the welfare level in country c if and only if $pc_y^a < \epsilon^a$. Formally,

PROPOSITION **2** *Bilateral concerted reductions in war efforts will enhance the welfare of the third neutral country if and only if* $(pc_y^a - \epsilon^a)m^c < 0$.

In a Heckscher-Ohlin world, how pc_y^a relates to ϵ^a depends on the the relative factor intensities. In fact, one can show that $pc_y^a < \epsilon^a$ if and only if the non-numeraire good is labor intensive. To see this, note that if the non-numeraire good is labor intensive, then the Stolper-Samuelson Theorem tells us that $\epsilon^a > 1$ (the so-called 'magnification effect'). This implies that $pc_y^a < \epsilon^a$, because $pc_y^a < 1$ if the numeraire good is normal. If, on the other hand, the non-numeraire good is land intensive, it follows from the same theorem that $\epsilon^a < 0$ and thus $pc_y^a > \epsilon^a$, assuming that the non-numeraire good is normal.

To summarize, in a Heckscher-Ohlin world, bilateral concerted reductions in war efforts will increase the welfare of the third neutral country if and only if the warring countries export the labor-intensive good. And thus, we conclude that the third country prefers peace if the warring parties are exporters of a labor-intensive good. By the same arguments, the third country prefers war if the warring parties are exporters of a land-intensive good. This suggests that the incentives for third parties may well be different in conflicts in different parts of the world.

4.2 Sticks and war

In this section, we assume that country c optimally chooses the level of tariffs whereas the warring countries choose the levels of soldiers optimally as given by (5) and (6). The three decisions are simultaneous. The optimality condition for t is given by:[14]

$$(E_2^c - tE_{12}^c) \cdot \frac{\partial u^c}{\partial t} = -\left(m^c - t\left(E_{11}^c - R_{11}^c\right)\right) \cdot \frac{\partial p}{\partial t} + t\left(E_{11}^c - R_{11}^c\right) = 0, \tag{19}$$

where from (17), we have

$$\frac{\partial p}{\partial t} = \frac{R_{11}^c - E_{11}^c}{\Delta_1(1 - tc_y^c)} < 0. \tag{20}$$

[14]Equation (19) gives the standard optimal tariff formula ('inverse-elasticity rule') for a large country with monopoly power in trade.

With the Nash equilibrium just described as the starting point, we now consider the effect of a decrease in tariffs in country c on war efforts in countries a and b. Here we assume the trade pattern considered in Proposition 1, where countries a and b are exporters of the labor-intensive non-numeraire good and country c is the importer of it.

From (20), it follows a decrease in t will increase p, i.e., improve the terms of trade in countries a and b. An increase in t increases domestic producers' and consumers' prices of the non-numeraire good and thus its demand. It has been shown before that an improvement in the terms of trade reduces the employment of soldiers and increases welfare in both warring countries if the warring countries export the labor-intensive non-numeraire good. Also, due to the envelope property, this decrease in t has no effect on the welfare level in country c. These results are formally stated below.

PROPOSITION **3** *Suppose that two warring countries export the labor-intensive good to the third country. Then a reduction in trade restrictions from the Nash optimum by the third country reduces war efforts in both warring countries and is Pareto superior.*

The above proposition suggests that sticks in the form of trade sanctions against the warring countries are counter-productive, and that more open trade is beneficial for all. As argued above, this situation applies to conflicts for many developing countries that tend to be exporters of labor-intensive basic goods. However, for reasons similar to the ones mentioned before, trade sanctions will reduce war efforts if the warring countries export the land-intensive good. However, the effect of trade sanctions on the welfare level of such countries will depend on the relative magnitudes of the conflict externality and the terms-of-trade effect.

4.3 Carrots and war

In this section, we assume that country c attempts to reduce war efforts in countries a and b by giving them foreign aid F. For simplicity, we set $t = 0$ in this case and assume the two

warring countries to be symmetric.[15] We also continue to assume that countries a and b are exporters of the labor-intensive non-numeraire good and country c is the importer of it.

From (17), setting $c_y^a = c_y^b$ (symmetry), we have

$$\Delta_1 \cdot \frac{\partial p}{\partial F} = c_y^c - c_y^a. \tag{21}$$

From (21) it follows that $\partial p/\partial F > 0$ if and only if $c_y^a > c_y^c$. That is, an increase in F will improve the terms of trade in countries a and b if and only if the warring countries spend a higher fraction on the non-numeraire good than the neutral importer of the good. We have already explained the channels through which foreign aid affects p. It has also been shown that an improvement in the terms of trade reduces the employment of soldiers. As for the effects on welfare levels of the warring countries, from (7) and (5) we find that for country a (by symmetry, a similar equation holds for country b)

$$E_2^a \, du^a = -m^a dp - R_3^a f_1 dL_s^a + \lambda dF, \tag{22}$$

and thus welfare increases in the two warring countries as a result of an increase in F if $c_y^a > c_y^c$. These results are formally stated next:

PROPOSITION 4 *Suppose that two warring countries are identical and export the labor-intensive good to the third country. Then an increase in foreign aid by the third country to the warring countries reduces war efforts in both countries if and only if* $c_y^a > c_y^c$. *Furthermore, such an increase in foreign aid increases welfare in the two recipient countries if* $c_y^a > c_y^c$.

If the non-numeraire good is a basic good (which is labor intensive and which the two warring countries export), it is quite reasonable to assume that $c_y^a > c_y^c$ if the two warring countries are developing countries and the third country is a developed one.

[15] Thus, we abstract from the tariff revenue effects when aid is altered. Such effects are considered in the next section when both instruments are changed simultaneously.

4.4 Carrots and sticks

In the preceding two subsections, we have seen that either a reduction in tariffs or an increase in foreign aid would reduce war efforts. Although the response of war effort to a tariff reduction is unambiguous, the response of war effort to an increase in foreign aid depends on the relative magnitudes of the marginal propensities to consume in the three countries. In this subsection we consider a policy initiative in country c that involves both carrots and sticks at the same time.[16] We consider two ways of relating changes in the two instruments. In the first case, the instruments are changed keeping government revenue constant and in the second case, welfare in country c is kept constant. These two cases are now taken up in turn in the following two subsections.

4.4.1 Revenue-neutral changes in carrots and sticks

We assume that country c changes both the level of aid and tariffs in such a way that its revenue, evaluated at the initial equilibrium, remains constant, i.e., dt and dF satisfy

$$dF = m^c dt. \tag{23}$$

Substituting (23) in (9), we get

$$\left(E_2^c - tE_{12}^c\right)\ du^c = -\left\{m^c - t\left(E_{11}^c - R_{11}^c\right)\right\}\ d(p+t). \tag{24}$$

With this assumption, substituting (23) in (17) we obtain

$$\Delta_1 \cdot \frac{dp}{dt} = \frac{R_{11}^c - E_{11}^c}{1 - tc_y^c} + m^c \left\{\frac{c_y^c}{1 - tc_y^c} - c_y^a\right\}, \tag{25}$$

$$\frac{\Delta_1}{2} \cdot \frac{d(p+t)}{dt} = E_{11}^a - R_{11}^a - \beta^a \cdot \frac{dL_s^a}{dp}. \tag{26}$$

[16] The exercise in this subsection can be seen as related to the literature on trade versus aid. Johnson (1967) was possibly the first to analyze the issue. He concluded that, ignoring secondary repercussions, a unit of foreign exchange from exports can never be as valuable (in terms of welfare) as a unit of foreign exchange from foreign aid. More recently, Kemp and Shimomura (1991) extend the Johnson analysis in a more formal model of international trade.

From equation (25) and (26), the following observations can be made. Suppose that the two warring countries export the labor-intensive non-numeraire good, i.e., $m^a < 0,\ m^b < 0$ and $m^c > 0$. Under this assumption, it has been shown that $dL_s^a/dp < 0$. Furthermore, if $c_y^c/(1 - tc_y^c) > c_y^a$, it follows from (25) that $dp/dt < 0$. That is, a decrease in both t and F according to the rule (23) will increase p and thus decrease L_s^a. In other words, when $c_y^c/(1-tc_y^c) > c_y^a$, fewer sticks and fewer carrots reduces war efforts. Note that $c_y^c/(1-tc_y^c) > c_y^a$ is only a sufficient condition, and even when this condition is not satisfied we will still have $dp/dt < 0$ as long as the import elasticity of demand for the non-numeraire good in country c $c_y^c\ \ (= -(E_{11}^c - R_{11}^c)(p+t)/m^c)$ is sufficiently large.

For the rest of the analysis, we shall assume that it is in the interest of the rest of the world (third country) that war efforts of the warring countries are reduced and that the identical warring countries export the labor-intensive good. From proposition 2 it follows that these assumptions are equivalent to assuming that $pc_y^a < \epsilon^a$. From the definition of β^a and β^b in (10), it also follows that if countries a and b are identical $\beta^a < 0$ and $\beta^b < 0$ if and only if $pc_y^a < \epsilon^a$. Thus, henceforth we shall assume that $\beta^a = \beta^b < 0$.

Turning to the effects on welfare, since $\beta^a < 0$ if the non-numeraire good is labor intensive, from (26) it then follows that $d(p+t)/dt > 0$ under the set of conditions described in the previous paragraph. This last result, in view of (25), implies that the aforementioned reform of t and F will increase the welfare of country c. As for the welfare of the warring countries, there are three effects; (i) they benefit from a terms-of-trade improvement (first term in (7)), (ii) reduction in war efforts increase their welfare through the conflict externality (third term in (7)), and (iii) the reduction in the amount of aid has a direct negative effect on their welfare (fourth term in (7)).[17] Given the symmetry between countries a and b, the net effect can be simplified as

$$2\Delta_1 E_2^a\ du^a = m^c d(p+t) + 2R_3^b dL_s^b,$$

[17]Note that the second term in (7) disappears as L_a^s is optimally chosen.

where the two terms are opposite in sign. If the first effect dominates, then an increase in both t and F will increase welfare in the two warring countries, but war efforts will increase. When the second effect dominates, a decrease in both t and F will reduce war efforts and increase welfare in the two warring countries. These results are formally stated as:

PROPOSITION **5** *Suppose that two identical warring countries export the labor-intensive good to the third country. Then a revenue-neutral decrease in the levels of both aid and tariffs satisfying (23) will reduce the level of war efforts in the two countries and increase the welfare of the third country if* $c_y^c/(1-tc_y^c) > c_y^a$. *Under the same conditions, the present reform may also increase welfare levels in the two warring countries. When* $c_y^c/(1-tc_y^c) < c_y^a$, *a revenue-neutral decrease in the levels of both aid and tariffs will reduce the level of war efforts if the import elasticity of demand for the non-numeraire good in the third country is sufficiently high.*

As before, if the non-numeraire good is a basic good (which is labor intensive and which the two warring countries export), it is quite reasonable to assume that c_y^a is high and c_y^c is low if the two warring countries are developing countries and the third country is a developed one. However, the condition $c_y^c/(1-tc_y^c) > c_y^a$ is only a sufficient one, and even under realistic situations, a revenue-neutral decrease in the levels of both aid and tariffs will reduce the level of war efforts if the import elasticity of demand is sufficiently high.

We note that revenue-neutral reductions tariffs and foreign aid are only Pareto superior if the war externalities are sufficiently large in the warring countries. Otherwise, the neutral country benefits at the expense of the warring countries in terms of welfare. Thus, though there exists incentives for the third party to target war reduction by reducing tariffs and aid, the warring countries may not be in favor of such policy reforms.

4.4.2 Welfare-neutral changes in carrots and sticks

In this subsection, we assume that country c changes the two instruments at its disposal in a such a way that leaves its welfare level given in (9) unchanged, i.e., dt and dF are chosen such that

$$(m^c - t\,(E_{11}^c - R_{11}^c))\,dp = -dF + t\,(E_{11}^c - R_{11}^c)\,dt, \tag{27}$$

where dp is given in (17).

Using (5) and (27), we get from (7) and (9)

$$\frac{dp}{dt} = -\frac{(1+tc_y^b)(E_{11}^c - R_{11}^c)}{2(E_{11}^a - R_{11}^a) + (E_{11}^c - R_{11}^c)(1+tc_y^b) - 2\beta^a \frac{dL_s^a}{dp}}, \tag{28}$$

$$\frac{d(p+t)}{dt} = \frac{2(E_{11}^a - R_{11}^a) - 2\beta^a \frac{dL_s^a}{dp}}{2(E_{11}^a - R_{11}^a) + (E_{11}^c - R_{11}^c)(1+tc_y^b) - 2\beta^a \frac{dL_s^a}{dp}}, \tag{29}$$

$$2E_2^a \cdot \frac{du^a}{dt} = 2R_3^a f_2 \cdot \frac{dL_s^b}{dt} + t(E_{11}^c - R_{11}^c) \cdot \frac{d(p+t)}{dt}, \tag{30}$$

Under the assumptions made, $m^a < 0,\ m^b < 0$ and $m^c > 0$, $dL_s^a/dp < 0$, and $\beta^a < 0$. Thus, from (28)-(30) we have $dp/dt < 0$, $d(p+t)/dt > 0$ and $du^a/dt < 0$. In other words, a decrease in t will increase the terms of trade of the warring countries, reduce their war efforts, and increase their welfare levels. how foreign aid moves to satisfy (27) when tariffs fall will depend on whether the initial level of the tariff is higher or lower than its non-cooperative optimal level. To be specific, the welfare-neutral rule (27) implies that a reduction in t will be accompanied by a reduction (expansion) in F if the initial level of tariff is lower (higher) than its optimal level. The results of this subsection are formally stated in the following:

PROPOSITION **6** *Suppose that two identical warring countries export the labor-intensive good to the third country. Then a welfare-neutral decrease in the levels of tariffs satisfying (27) will reduce the level of war efforts and increase welfare levels in the two countries. Such a decrease in tariff will be accompanied by a decrease (increase) in foreign aid if the initial level of tariff is lower (higher) than its non-cooperative optimal level.*

To summarize, we find that a decrease in tariffs in the present case would be welcome by all parties. However, the accompanying change in foreign aid is negative if the initial level of tariffs imposed by country c is 'low'. In other words, donor countries will withhold aid to promote peace if they are initially friendly toward trade.

5 Conclusion

Unfortunately, bilateral wars between countries over disputed territory is not uncommon and the international community often — though not always — takes an active role in attempting to resolve such conflicts. The interest is not selfless, because conflicts can have important *economic* consequences on other countries that trade with the warring countries. The willingness for third parties to actively engage in conflict resolution can depend on whether or not they themselves lose from such conflicts. In this paper we focus on the crucial role of a third country in the resolution of a conflict between two warring countries. Can the third party help resolve conflicts by using carrots such as foreign aid and sticks such as trade sanctions? Which of the two instruments is likely to be more effective in the resolution of conflicts? These are some of the issues that this paper has attempted to address. We do so by developing a general three-country, many-good, many-factor trade-theoretic model of international trade in which the level of the conflict is determined endogenously as a Nash equilibrium.

We start our analysis by examining the effect of globalization on conflict and find that under realistic assumptions for many countries, reduction in trade costs for the warring countries is likely to reduce the level of conflict between them. We also derive a necessary and sufficient condition under which a concerted, piecemeal reduction in war efforts in the two warring countries from their Nash equilibrium levels is welfare-enhancing for the third country. Once again, we find that under realistic assumptions on the pattern of trade that apply to many countries, the third country will gain from reduction in war efforts.

Then we move on to the main issues of the paper, *viz.*, can the third party reduce the level of conflicts by using carrot or stick policies? We consider two possible instruments for the third country: trade sanctions (stick) and foreign aid (carrot). When the two instruments are used one at a time, we find that whereas a reduction in trade sanctions would unambiguously reduce war efforts and be strictly Pareto improving, an increase in foreign aid would have similar effects only under certain (albeit realistic) situations. Finally, we consider the situation where the two instruments are used simultaneously. When the instruments are changed in a revenue-neutral way, a reduction in both tariffs and aid will reduce conflict, under certain conditions. However, when the changes are welfare-neutral for the third country, a reduction in tariffs will always reduce war efforts and such a policy is Pareto improving. However, such a reduction in tariffs needs to be accompanied by either a reduction in aid or an increase in aid depending on whether the initial level of tariff is low or high.

References

[1] Anderson, James E. and Eric van Wincoop (2004), "Trade Costs," *Journal of Economic Literature*, (forthcoming September issue).

[2] Anderson, James E. and Douglas Marcouiller (2004), "Anarchy and Autarky: Endogenous Predation as a Barrier to Trade" *International Economic Review*, forthcoming.

[3] Anderton, Charles H., Roxane A. Anderton and John R. Carter (1999), "Economic Activity in the Shadow of Conflict," *Economic Inquiry*, 37 (1), 166-79.

[4] Barbieri, Katherine (1996), "Economic Interdependence: A Path to Peace or a Source of Interstate Conflict?," *Journal of Peace Research*, 33(1), 29-49.

[5] Bhagwati, J.N., Brecher, R. and Hatta, T. (1983), "The Generalized Theory of Transfers and Welfare: Bilateral Transfers in a Multilateral World," *American Economic Review,* 73, 57-76.

[6] Copeland, B. R., and M. S. Taylor (2003), *Trade and environment: theory and evidence*, Princeton University Press.

[7] Dixit, A.K. and V. Norman (1980), *Theory of international trade*, Cambridge University Press.

[8] Dorussen, Han (1999), "Balance of Power Revisited: A Multi-Country Model of Trade and Conflict," *Journal of Peace Research*, 36(4), 443–462.

[9] Dorussen, Han and Håvard Hegreto (2003), "Extending the Multi-Country Model of Trade and Conflict," in *Globalization and Armed Conflict*, edited by Gerald Schneider, Katherine Barbieri, and Nils Petter Gleditsch, 77-102. Boulder, CO: Rowman & Littlefield.

[10] Garfinkel, Michelle R., Stergios Skaperdas, and Constantinos Syropoulos (2004), "Globalization and Domestic Conflict," mimeo.

[11] Gowa, Joanne (1994), *Allies, Adversaries, and International Trade*, Princeton, NJ: Princeton University Press.

[12] Grossman, Herschel I. and Minseong Kim (1996), "Predation and Production", in Michelle R. Garfinkel and Sergios Skaperdas, ed., *The Political Economy of Conflict and Appropriation*, Cambridge: Cambridge University Press, 57–72.

[13] Haaparanta, Pertti and Kirsti Kuisma (2004), "Trade, War, and Peace," Helsinki School of Economics Working Paper.

[14] Hess, Gregory D. (2003), "The Economic Welfare Cost of Conflict: An Empirical Assessment," Claremont Colleges Working Papers in Economics, January.

[15] Hirshleifer, Jack (1988), "The Analytics of Continuing Conflict," *Synthese*, 76, 201-233.

[16] Hirshleifer, Jack (1989), "Conflict and Rent Seeking Functions: Ratio and Difference Models of Relative Success," *Public Choice,* 63(2), 101-112.

[17] Hirshleifer, Jack (1991), "The Paradox of Power," *Economics and Politics*, 3, 177-200.

[18] Hirshleifer, Jack (1995), "Anarchy and its Breakdown," *Journal of Political Economy*, 103, 15-40.

[19] Johnson, H.G. (1967), *Economic Policies Toward Less Developed Countries*, Washington, D.C.: The Brookings Institute.

[20] Kemp, M.C. and K. Shimomura (1991), "Trade or Aid?" in *Trade Policy and International Adjustments*, A. Takayama, M. Ohyama and H. Ohta (eds.), San Diego: Academic Press.

[21] Neary, H. (1997), "A Comparison of Rent-Seeking Models and Economic Models of Conflict," *Public Choice*, 93, (3/4), 373-388.

[22] Oneal, John R. and Bruce Russett. (1999), "Assessing the Liberal Peace with Alternative Specifications: Trade Still Reduces Conflict," *Journal of Peace Research,* 36, 423-42.

[23] Polachek, Solomon W., John Robst, and Yuan-Ching Chang (1999) "Liberalism and Interdependence: Extending the Trade-Conflict Model," *Journal of Peace Research,* 36(4), 405–422.

[24] Reuveny, Rafael (1999), "The Trade and Conflict Debate: A Survey of Theory, Evidence and Future Research," *Peace Economics, Peace Science and Public Policy*, 6.(1), 23-49.

[25] Skaperdas, Sergios (1992), "Cooperation, Conflict, and Power in the Absence of Property Rights," *American Economic Review,* 82(4), 720–739.

[26] Skaperdas, Sergios and Constantinos Syropoulos (1996),"Competitive Trade with Conflict," in Michelle R. Garfinkel and Sergios Skaperdas, ed., *The Political Economy of Conflict and Appropriation*, Cambridge: Cambridge University Press, 73–96.

[27] Skaperdas, Sergios and Constantinos Syropoulos (2001), "Guns Butter, and Openness: On the Relationship Between Security and Trade," *American Economic Review, Papers and Proceedings,* 91(2), 353–357.

[28] Syropoulos, Constantinos (2004), "Trade openness and international conflict," paper presented at the conference 'New Dimensions in International Trade: Outsourcing, Merger, Technology Transfer, and Culture,' held at Kobe University, Japan during December 11-12, 2004.

[29] Werner, Suzanne (1997), "In Search of Security: Relative Gains and Losses in Dyadic Relations," *Journal of Peace Research,* 34(3), 289–302.