GLOBALIZATION AND DOMESTIC CONFLICT

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Abstract

We examine how globalization affects trade patterns and welfare when conflict prevails domestically. We do so in a simple model of trade, in which a natural resource like oil is contested by competing groups using real resources (”guns”). Thus, conflict is viewed as ultimately stemming from imperfect property-rights enforcement. When comparing autarky with free trade in such a setting, the gains from trade have to be weighed against the possibly higher resource costs of conflict. We find that importers of the contested resource gain unambiguously. By contrast, countries exporting the contested resource will lose under free trade, unless the international price of the resource is sufficiently high. Regardless of what price obtains in international markets, countries tend to over-export the contested resource relative to what we would observe if there were no conflict; for some range of prices, the presence of conflict even inverts the country's comparative advantage. We find further that an increase in the international price of the contested resource over an even wider range reduces welfare, an instance of the “natural resource curse.”

JEL Code: D72, D74, D78, F02, F10, K42.

Keywords: globalization, trade openness, property rights, enforcement, insecurity, conflict.

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1 Introduction

In the debate regarding the effects of globalization, economists often take the rigorous neoclassical paradigm of trade as their starting point.[1] The canonical versions of that paradigm assume that property rights are perfectly and costlessly enforced. Under such conditions, the effects of greater trade openness and, more generally, of globalization are typically found to be beneficial. However, in many circumstances, property rights are either not well-defined or are costly to enforce. Thus, it is only natural to ask how such deviations from the canonical paradigm of trade would influence our assessment of the effects of globalization.[2]

For the most part, economic analyses of imperfectly enforced property rights have concentrated on open-access resources—fisheries, environmental resources, the commons in general—in which over-exploitation is the main source of inefficiency. With regard to the effects of globalization, Chichilnisky (1994) and Brander and Taylor (1998) have shown how removing the barriers to trade of an open-access resource can further stimulate its over-exploitation and lead to lower welfare.[3]

In this paper, we adopt a different approach, one that enables us to explore an altogether different set of inefficiencies arising from imperfect property-rights enforcement in relation to globalization—namely, the costs of enforcement and conflict within a country.[4] Some costs of enforcement,

[1] See, for example, Bhagwati's (2004) multi-faceted discussion and argument in support of the net benefits of globalization. Stiglitz (2002) provides a different view, emphasizing the role of finance and international organizations, such as IMF and the World Bank.

[2] The specification and enforcement of property rights in a modern economy would seem to require (i) the presence of a state that can define these rights legislatively, (ii) an independent judiciary and non-corrupted power to enforce them, and (iii) the fiscal ability to maintain that infrastructure. Olson (2000, p.183) dubbed the modern markets that require property rights specification and enforcement, in contrast to the *spontaneous* markets of much of history that can rely on self-enforcement, as *socially-contrived*. However, even a near-complete specification of property rights cannot ensure costless enforcement. Given the resources devoted to enforcement by the state, individual parties may need to spend time or money on litigation and related activities to defend their rights.

[3] Hotte et. al. (2000) examine the effect of trade in an open-access resource but also allow for private enforcement and its evolution in a dynamic context.

[4] Skaperdas and Syropoulos (2001) and Skaperdas and Syropoulos (2002) have adopted this approach to explore the welfare consequences of greater openness in the presence of conflict *between* nations who possibly trade with the rest of the world. See Barbieri and Schneider (1999) for a review of the recent scholarship, produced largely though not exclusively by political scientists, on trade and conflict. This scholarship has resulted primarily in two opposing views: (i) the liberal view, that trade between nations would promote peace; and (ii) the realist view, that the effect of trade would have a negative

such as those reflected in the resources regularly expended in litigation and related activities as individuals and groups try to protect their rights, are observed everywhere, even in high-income countries. Many countries, however, face more severe and costly enforcement problems that manifest themselves in a variety of forms of domestic conflict, including strikes and lockouts, military coups, low-level ethnic, religious or class rivalries, as well as rampant basic insecurity that the state is simply unable to curtail. As Rodrik (1998, 1999) has argued, managing such conflicts is critical for successful economic development. Perhaps an even more important case of problematic enforcement is simply that of civil wars. The economic costs of civil conflicts have been overwhelming during the post-World War II period. The costs range from the resources allocated directly to arming and those destroyed in the struggle to the indirect losses associated with a reduction in investment and trade due to greater insecurity as well as other allocative effects that can extend well beyond the duration of the war.[5]

We suppose that a potentially tradeable natural resource, like oil, is contested by different domestic groups.[6] The degree of openness to international markets faced by the contending parties affects not only the stakes of the contest (the value of the disputed resource), but the opportunity costs of contestation and conflict as well. To highlight the ways in which openness matters, we examine conflict in a small country under two polar regimes:

effect or, at best, no effect.

[5]Recent studies of these effects, conducted by researchers at the World Bank, are distilled in Collier et. al. (2003). With the methodology developed by Lucas (1987) to estimate the welfare costs of the business cycle, Hess (2003) estimates the welfare costs of conflict coming from its effects on consumption alone, to be, on average, for 147 countries from 1960–1992, 8 percent of steady-state consumption. The individual estimates for some countries are, not surprisingly, a bit smaller. For the United States, for example, the estimated cost is 3.2 percent. However, even this estimate is far greater than the Lucas-type estimate of the welfare cost of the business cycle in the United States [Hess, p. 17]. Moreover, the estimates for some lower-income countries are dramatically higher—e.g., the cost is 65 percent in Iraq and 40.5 percent in Angola.

[6]For an overview of the various contested natural resources around the globe and the problems they induce, see Klare (2001). There is now a fairly sizeable empirical literature on the relationship between a country's natural resource wealth and civil war. As discussed by Ross (2004) in his synthesis and review, the evidence is quite mixed; and while there appear to be some regularities, very little has been done to distinguish between different theoretical explanations. To get a flavor for some of the difficulties inherent in empirical work of this kind, see Sambanis (2004), who applies the qualitative methodology of cases studies to fill in the gaps left by formal-quantitative models of civil war to help uncover new and changing political processes that lead to civil conflict. While we do not add directly to the empirical literature, our framework offers new insights of relevance for the theory.

autarky and free trade. One possibility is that free trade induces less arming and less domestic conflict, in which case free trade would unambiguously yield higher welfare. The other possibility is that free trade induces more arming and conflict; in this case, when comparing the two trading regimes, the familiar gains to trade must be balanced against the increased costs of arming and conflict. Some of our main findings are summarized below.

First, countries importing the contested resource under free trade unambiguously gain relative to the autarkic regime. In addition to realizing the regular gains from trade, such countries also experience a reduction in their costs of conflict. To be more precise, because the price of the contested resource is lower in international markets than it would be under autarky, removing the barriers to trade with other nations pacifies the conflict at home, thereby increasing welfare by more than it would were property rights perfectly and costlessly enforced.

Second, countries exporting the contested resource under free trade could lose in comparison to autarky. The closer the international price of the contested resource is to its autarkic price, the more likely is such an outcome. At the autarkic price, there are no gains from trade, and the level of conflict under the two regimes are identical. But, as the international price of the contested resource rises above the autarkic price, a shift to free trade implies a discrete jump in the stakes of the contest to intensify domestic conflict so that its costs are higher than the gains from trade. Only when the international price of the contested resource rises above some threshold are the gains from trade sufficiently high to compensate for the (still increasing) costs of conflict, so that trade becomes preferable to autarky.

Third, an increase in the international price of the contested resource can *reduce* the exporting country's welfare. More likely when the international price is especially close to its value under autarky, this effect is reminiscent of the "natural resource curse"—that is, the tendency for natural-resource abundant countries to have weak economic growth (see, for example, Sachs and Warner 1995 and Ross, 2003). The reduced welfare reflects an increase in the intensity with which groups contest the resource as its value rises in global markets, generating a higher cost of conflict that swamps the larger gains from trade that also come with the higher price.[7]

[7]Dal Bó and Dal Bó (2004) similarly find that an increase in the international price of the natural resource can induce a greater degree of conflict; however, the source and the nature of conflict in their analysis differ from ours. The particular mechanism we study is closer to that featured in Hodler's (2004) analysis of rivaling groups, but his focus is on a closed economy. Also see Mehlum, Moene, and Torvik (2002), who show how the curse

Fourth, for a certain range of international prices, domestic conflict reverses the country's comparative advantage relative to that which we would observe if the groups within that country co-existed peacefully. To be more precise, over that price range, if the groups' claims to the natural resource were perfectly secure or costlessly enforced, the country would be a net-importer of oil; however, under imperfect property-rights enforcement, the country is instead a net-exporter of oil. More generally, whether the international price of oil falls within that range or not, domestic conflict distorts production decisions, to reduce the quantity of other commodities supplied domestically relative to the aggregate domestic supply of the contested resource, thereby generating a larger excess supply of the contested resource available for export. That is to say, domestic conflict imparts a positive bias on the country's exports of that good relative to the benchmark case of no conflict. Our analysis implies, then, that a country's trade pattern is not invariant to the emergence of domestic conflict. Treating the trade pattern of any of the many countries that experience civil wars and other forms of domestic conflict as indicative of their true comparative advantage either in empirical studies or for policy purposes appears unjustified.

Finally, as the degree of insecurity increases, the range of international prices for which autarky is superior to free trade and the range over which the natural resource curse occurs widen. In addition, a country that is richer in "oil," given its labor endowment and the degree of insecurity, has a lower threshold that would make the country vulnerable to greater openness. Thus, both endowments and "institutions," the latter in the form of security, determine the welfare consequences of globalization.

2 The basic setting: contesting a resource

We present our analysis in the context of a highly simplified version Heckscher-Ohlin model of trade, modified to allow for imperfect property rights enforcement. Despite the simplicity of the model, our findings are qualitatively robust, and in the appendix, we show how the results can be generalized in a fully-extended version of the Heckscher-Ohlin model [see Appendix A.2].

Consider a country in which N groups compete for claims to T_0 units of land. Each group $i = 1, 2, ..., N$ is endowed with T^i and L^i units of secure land and labor, respectively, which can be used to produce consumption

is associated only with countries that have weak institutions. For a mechanism based on electoral politics and for references to the literature, see Robinson, Torvik, and Verdier (2003).

goods. For simplicity, we assume here that there is only one potential use for land, the extraction of *oil*, and that one unit of land yields one unit of oil. Labor, however, can be used to produce, also on a one-to-one basis, *butter* as well as *guns*. Let G^i denote group i's level of arming or guns.[8] Then, $L^i - G^i$ (≥ 0) units of labor will be available for the production of butter; therefore, group i's maximal production of butter will be $\max\{L^i - G^i, 0\}$.

Oil and butter are final consumption goods, produced under perfectly competitive conditions. They can be traded domestically or, depending on the trade regime, internationally. Let O^i and B^i represent group i's consumption of oil and butter respectively. The preferences of each group i take the Cobb-Douglas form,

$$U(O^i, B^i) = (O^i)^\alpha (B^i)^\beta \tag{1}$$

where $\alpha \in (0, 1)$ and $\alpha + \beta = 1$.

All groups would like to take control of the contested territory, T_0, for its oil. We rule out the possibility of contracting, whereby the groups could limit arming, and suppose instead that claims on land can be settled only via overt conflict or, equivalently in our model, under the threat of conflict. The inability to contract on arming can be due to a variety of reasons that are usually associated with weak governance and inadequate institutions of conflict management. Each group will have an incentive to allocate resources to arming in order to enhance its probability of winning T_0. But the production of guns is costly—to produce more guns a group must forego some production of butter. We will examine how the groups balance these effects at the margin and how trade openness changes the incentives for guns-versus-butter production. As will become obvious below, these incentives depend critically on the ratio of insecure land in the country, T_0, to the country's aggregate endowment of land, $\bar{T} \equiv T_0 + \sum_{i=1}^N T^i$. Henceforth, we will refer to this ratio as the *degree of insecurity*, and denote it by $\tau = T_0/\bar{T}$.

We model intergroup interactions as a winner-take-all contest in which the probability, q^i, that group i will emerge as the winner depends on the relative amount of guns the group possesses. Group i's probability of winning is specified as follows:

$$q^i \equiv q^i\left(G^i, G^{-i}\right) = \frac{G^i}{\sum_{j=1}^N G^j} \tag{2}$$

[8] Note that "guns" can stand for any costly appropriative activity, such as such as ordinary rent-seeking, influence activities or litigation, that subtracts from useful production and welfare. These are precisely the costs of enforcement.

for $\sum_{j=1}^{N} G^j > 0$; otherwise $q^i = \frac{1}{N}$ for all i, where G^{-i} denotes the vector of guns that excludes G^i. According to this specification, group i's probability of winning is increasing in its own allocation to arms, $q^i_{G^i} > 0$, and decreasing in the allocation to arms by all other groups, $q^i_{G^j} < 0$, $j \neq i$.[9]

The timing of actions is as follows:

1. Each group i chooses its allocation of labor to the production to guns, G^i, $i = 1, 2, \ldots, N$. Groups make their choices simultaneously. Let G denote the vector of all groups' gun choices. The implied production of butter for each group i is $\max\{L^i - G^i, 0\}$, for $i = 1, 2, \ldots, N$.

2. Given the choices of guns (G) and the technology of intergroup conflict as described in equation (2), one group emerges as the "winner" of the contest and takes control of the disputed land; if group i is the winner, its land endowment and thus production of oil are $T^i + T_0$; otherwise, its land endowment and production of oil are T^i.

3. Then, given the production of butter and oil by all groups, competitive trade takes place.

We examine the incentives to arm and the resultant welfare of each group under two polar trade regimes: *autarky* and *free trade*. Under autarky, there is no trade with the outside world, and prices are determined domestically within an integrated market. Under free trade, assuming that the country is small, prices are given in international markets.

To derive the expected payoffs under these two regimes, we need to first identify the indirect utility functions implied by (1) and describe some of their properties. To proceed, let $\widetilde{T}^i$ denote group i's contingent land endowment. As previously described,

$$\widetilde{T}^i = \begin{cases} T^i + T_0 & \text{if group } i \text{ emerges as the winner in the contest;} \\ T^i & \text{otherwise.} \end{cases}$$

Furthermore, let p denote the relative price of oil measured in units of butter. The production structure specified above implies that the marginal product

[9] First introduced by Tullock (1980), this functional form has been used extensively in the rent-seeking literature as well as in the literatures on tournaments and conflict and falls within the general class of contest success functions, axiomatized by Skaperdas (1996): $q(G^i, G^{-i}) = f(G_i)/\sum_{j=1}^{N} f(G^j)$, where $f(\cdot)$ is a non-negative, increasing function. Also see Hirshleifer (1989), who investigates the properties of two important functional forms of this class, including the "ratio success function," where $f(G) = G^m$ with $m > 0$, which simplifies to (2) when $m = 1$.

of guns and the opportunity cost of labor are identically given by 1. We can now write group i's contingent income or revenue function as

$$R^i \equiv R(p, \widetilde{T}^i, L^i - G^i) = p\,\widetilde{T}^i + L^i - G^i. \tag{3}$$

Abstracting from international transfers of income, aggregate expenditure on butter and oil must be equal to this measure of income or GDP.[10] Imposing this constraint at the group level, group i's contingent indirect utility function implied by (1) can be written as

$$V^i \equiv V(p, R(p, \widetilde{T}^i, L^i - G^i)) = \mu(p)\left[p\,\widetilde{T}^i + L^i - G^i\right], \tag{4}$$

where $\mu(p) = \beta^\beta(\alpha/p)^\alpha$ represents each group's marginal utility of income. One can verify that group i's contingent demand and supply functions for oil are respectively $\alpha R^i/p$ and $\widetilde{T}^i$; therefore, group i's excess demand function for oil, given the realization of $\widetilde{T}^i$, is

$$M^i = \frac{\alpha R^i}{p} - \widetilde{T}^i, \tag{5}$$

which is positive if the group demands oil and negative if it supplies it.[11]

Differentiation of group i's indirect utility function with respect to the relative price, p, and its guns, G^i, using Roy's identity, yields

$$dV^i = \mu(p)\left[-M^i dp - dG^i\right]. \tag{6}$$

The first term inside the brackets weighted by the marginal utility of income ($\mu(p)$) represents the welfare effect of an exogenous price increase. If group i's excess demand for oil (M^i) is positive, the effect is negative; otherwise, the effect is positive. The second term inside the brackets similarly weighted by the marginal utility of income represents the marginal cost of producing an additional gun to group i, given $\widetilde{T}^i$. When group i produces more guns,

[10] GDP, as typically measured, includes expenditures on arming. Since such expenditures are not productive and arms are not directly consumed, their inclusion in GDP makes this aggregate a misleading measure of welfare.

[11] It is worth noting at this point that our assumption that the utility function is homogeneous of degree one implies that each group behaves as if it is risk neutral. To be more precise, for any given choice of guns, each group i would be indifferent between (a) engaging in actual conflict where q^i equals the probability it will win the entire plot of the contested land and (b) dividing the contested land in which case q^i equals group i's share. The reader is free to use either interpretation of the model.

its production of butter must fall, implying less income and a reduction in its overall welfare.[12]

Given the allocation of resources to the production of guns by all groups $i = 1, 2, \ldots, N$, (G), the relative price of oil that solves $\sum_{i=1}^{N} M^i = 0$ is the market-clearing price that will prevail in the country in the absence of international trade (autarky). Denoting that price by p_A, where "A" indicates the value of the variable under "autarky," one can verify that

$$p_A = \frac{\alpha}{\beta} \frac{\sum_{i=1}^{N} (L^i - G^i)}{(T_0 + \sum_{i=1}^{N} T^i)}.$$

To draw out some of the implications of this expression, define the following aggregates: $\bar{L} \equiv \sum_{i=1}^{N} L^i$ and $\bar{G}_A \equiv \sum_{i=1}^{N} G_A^i$. Then, the autarkic price, p_A, can be written as follows:

$$p_A = \frac{\alpha}{\beta} \left[\frac{\bar{L} - \bar{G}}{\bar{T}} \right], \tag{7}$$

As revealed by (7), p_A does not depend on the distribution of either labor or land across groups, nor does it depend on the distribution of guns. Instead, it depends only on the aggregate quantities. Note, in particular, that when a greater share of the country's resources are allocated to the production of guns $\bar{G}$, given the aggregate labor endowment $\bar{L}$, the amount of butter produced domestically necessarily falls; hence p_A depends negatively on the aggregate level of guns. This property holds more generally, as long as gun production uses labor more intensively relative to the country's endowment [see Appendix A.2 for the more general model].

3 The no-conflict case as a benchmark

Before going on to examine what occurs under conflict, it is helpful for later comparisons as well as for developing some intuition for our results to consider briefly the no-conflict or "Nirvana" case in which property rights are perfectly secure—that is, when there is no dispute over land ($\tau = 0$) such that groups have no incentive to arm ($\bar{G} = 0$). In this hypothetical case, from (7), the autarkic price, denoted by p_A^n, equals:

$$p_A^n = \tfrac{\alpha}{\beta} \bar{L}/\bar{T} = \tfrac{\alpha}{\beta} l \tag{8}$$

[12] Notice from (5) that the group's (contingent) excess demand for oil depends on, among other factors, the quantity of labor it allocates to the production of guns.

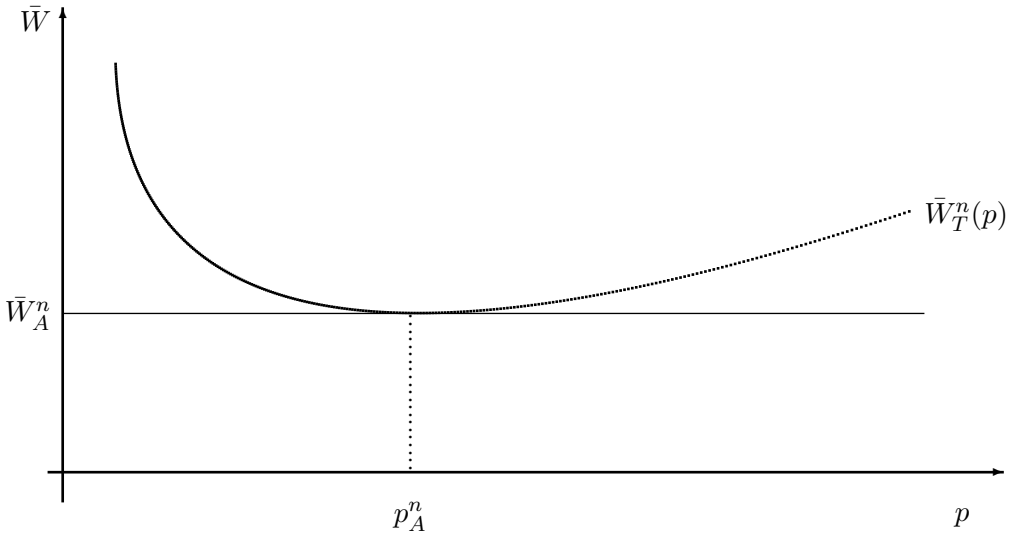

Figure 1: Free trade without conflict

where $l \equiv \bar{L}/\bar{T}$ indicates the country's aggregate labor-land endowment ratio. In turn, summing (3) across the N groups shows that, under autarky with complete security, the country's national income is $\bar{R}_A^n = p_A^n \bar{T} + \bar{L} = \frac{l}{\beta}\bar{T}$. Then, using (4), one can verify that aggregate welfare is

$$\bar{W}_A^n = \mu(p_A^n)\bar{R}_A^n = \mu(\tfrac{\alpha}{\beta}l)\tfrac{l}{\beta}\bar{T}, \tag{9}$$

where as previously defined, $\mu(p) \equiv \beta^\beta(\alpha/p)^\alpha$.[13] The welfare of the individual groups can similarly be written as functions of their initial endowments. In the case of identical groups, the welfare of each one would be $\bar{W}_A^n/N$.

Under free trade, the relative price of oil p would be determined in international markets. Then, with the maintained assumption of complete security of land endowments, aggregate welfare, again calculated using (4), would be

$$\bar{W}_T^n(p) = \mu(p)(p\bar{T} + \bar{L}) = \mu(p)(p + l)\bar{T}. \tag{10}$$

Supposing that groups are identical, the welfare of each would be $\bar{W}_T^n(p)/N$. As one can easily verify, $\bar{W}_T^n(p)$ is a convex function of p, reaching its minimum at p_A^n, as depicted in Figure 1. To the left of p_A^n where the international price of oil is lower than the autarkic price, the country would import oil

[13] With this definition and the solution for the price in the no-conflict case under autarky (8), the country's aggregate welfare in this benchmark case simplifies as $\bar{W}_A^n = \bar{L}^\beta \bar{T}^\alpha$.

and export butter. To the right of p_A^n, where the international price of oil is higher than the autarkic price, the country would be an exporter of oil and an importer of butter. Clearly, in the hypothetical case where the groups' land endowments are perfectly secure, welfare would be at least as high under free trade as that under autarky.

4 Conflict under alternative trading regimes

We now consider the case where the groups' land endowments are insecure: $\tau > 0$. First we examine the equilibrium allocation of resources under the regime of autarky and then we move on to the equilibrium allocation under the regime of free trade.

4.1 Autarky

Under autarky, given the country's aggregate level of guns, $\bar{G}_A$, the relative price of oil is given by (7) regardless of the outcome of the conflict over the contested land, T_0. Group i's land endowment will equal $T^i + T_0$ with probability $q^i(G^i, G^{-i})$ and T^i with probability $1 - q^i(G^i, G^{-i})$. Then, from equation (4), group i's expected payoff under autarky will be:

$$W_A^i(G; p_A) = \mu(p_A)\left[p_A(T^i + q^i T_0) + L^i - G^i\right], \tag{11}$$

where, as defined above, G represents the vector of gun choices by all groups $i = 1, 2, \ldots, N$. We suppose that each group factors in the effect that its own choice of guns has on the relative price, p_A. However, groups make their choices simultaneously. Given our specifications for production, preferences, and the contest success function, a unique Nash equilibrium can be shown to exist.

At an interior optimum $G_A^{i*} \in (0, L^i)$, the following condition is satisfied for each group i:

$$\begin{aligned}\frac{\partial W_A^i(G_A^{i*}; p_A)}{\partial G^i} &= \mu(p_A)(q^i_{G^i} p_A T_0 - 1) + \Bigg[\mu'(p_A)\big[p_A(T^i + q^i T_0) \\ &\qquad + L^i - G_A^{i*}\big] + \mu(p_A)(T^i + q^i T_0)\Bigg]\frac{\partial p_A}{\partial G^i} \\ &= \mu(p_A)\left[(q^i_{G^i} p_A T_0 - 1) - \widehat{M}^i \frac{\partial p_A}{\partial G^i}\right] = 0, \end{aligned} \tag{12}$$

where $\widehat{M}^i$ denotes group i's *expected* excess demand for oil. That is,

$$\widehat{M}^i = -\frac{\mu'(p_A)}{\mu(p_A)}\left[p_A(T^i + q^i T_0) + L^i - G_A^{i*}\right] - (T^i + q^i T_0),$$

derived analogously to (5) using Roy's identity. The first term inside the brackets in the last line of (12) represents the net expected marginal benefit of guns, keeping the autarkic price p_A constant. As described earlier, the production of an additional gun enhances group i's chances of taking control of the disputed land, T_0 and the oil contained therein. As long as the relative price of oil p_A is not too low, this expected net benefit is positive. The second term inside the brackets represents the indirect effect that an additional gun would have on group i's expected payoff through its effect on the relative price of oil. The sign of this indirect effect depends on whether the group is a net buyer $\widehat{M}^i > 0$ or seller $\widehat{M}^i < 0$ of oil.

When groups are identical, no one group can expect to be a net seller or buyer of oil. Hence, each group's expected excess demand for oil must equal zero: $\widehat{M}^i = 0$, for all i.[14] In this case, groups behave *as if* they can have no influence on the country's autarkic price. That is to say, the equilibrium quantity of guns satisfies the condition, $q^i_{G^i} p_A T_0 - 1 = 0$.[15] That quantity of guns and the implied autarkic price are respectively

$$G^*_A = \frac{(N-1)T_0 p^*_A}{N^2} = \frac{\alpha\tau(N-1)\bar{L}}{\beta N^2 + \alpha\tau N(N-1)} \tag{13a}$$

$$p^*_A = \frac{\alpha N l}{\beta N + \alpha\tau(N-1)}. \tag{13b}$$

for $i = 1, 2, \ldots, N$, where as previously defined $\tau \equiv T_0/\bar{T} > 0$ indicates the *degree of insecurity*. Not surprisingly, the optimizing choice of guns, G^*_A, is positively related to the autarkic price of land and oil. The autarkic price itself, p^*_A, is increasing in the aggregate labor endowment, $\bar{L}$, and is decreasing in the degree of insecurity, τ, and in the number of groups in competition, N. In addition, p^*_A is strictly less than the autarkic price under "Nirvana", p^n_A. The ratio of the two prices, given by

$$\frac{p^*_A}{p^n_A} = \frac{\beta N}{\beta N + \alpha\tau(N-1)} < 1 \tag{14}$$

[14] Interpreting the conflict over T_0 as a winner-take-all contest, there will be ex post heterogeneity and thus the groups would be expected to trade after the conflict outcome is realized. In particular, the group that takes control of the land and thus oil would be expected to be a net seller of oil, whereas all other groups would be expected to be net buyers. When we interpret q^i as shares instead of probabilities, the assumption that groups are identical ex ante would imply that they are identical ex post. Hence, there would be no trade: $M^i = \widehat{M}^i = 0 \; \forall \; i$.

[15] Even if groups were not identical, this condition would be the relevant one, provided that each group were a price taker in its choice of guns.

is also decreasing in the degree of insecurity, τ, as well as in the number of groups, N. The effects of τ and N on the ratio p_A^*/p_A^n can be attributed to labor being an essential input into the production of guns. Specifically, with an increase in either τ or N, which under conflict increases the incentive to arm, additional resources are diverted away from the production of butter, implying a higher relative price of butter or equivalently a lower relative price of oil.

Proceeding to the more general case which allows for asymmetries, we sum the conditions in (12) across all N groups to obtain

$$\begin{aligned}\sum_{i=1}^{N}\frac{\partial W_A^i}{\partial G^i} &= \mu(p_A)\left[p_A T_0\sum_{i=1}^{N}q_{G^i}^i - N - \sum_{i=1}^{N}\widehat{M}^i\frac{\partial p_A}{\partial G^i}\right]\\ &= \mu(p_A)\left[p_A T_0\left(\sum_{i=1}^{N}q_{G^i}^i\right) - N\right] = 0. \qquad (15)\end{aligned}$$

Note that, in the first line of the expression, $\partial p_A/\partial G^i$ can be factored out of the sum of $\widehat{M}^i$ since, by (7), its value is independent of i. The second line in the expression then follows from the domestic market-clearing condition, $\sum_{i=1}^{N}\widehat{M}^i = 0$. By the specification of the conflict technology in (2), we have $q_{G^i}^i = \left[\bar{G} - G^i\right]/(\bar{G})^2$, implying that (15) can be rewritten as follows:

$$\sum_{i=1}^{N}\frac{\partial W_A^i}{\partial G^i} = \mu(p_A)\left[p_A T_0\tfrac{N-1}{\bar{G}} - N\right] = 0.$$

We can now combine (7) and the above expression to obtain solutions respectively for the aggregate quantity of guns and autarkic price in an interior Nash equilibrium:

$$\bar{G}_A^* = \frac{\alpha\tau(N-1)\bar{L}}{\beta N + \alpha\tau(N-1)} < \bar{L} \qquad (16a)$$

$$p_A^* = \frac{\alpha N l}{\beta N + \alpha\tau(N-1)}. \qquad (16b)$$

As (16) reveals, in the Nash equilibrium under autarky when no group exhausts its entire labor endowment in the production of guns or equivalently when the resource constraint $L^i - G_A^{i*} \geq 0$ binds for no group $i = 1, 2, \ldots, N$, both the market-clearing price and the aggregate quantity of guns are independent of the distribution of endowments across groups.

Substitution of the aggregate solutions (16) into (12), after simplifying, yields the following expression for group i's equilibrium production of guns under autarky:

$$G_A^{i*} = \frac{\bar{G}_A^*}{N}\left[\frac{\beta\bar{T} + \alpha(N-1)(\alpha L^i - \beta p_A^* T^i)}{\beta\bar{T} + \alpha\,(N-1)\,(N-\alpha)\left(\tau\bar{T}/N^2\right)}\right], \tag{17}$$

which is strictly less than L^i, by assumption. The interior autarkic equilibrium, then, is fully described by this expression, the equilibrium aggregate quantity of guns, $\bar{G}_A^*$, shown in (16a) and the equilibrium relative price of oil, p_A^*, shown in (16b). For future reference, we denote group i's equilibrium expected payoff under this regime by W_A^{i*}. When groups are identical, aggregate welfare is:

$$\bar{W}_A^* = \mu\left(\frac{\alpha N l}{\beta N + \alpha\tau(N-1)}\right)\frac{\bar{T}Nl}{\beta N + \alpha\tau(N-1)}, \tag{18}$$

where $\mu(\cdot)$ represents the marginal utility of income as defined earlier. It is straightforward to show that autarkic aggregate welfare in the absence of conflict, $\bar{W}_A^n$, is always greater than autarkic aggregate welfare under conflict, $\bar{W}_A^*$.[16] As such, when groups are identical, the welfare of any individual group would be lower under conflict as well.[17]

The following proposition summarizes our main findings thus far:

Proposition 1 (*Autarky*) *Suppose that barriers preclude trade between countries, but groups within a given country may trade freely.*

(i). *The autarkic price under conflict* (p_A^*) *is strictly less than the autarkic price in the absence of conflict* (p_A^n) *and is decreasing in the degree of insecurity* (τ). *Furthermore, the ratio of* p_A^* *to* p_A^n, *as shown in equation* (14), *is also decreasing in the degree of insecurity.*

(ii). *Autarkic aggregate welfare in the absence of conflict,* $\bar{W}_A^n$, *is always higher than autarkic aggregate welfare under conflict,* $\bar{W}_A^*$.

[16] Using the simplified solution for $\bar{W}_A^{n*}$ shown in footnote 13, it is possible to rewrite (18) as $\bar{W}_A^* = \bar{W}_A^{n*}\phi$ where $\phi \equiv [N\beta/(N\beta + \alpha\tau(N-1))]^\beta$. Since $\phi < 1$, it follows that $\bar{W}_A^* < \bar{W}_A^{n*}$.

[17] With variation across groups, there is no unique set of comparisons because, for each set of secure endowments and contested land, there is no unique set of land endowments that could be assigned to the no-conflict case.

4.2 Free trade

Under free trade, each group can trade, without restrictions, butter and oil at a relative price p which is determined in international markets. Moreover, we suppose that this price cannot be influenced by any group or by the country as a whole. In other words, the country can be considered "small".[18] Using equation (4), the expected payoff of group i in this case equals

$$W_T^i(G;p) = \mu(p)\left[p\left(T^i + q^i T_0\right) + L^i - G^i\right], \tag{19}$$

where as defined above G represents the vector of gun choices by all groups $i = 1, 2, \ldots, N$. At the symmetric interior optimum we have:

$$\frac{\partial W_T^i(G_T^*;p)}{\partial G^i} = \mu(p)(q_{G^i}^i p\, T_0 - 1) = 0,$$

from which we can solve for the equilibrium production of guns under trade when land endowments are not perfectly secure:

$$G_T^* = \frac{(N-1)p\, T_0}{N^2} = \frac{(N-1)p\, \tau \bar{T}}{N^2}, \tag{20}$$

for all i, where $\tau \equiv T_0/\bar{T}$. Note that, even when the secure land endowments are not identically distributed across groups, this equilibrium is symmetric. That is, provided the relevant resource constraint is satisfied, groups of different sizes will produce the same quantity of guns.

What relevant resource constraints do we have in mind? Since groups have, by assumption, access to international markets, it seems reasonable to suppose that they can trade the right to obtain guns beyond what can be obtained domestically (that is, beyond L^i), against the oil that can be obtained from the group's secure land endowment (T^i) alone, or even against the oil that the group expects to obtain from its participation in the domestic conflict ($q^i(G^i, G^{-i})T_0$). As Collier et. al. (2003, p. 77) state: "A particularly remarkable recent development is for rebel groups to raise finance by selling the advance rights to the extraction of minerals that they currently do not control, but which they propose to control by purchasing armaments financed through the sale of extraction rights." Former President of the Democratic Republic of Congo, Lawrence Kabila, financed his

[18] Supposing that the groups and the country as a whole are large enough to affect international prices, and that they recognize their effects in their strategic decisions would unnecessarily complicate our derivations without qualitatively changing our results. Skaperdas and Syropoulos (2002) allow for a strong effect of individual players on prices in a model similar to the one of this paper.

rebellion against Mobutu Sese Seko with such a scheme. Similarly, Ross (2003, p. 33) cites reports of former President of Congo-Brazzaville Denis Sassou-Nguesso financing his private militias through pledges of future oil contracts, whereby he was able to come to power. Over the past decade, buying arms in international markets has become far easier than it had been in the past. Indeed, there now exist international private security firms that offer comprehensive packages, including everything from tactical advisors to whole units complete with attack helicopters and jets. Such military "imports" have been decisive factors in countries like Sierra Leone and Angola [see Davis 2000 and Singer 2003].

Provided that groups are sufficiently similar, these expanded opportunities for them to obtain arms ensure the symmetric solution in (20) always obtains in equilibrium under free trade.[19] Accordingly, group i's equilibrium expected payoff in this regime, $W_T^i(p)$, can be shown to equal:

$$W_T^i(p) = \mu(p)\left[p\left(T^i + \tfrac{T_0}{N^2}\right) + L^i\right], \tag{21}$$

which is convex in p, reaching its minimum at

$$p_{\min}^i = \frac{\alpha}{\beta}\left[\frac{N^2 L^i}{N^2 T^i + T_0}\right]. \tag{22}$$

Since G_T^* is the same for all i, each group has an equal chance of securing T_0. Thus, as (21) and (22) show, any variation in secure endowments across groups will generate variation in welfare under free trade for any given price. Again, for ease of comparison, we focus on the case of identical groups, implying that aggregate welfare and the (unique) minimum price become

[19] Specifically, if land endowments as well as expected contested land capture can be used as collateral to obtain guns beyond L^i, the condition for (20) to obtain is $p^{-1} \geq (N-1)T_0/N^2L^i - (T^i + q_iT_0)/L^i$ for all i. Sufficient symmetry across the groups in terms of the distribution of secure endowments ensures that the right-hand-side of this inequality is negative such that the constraint could not bind for any positive prices p. Even with considerable variation in the distribution of endowments, the condition may hold. However, this is less likely, as the price for oil increases and the conflict over land intensifies. Of course, in the absence of the opportunities provided, for example, by the international private security firms, the relevant resource constraint for the symmetric equilibrium shown in (20) to be an equilibrium is that the relative price be sufficiently low such that the production of guns does not exhaust any group's labor endowment, $G_T^* \leq L^i$: $p^{-1} \geq \frac{(N-1)T_0}{N^2L^i}$ for all i.

respectively

$$\begin{aligned} \bar{W}_T(p) &= \mu(p)\left[p\left(1-\tfrac{N-1}{N}\tau\right)+l\right]\bar{T} && \text{(23a)} \\ &= \bar{W}_T^n(p)-\mu(p)p\tfrac{N-1}{N}\tau\bar{T} && \text{(23b)} \\ p_{\min} &= \frac{\alpha N l}{\beta N-\beta\tau(N-1)} && \text{(23c)} \end{aligned}$$

Then, the properties described below follow straightforwardly.

Proposition 2 (*Free Trade*) *Suppose the competing groups are identical.*

(i). *The international price that minimizes the country's aggregate welfare under trade and conflict* ($p_{\min}$) *is strictly greater than the autarkic (and minimum) price in the absence of conflict* (p_A^n)*, and is increasing in the degree of insecurity* τ*. Furthermore, the ratios*

$$\frac{p_{\min}}{p_A^n}=\frac{\beta N}{\beta N-\beta\tau(N-1)} \quad \textit{and} \quad \frac{p_{\min}}{p_A^*}=\frac{\beta N+\alpha\tau(N-1)}{\beta N-\beta\tau(N-1)}$$

are both increasing in the degree of insecurity, τ*.*

(ii). *For any given international price* p*, aggregate welfare under conflict,* $\bar{W}_T(p)$*, is strictly lower than aggregate welfare in the absence of conflict,* $\bar{W}_T^n(p)$*. Furthermore, the higher is the degree of insecurity, the lower is* $\bar{W}_T(p)$*.*

Part (ii) of Proposition 2 is to be expected, as insecurity induces arming that reduces welfare. The interpretation and significance of part (i) will become evident in the comparisons we undertake in the next section.

5 Comparing the two trading regimes under conflict

Having characterized the allocation of resources under the two polar trading regimes, we are now ready to compare them in terms of both arming and welfare. For tractability, we will only consider the case of identical groups. The comparison reveals two key forces at play here: (i) the well known gains from trade that favor trade over autarky, as was demonstrated above in the benchmark case without conflict; and (ii) the induced effects of trade on the groups' incentive to fight over the contested resource, which may or may not favor the trade over autarky.

Consider first the level of arming. Note that, whereas guns under autarky depend only on the endowments and other parameters of the model as shown in (13a), guns under free-trade critically depend on the relative price p and negatively so as shown in (20). Using (13a) and (20), we calculate the ratio of guns in the two regimes, θ, which provides a convenient summary measure:

$$\theta \equiv \frac{G_A^*}{G_T^*} = \frac{p_A^*}{p}.$$

As this expression shows, the groups' optimizing allocation to guns under anarchy is lower than that under free-trade if and only if the international relative price of guns is higher than its domestic autarkic price.

The logic here is straightforward: A high price of oil induces more guns production both because guns are cheaper to produce and because land and oil are more valuable in international markets and thus induce more competition for the capture of the contested land. When the international price p is higher than the autarkic price p_A^* ($\theta < 1$), the groups and the country as a whole import butter and export oil. By contrast, when p is lower than p_A^* ($\theta > 1$), butter is more valuable in the international market than it is domestically, and oil is less valuable internationally than it is in the domestic market. The groups and the country, therefore, export butter and import oil, and they use less labor in the production of guns than they would under autarky.

Moving on to the relative appeal of free trade, note that the payoffs under autarky would equal the payoffs under trade if the international price were the same as the autarkic price: $\bar{W}_T(p_A^*) = \bar{W}_A^*$. Since $\bar{W}_T(p)$ is convex in p and obtains its minimum at $p_{\min}$, how welfare under free trade, $\bar{W}_T(p)$, ranks relative to welfare under autarky, $\bar{W}_A^*$, depends on how $p_{\min}$ is related to the autarkic price p_A^*. In particular, if these two prices were to coincide, then the expected payoffs under autarky would fall below the expected payoffs under trade everywhere except at that minimum price. However, from Proposition 2 part (i) we have $p_{\min} > p_A^n$ and from Proposition 1 part (i) we have $p_A^n > p_A^*$. Therefore, we must have $p_{\min} > p_A^*$, implying that there exists some range of international prices for which the groups are better off under autarky than under trade.

But we can be more precise in characterizing this range of prices. In particular, given the convexity of $\bar{W}_T(p)$, there exists another price $p' > p_{\min}$ defined uniquely by the condition, $\bar{W}_T(p') = \bar{W}_A^*$. Therefore, as illustrated in Figure 2, for all $\tilde{p} \in (p_A^*, p')$, the expected payoffs under free trade are lower than the payoffs expected under autarky ($\bar{W}_T(\tilde{p}) < \bar{W}_A^*$), whereas for

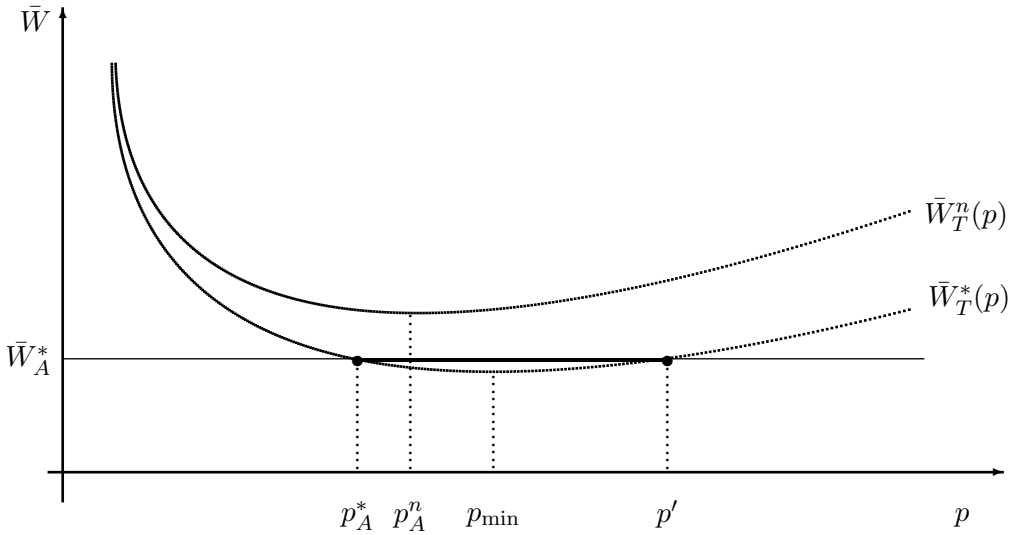

Figure 2: Free trade with conflict

prices outside that interval the payoffs expected under trade are at least as high as those expected under under autarky.

We summarize the key implications of our analysis as they relate to the welfare comparison of the two regimes in the following proposition:

Proposition 3 (*Relative Appeal of Free Trade*) *Suppose the competing groups are identical.*

(i). *When the international price of oil p is lower than p_A^* or higher than p', welfare under free trade is higher than welfare under autarky.*

(ii). *When the international price of oil is between p_A^* and p', welfare under autarky is higher than welfare under free trade.*

(iii). *The price p' is increasing in the degree of insecurity τ. The ratio $\frac{p'}{p_A^*}$ is increasing the degree of insecurity τ as well. Thus, the range of prices for which autarky dominates trade is increasing in the degree of insecurity.*

When the international price for oil p is lower than its autarkic price (p_A^*), the production of guns under trade is lower. In this case, removing the barriers to trade reduces the groups' incentives to fight over the contested

resource, implying that domestic conflict is less intense. With this benefit *and* the familiar gains from trade, there should be no doubt that welfare is higher than it would be under autarky. However, as the international price of oil rises, domestic conflict intensifies, becoming just as severe as it is under autarky once the international price reaches the price that would obtain under autarky ($p = p_A^*$); at the same time, the gains from trade fall to zero. It is at this point, as shown in Figure 2, where welfare under autarky is identical to that under trade.

As the international price continues to rise above the autarkic price, domestic conflict intensifies further; while the gains from trade rise above zero, those gains are not sufficiently large to compensate for the higher burden of guns; thus, as the international price of oil rises above its autarkic price, welfare under trade falls below that which could be obtained under anarchy. Yet, as Proposition 3 indicates, even further increases in the international price will eventually make free trade relatively more appealing. That is to say, when the international price of oil becomes sufficiently high ($p > p'$), the gains from winning the valuable land and selling the oil in the global marketplace become very large and begin to outweigh the (normalized) opportunity cost of guns.

Part (iii) of the Proposition, the proof of which is given in Appendix A.1, establishes that the range of international prices for which autarky is superior to trade ($p \in (p^*, p')$) expands as insecurity (τ) increases, an intuitively plausible but non-trivial property. Figure 3 illustrates this property and also shows how an increase in the degree of insecurity shifts the welfare curve, assuming trade, down.

One can also verify that the prices p_A^*, p_A^n, and $p_{\min}$ are increasing in the labor-to-land endowment ratio $l \equiv \bar{L}/\bar{T}$. That is to say, the labor-to-land endowment ratio affects these critical prices by effectively shifting all the curves, in the figures we have shown, to the right. A higher l makes the range of international prices (those below p_A^*) for which free trade is superior larger since the country is an importer of oil and an exporter of butter over that range.[20]

Another interesting implication, which follows from our previous discussion and is illustrated in Figure 2, concerns the welfare effect of an increase in the international price of the contested resource.

Proposition 4 (*Resource Curse*) *Suppose the competing groups are iden-*

[20] The effect of l on p' is generally ambiguous. But, for large enough $l \equiv \bar{L}/\bar{T}$, p' is also increasing in l.

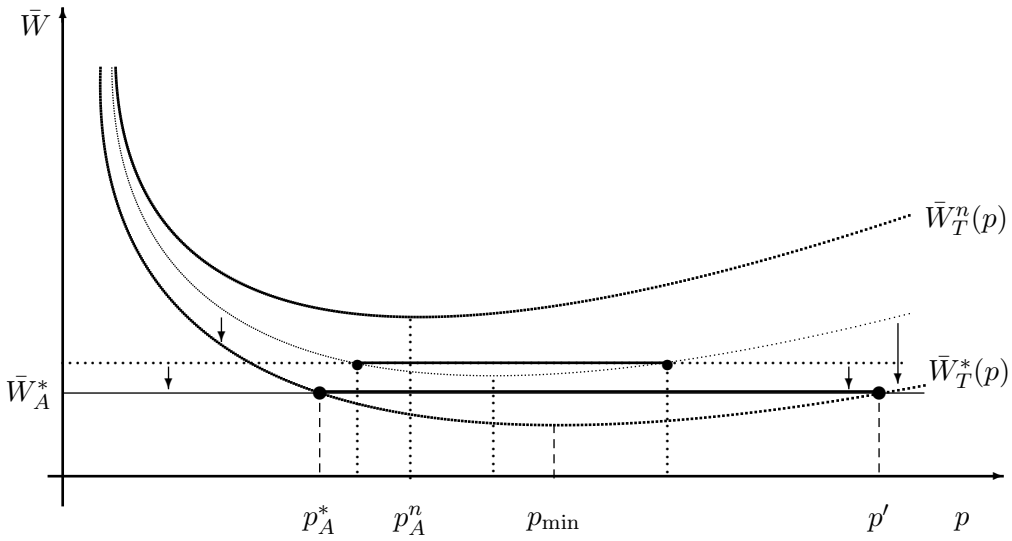

Figure 3: When the degree of insecurity rises

tical. Then, for international prices between p_A^* and $p_{\min}$, aggregate welfare under free trade, $\bar{W}_T^*(p)$, is decreasing in the international price p.

This finding is reminiscent of what others (including, but not limited to, Sachs and Warner 1995 and Ross 2003) have called the "resource curse," but is based on a different logic. In particular, as suggested earlier, for $p \in [p_A^*, p_{\min})$, increases in the international price of the contested resource induce a greater degree of domestic conflict. While the familiar gains from trade increase with increases in p over this range, these increases are swamped by the large increases in the burden of guns.

It is important to note, in relation to the resource curse, that national income under free trade, which is given by

$$\bar{R}_T^*(p) = [p(1 - \tfrac{N-1}{N}\tau) + l]\bar{T},$$

is everywhere increasing in the international price p, even over that range for which welfare is falling. Thus, particularly for $p \in [p_A^*, p_{\min})$, it would seem that our measure of income tends to overstate welfare. But, there is no reason to believe that commonly used measures of aggregate income (e.g., GDP) do any better. If anything, there is reason to believe that they do worse. Specifically, our theoretical construct, in contrast to conventionally used measures based on national income and product accounts, excludes

expenditures on arming. Thus, the conventional measures of national income would tend to overstate welfare by even more than our theoretical measure. But the point here is not to "advocate" our theoretical measure. Instead, the point is to note that reports of income founded on conventional income accounting might not be able to identify fully the extent of the natural resource curse, and the curse itself might be not only more severe but also more pervasive, affecting more countries than currently believed.[21]

Another implication of the analysis that we draw out here is that conflict also affects the pattern of trade. Specifically, when $p \in (p_A^*, p_A^n)$, the presence of insecure land endowments reverses the direction of the country's comparative advantage relative to the hypothetical scenario where land endowments are perfectly secure. To illustrate this effect, we calculate the country's aggregate excess demand for oil under free trade, in the hypothetical case of no conflict ($\bar{M}_T^n(p)$) and the more realistic case of conflict ($\bar{M}_T^*(p)$), using (5),

$$\bar{M}_T^n(p) = \beta \left[\frac{p_A^n}{p} - 1 \right] \bar{T} \tag{24a}$$

$$\bar{M}_T^*(p) = \beta \left[\frac{p_A^*}{p} - 1 \right] \bar{T}. \tag{24b}$$

For both cases, $\bar{M}_T(p)$ is positive when the country imports oil and negative when it exports oil. As (24a) reveals, in the absence of conflict, the country would export butter and import oil whenever $p < p_A^n$. But (24b) shows that if, at the same time, $p > p_A^*$, then under trade with conflict, the country would export oil and import butter. This sharp divergence of trade patterns depending on the presence of domestic conflict is a result of the diversion of resources (specifically labor in this model) away from the production of butter to the production of guns under conflict.[22] From Proposition 1 part (i), it can be seen that, the range of prices for which the country's comparative advantage reverses under conflict relative to the hypothetical

[21] Candidates for this designation would be countries that have, for example, low ranks in term of the UNDP's Human Development Index (HDI) compared to their rank in terms of GDP. Such countries appear to fall into one of either two categories: those that are significant oil exporters (like Saudi Arabia or Angola) and those that have significant domestic cleavages (like Algeria and South Africa). See the table for HDI in: http://hdr.undp.org/reports/global/2003/indicator/index.html.

[22] As noted below, it does not depend on the particular production structure we have employed. Domestic conflict's sharp effect on the country's trade pattern would remain intact as long as there is a difference in the factor intensities in the production of arms and oil.

case of no-conflict is wider for countries having a greater degree of insecurity τ. But the effects of insecurity trade patterns is not limited to cases where the price falls within that particular range. Equation (24b) shows that a country's excess demand for oil is increasing in p_A^* , which Proposition 1 part (i) indicates is decreasing in the degree of insecurity. Thus, the degree of insecurity, τ, generally reduces the country's excess demand for oil. We summarize these findings in the following proposition:

Proposition 5 (*Trade Pattern Effects*) *The domestic demand for oil is decreasing in the degree of insecurity τ, and the country over-exports oil (relative to the hypothetical no-conflict case). When the international price of oil is between p_A^* and p_A^n, there is a reversal in the country's comparative advantage (relative to the no conflict case) with the country exporting oil instead of butter.*

In oil-exporting countries where there is domestic conflict over that same resource we would expect these exports to be higher than those that would obtain in the absence of conflict. If, for example, the resources expended on Nigeria's civil wars and the various other forms of domestic conflict that have been present there over the years were instead used in production, the local economy would have absorbed more of the oil production and less of it would have been exported.

As shown in the Appendix [A.2], this trade-pattern effect extends to more general production functions for guns, as well as for butter and oil. Within the standard Heckscher-Ohlin model of trade, all that is required is that the land-labor factor intensity of gun production be lower than the labor-land country endowment ratio, $l \equiv \bar{L}/\bar{T}$.

6 Concluding remarks

Since 1945, 127 civil wars (each causing, by definition, at least 1,000 deaths) have emerged in 73 countries. The total number of casualties resulting directly from these wars is conservatively estimated to be at least 16.2 million.[23] The accompanying direct and indirect economic costs have also been immense. These wars have not abated since the end of the Cold War; they

[23] See Fearon and Laitin (2003, p.75) who base their findings on the *Correlates of War* project, among other sources. Using Singer and Singer (1994) updated to include the Kargil and Eritrean wars, they report further that the same period witnessed a much smaller number of interstate wars, with proportionately fewer casualties. This trend represents a reversal from the first 45 years of the twentieth century.

have spread into Eastern Europe and Central Asia (Collier at. al, 2003, Ch.4), and many pre-existing wars last longer than they had in the past [Fearon and Laitin, 2003]. Furthermore, low-level insurgencies, civil unrest, and more conventional forms of domestic conflict are present in an additionally large number of countries, and these have their own added costs (Rodrik, 1999).

Our results suggest that globalization in the presence of domestic conflict is not the unmitigated good that it was shown to be within the context of traditional trade models where all endowments are seen to be perfectly secure. Although for importers of oil and other natural resources opening up the economy brings the regular benefits of trade and reductions in conflict, for exporters of the same resources opening the economy to trade can very well induce a large diversion of productive resources to conflict that more than offsets the familiar gains from trade. Welfare can even be decreasing while the price of the exported resource is increasing, and the country in conflict might be exporting a good that it would be importing in the absence of conflict.

The increase in domestic conflict observed in the post-war period is also correlated with the emergence of weak new post-colonial and post-communist states that have been unable to develop the legal infrastructure, enforcement, and institutions which would be expected to manage the various conflicts. As even the strong states of high-income countries are said to be weakening in many of the same dimensions (see, e.g., Van Creveld, 1999), it is doubtful that the governance of security can be significantly improved in low-income countries without qualitative changes in the way the international economy is governed.

A Appendix

A.1 Proof of Proposition 3, part (iii).

As noted earlier, p' is defined by $W_T(p') = W_A^*$, which, using (18) for W_A^* and (23a) for $W_T(p')$, can be written as

$$\left[\frac{\beta N l}{\beta N + \alpha\tau(N-1)}\right]^{\beta} - \frac{\alpha}{p'^{\alpha}}\left[p'(1-\tau\tfrac{N-1}{N}) + l\right] = 0. \tag{A.1}$$

An application of the implicit function theorem to (A.1) yields:

$$\frac{\partial p'}{\partial \tau} = -\frac{p'^{\alpha} A}{B}, \qquad \text{where} \quad \begin{array}{rcl} A & \equiv & p'^{\beta}\frac{N-1}{N} - \beta p_A^{*\beta}\frac{N-1}{\beta N+\alpha\tau(N-1)} \\ B & \equiv & \frac{\alpha l}{p'} - \beta\left[1-\tau\frac{N-1}{N}\right]. \end{array} \tag{A.2}$$

Since $p' > p_A^*$, we must have from the definition of A,

$$A > p_A^{*\beta}\left[\frac{N-1}{N} - \beta\frac{N-1}{\beta N+\alpha\tau(N-1)}\right] = p_A^{*\beta}\frac{N-1}{N}\left[\frac{\alpha\tau(N-1)}{\beta N+\alpha\tau(N-1)}\right].$$

The expression on the right hand side of the equality above is strictly positive, implying $A > 0$. To sign B, note that (23c) implies $p_{\min} = \alpha\, l/\beta[1 - \tau\frac{N-1}{N}]$. From the inequality $p' > p_{\min}$, it follows that $p'\beta\left[1-\tau\frac{N-1}{N}\right] > \alpha l$, and therefore $B < 0$. With (A.2), the inequalities $A > 0$ and $B < 0$, in turn, imply that the price p' is increasing in the degree of security τ: $\partial p'/\partial\tau > 0$. Then, with Proposition 1 part (i), that p_A^* is decreasing in τ, one can verify that the ratio, p'/p_A^*, is increasing in τ. ‖

A.2 General production structures and patterns of trade

Here we outline an extension of our model in which the production structure is generalized along the lines of the standard Heckscher-Ohlin model of trade, to show how our results regarding the pattern of trade extend with some qualifications. As before, denote the relative price of oil (measured in units of butter) by p. Now let the price of labor and the price of land be denoted respectively by w and r, and assume that all commodities can be produced using land and labor with constant returns to scale technologies. For specificity, identify the corresponding technologies for the production of these goods, $J = O, B, G$, with the unit cost functions $c^J \equiv c^J(w, r)$, which we assume are linear homogeneous and concave in their arguments. By Shephard's lemma, c_w^J and c_r^J indicate respectively the (conditional) unit labor and unit land requirements in the production of good J, where the subscript denotes the partial derivative of the cost function with respect to that factor price. The linear homogeneity of c^J implies that the unit labor and land requirements are homogenous of degree zero and further that the labor-land factor intensity ratio in industry J, $l_J \equiv c_w^J/c_r^J$, is decreasing in the wage-rental ratio, $\omega \equiv w/r$.

Within this more generalized production structure, supposing that labor (land) is employed intensively in the production of butter (oil)—that is, $l_B(\omega) > l_O(\omega)$ for all relevant ω—we identify the conditions under which (i)

the autarkic relative price of oil in the presence of conflict continues to be below that which obtains in the "Nirvana" case; and, (ii) there is a tendency to over-export oil in the presence of conflict relative to the Nirvana case.[24] The key condition for both results, given $l_B(\omega) > l_O(\omega)$, is that the country's (and, under symmetry, the representative group's) labor-land factor endowment ratio $l \equiv \bar{L}/\bar{T}$ is higher than the labor-land factor intensity ratio in the production of guns: $l_G = c_w^G/c_r^G$. Otherwise, the results are reversed. Either way, we can see that the country's pattern of trade will depend on the presence of conflict.

A.2.1 The effect of conflict on the autarkic price

Focusing on diversified production for oil and butter, with the price of butter normalized to one, competitive pricing requires

$$c^O(w,r) = p \tag{A.3a}$$
$$c^B(w,r) = 1. \tag{A.3b}$$

Under our assumptions, these two conditions together define the equilibrium values of w and r as a functions of product prices. An application of the implicit function theorem to (A.3) confirms, consistent with the Stolper-Samuelson theorem, that an exogenous increase in the relative price of the oil (p) generates a disproportionate increase in the reward to the factor employed intensively in this industry (land), while reducing the real reward paid to the other factor (labor): $pr_p/r > 1$ and $w_p < 0$, where the subscript denotes the partial derivative with respect to that variable.

Let $\bar{X}_J \equiv \sum_{i=1}^N X_J^i$ denote the country's aggregate output of $J = O, B$, and recall that $\bar{G} \equiv \sum_{i=1}^N G^i$ indicates the country's aggregate allocation to guns.[25] Then, given the quantities of labor and land resources allocated produce $\bar{G}$, factor-market clearing requires the residual quantities of labor and land, $\bar{L} - c_w^G$ and $\bar{T} - c_r^G \bar{G}$, be allocated to the production of consumption goods, $\bar{X}_J$ $J = B, O$, as follows:

$$c_w^O \bar{X}_O + c_w^B \bar{X}_B = \bar{L} - c_w^G \bar{G} \tag{A.4a}$$
$$c_r^O \bar{X}_O + c_r^B \bar{X}_B = \bar{T} - c_r^G \bar{G} \tag{A.4b}$$

[24] While consistent with the production structure specified in the main text, this assumption on factor intensities is not as restrictive and, moreover, is not important for the central result of the paper that trade openness can aggravate domestic conflict.

[25] As defined in the main text, X_O^i and X_B^i denote group i's output levels of oil and butter, respectively, contingent on the realization, $\tilde{T}^i$.

We will later refer to the ratio $\bar{l}_X \equiv \left(\bar{L} - c_w^G \bar{G}\right) / \left(\bar{T} - c_r^G \bar{G}\right)$ as the labor-land residual factor endowment ratio.

With the country's factor endowments, $\bar{L}$ and $\bar{T}$, the two conditions shown in (A.4) pin down the aggregate quantities of oil and butter that will be supplied by the country, $\bar{X}_O$ and $\bar{X}_B$, as functions of $\bar{G}$ and p. For our purposes, it suffices to solve these equations for the relative supply of oil function (measured in units of butter):

$$\rho(\bar{G}, p) \equiv \frac{p\bar{X}_O}{\bar{X}_B} = \frac{p\, c_r^B}{c_r^O} \frac{\left(l_B - \bar{l}_X\right)}{\left(\bar{l}_X - l_O\right)}. \tag{A.5}$$

Conflict's effect on the autarkic price operates partly through $\bar{G}$'s effect influence on this relative supply of oil. To evaluate this effect, first observe that an increase in aggregate guns, $\bar{G}$, given p, reduces the residual quantities of both labor and land available for the production of consumption goods. Nevertheless, we can pin down net effect of the increase in $\bar{G}$ on $\bar{l}_X$, as it depends on the difference between the labor-land factor endowment ratio, $l = \bar{L}/\bar{T}$, and the labor-land factor intensity ratio on the production of guns, $l_G = c_w^G / c_r^G$:

$$\frac{\partial \bar{l}_X}{\partial \bar{G}} = \frac{c_r^G (l - l_G)\bar{T}}{(\bar{T} - c_r^G \bar{G})^2} \quad \gtreqless 0 \;\text{ if }\; l \gtreqless l_G.$$

Whether positive or negative, the change in $\bar{l}_X$ then directly affects the relative supply of oil:

$$\frac{\partial \rho(\bar{G}, p)}{\partial \bar{l}_X} = -\frac{p\, c_r^B}{c_r^O} \frac{(l_B - l_O)}{(\bar{l}_X - l_O)^2} < 0,$$

where the inequality, consistent with the Rybczynski theorem, follows from the assumption that labor is employed intensively in the production of butter, $l_B > l_O$.[26] Combining these two effects, for given p, implies

$$\frac{\partial \rho(\bar{G}, p)}{\partial \bar{G}} = \frac{\partial \rho(\bar{G}, p)}{\partial \bar{l}_X} \frac{\partial \bar{l}_X}{\partial \bar{G}} \quad \lesseqgtr 0 \;\text{ if }\; l \gtreqless l_G. \tag{A.6}$$

If the labor-land factor endowment ratio is less than the labor-land factor intensity of guns production, $l < l_G$, an exogenous increase in $\bar{G}$ decreases disproportionately the residual amount of labor available for the production

[26] One can show more generally, with an application of the implicit function theorem to (A.4), that an increase in the quantity of land (labor) used to produce oil and butter leads to disproportionate increase in the output of the industry which uses the factor intensively, oil (butter), and a decrease in the output by the other industry, butter (oil).

of oil and butter; the resulting decline in $\bar{l}_X$ implies an increase in the relative supply of oil, measured in units of butter; otherwise, the effect is reversed.

Next, we derive the equilibrium condition for the relative price of oil under autarky. Let $R^i \equiv R(p, \widetilde{T}^i - c_r^G G^i, L^i - c_w^G G^i)$ denote group i's revenue or GDP function contingent on the realization of the outcome of contest for land, $\widetilde{T}^i$. As before, this function is the maximized value of the group's gross domestic product or, equivalently, the minimized value of the group's expenditures on land and labor in the production of oil and butter:

$$R^i = pX_O^i + X_B^i = r[\widetilde{T}^i - c_r^G G^i] + w[L^i - c_w^G G^i]. \tag{A.7}$$

It is well-known that $X_O^i = R_p^i$, $w = R_L^i$, and $r = R_T^i$, where the subscripts on R denote partial derivatives with respect to that variable [Dixit and Norman (1980)].[27]

Maintaining the linear homogeneous specification for the representative consumer's preferences, group i's indirect utility function can be written as $V^i = \mu(p)R^i$ where as previously defined $\mu(p)$ is the marginal utility of income, with $\mu' < 0$ and $\mu'' > 0$. From Roy's identity, group i's contingent demand function for oil is $D_O^i = \alpha(p)R^i/p$, where $\alpha(p) \equiv -p\mu'(p)/\mu(p) > 0$ is the expenditure share on oil.[28] It follows that group i's excess demand function for oil is $M^i \equiv D_O^i - X_O^i = \alpha(p)R^i/p - R_p^i$.

When there are no barriers to trade, the international price p is taken as given. The country as a whole can be either a net importer $\sum_{i=1}^N M^i \equiv \bar{M}(\bar{G}, p) > 0$ or a net exporter $\bar{M}(\bar{G}, p) < 0$. Under autarky, however, the country can be neither. But since domestic markets are fully integrated, the autarkic price, p_A, is the price, given the allocation of guns by all groups, that satisfies the condition, $\bar{M}(\bar{G}, p) = 0$. This condition implicitly defines the equilibrium price of oil, $p = p_A$, in units of butter, as a function of the country's aggregate endowments, given the aggregate allocation to guns, $\bar{G}$.

To derive that condition, define the country's aggregate revenue (or GDP) function as $\bar{R} = R(p, \bar{T} - c_r^G \bar{G}, \bar{L} - c_w^G \bar{G})$. One can verify that $\bar{R} \equiv \sum_{i=1}^N R_i$ and further that $\bar{R}_p = \sum_{i=1}^N R_p^i$ $(= \bar{X}_O)$. The condition

[27] Sharply pronounced asymmetries in the groups' contingent endowments can induce complete specialization in the production of oil or butter by some groups. Allowing for such specialization would require significant changes in the analysis. But, to keep focused on the issues at hand, we consider only the case of diversified production.

[28] With linear homogeneous preferences, group i's expenditure function $E^i(p, U^i) = e(p)U^i$ where U^i is utility and $e'(p) > 0$, $e''(p) < 0$ where primes denote derivatives. One can easily verify: (1) $\mu(p) \equiv 1/e(p)$; (2) $\alpha(p) \equiv -p\mu'(p)/\mu(p) = pe'/e(p) > 0$; (3) $p\alpha'(p)/\alpha(p) + \alpha(p) - 1 = pe''(p)/e'(p) < 0$.

for the autarkic price is then

$$\bar{M}(\bar{G},p)=\frac{\alpha(p)}{p}\bar{R}-\bar{R}_p=\frac{\bar{R}}{p}\left[\alpha(p)-\frac{p\bar{R}_p}{\bar{R}}\right]=0. \tag{A.8}$$

Note that $\frac{p\bar{R}_p}{\bar{R}}=\frac{\rho}{1+\rho}$, the fraction of the country's GDP that comes from oil production. This fraction can be written as a function of the country's relative supply of oil. By applying the implicit function theorem (A.8), we will be able to identify the effect of a change in $\bar{G}$ on the autarkic price, p_A:

$$\frac{\partial p_A}{\partial \bar{G}}=-\frac{\bar{M}_{\bar{G}}}{\bar{M}_p} \tag{A.9}$$

Tedious algebra shows that, $\bar{M}_p<0$, the condition for Walrasian stability, is satisfied.[29] Hence, the sign of (A.9) is given by that of $\bar{M}_{\bar{G}}$.

From (A.8), market-clearing requires $\alpha(p)-p\bar{R}_p/\bar{R}=0$. Using that requirement with the observation that $p\bar{R}_p/\bar{R}=\rho/(1+\rho)$, one can verify

$$\bar{M}_{\bar{G}}=-\frac{\bar{R}}{p(1+\rho)^2}\frac{\partial\rho(\bar{G},p)}{\partial\bar{G}}.$$

Accordingly, by our assumption that $l_B>l_O$, we can use (A.6) to find

$$\frac{\partial p_A}{\partial\bar{G}}\begin{matrix}\leqq\\ \geqq\end{matrix}0 \quad \text{if} \quad l\begin{matrix}\leqq\\ \geqq\end{matrix}l_G. \tag{A.10}$$

Thus, consistent with our finding in the main text, provided that butter is labor intensive $l_B>l_O$ and the labor-land factor intensity ratio in the production of guns exceeds the labor-land factor endowment ratio $l_G>l$, an exogenous increase in $\bar{G}$ implies an increase in p_A. It should also be clear by now that, as before, the autarkic price is independent of the outcome of the conflict. That is, p_A is not subject to uncertainty.

[29] One can use (A.8) to calculate:

$$\begin{aligned}\bar{M}_p &= \alpha'\frac{\bar{R}}{p}-\alpha\frac{\bar{R}}{p^2}+\alpha\frac{\bar{R}_p}{p}-\bar{R}_{pp}-\bar{R}_{pT}\left(c^G_{rw}w_p+c^G_{rr}r_p\right)\\ &\quad -\bar{R}_{pL}\left(c^G_{ww}w_p+c^G_{wr}r_p\right).\end{aligned}$$

Since $\bar{R}/p\neq 0$, market-clearing requires $\bar{R}_p=\alpha\bar{R}/p$. Algebraic manipulations and substitutions, with that requirement, show that the first three terms can be written as $\alpha\bar{R}[p\alpha'/\alpha-1+\alpha]/p^2$, which is negative since α, the expenditure share for oil, is less than 1 and decreasing in p [also see footnote 28]. Furthermore, the country's supply of oil is increasing in its price, $\bar{R}_{pp}>0$. Next, the linear homogeneity of the cost function for guns implies $c^G_{wr}=c^G_{rw}=-c^G_{ww}w/r=-c^G_{rr}r/w$. As such, one can simplify last two terms of the expression as $-wrc^G_{wr}\left(r_p/r-w_p/w\right)^2<0$. Since $c^G_{wr}>0$ and $r_p>0$, while $w_p<0$, this simplified term is similarly negative. Thus, $\bar{M}_p<0$

A.2.2 The effect of conflict on the pattern of trade

To this point we have derived the equilibrium relationship between the relative price under autarky and the aggregate quantity of guns. Nothing has been said, however, about the optimizing choice of guns under either trade regime.

To proceed, we can define group i's expected payoff, as $W^i = \mu(p)\widehat{R}^i$, where $\widehat{R}^i$ is given by (A.7) with $\tilde{T}^i$ replaced by $T^i + q^i T_0$. Focusing on identical groups, it is straightforward to show that the optimizing choice of guns by group i (either under autarky or free trade) requires

$$W^i_{G^i} \equiv \frac{W^i(G,p)}{\partial G^i} = \mu(p)\left[rT_0 q^i_{G^i} - c^G\right] = 0,$$

where r depends on p as shown in (A.3). Aggregating this condition across all groups i, using $q^i_{G^i} = (\bar{G} - G^i)/\bar{G}^2$, yields the following:

$$\sum_{i=1}^{N} W^i_{G^i} = \mu(p)\left[(N-1)T_0 r/\bar{G} - Nc^G\right] = 0 \tag{A.11}$$

It follows that $\bar{G}^* = T_0 \frac{N-1}{N}(c^G/r)^{-1}$. Since c^G depends on factors prices, which in turn depend on price p, this solution with the Stolper-Samuelson theorem can be used to obtain

$$\begin{aligned}\frac{\partial \bar{G}^*}{\partial p} &= -T_0 \frac{N-1}{N}(c^G/r)^{-2}\frac{\partial (c^G/r)}{\partial p} \\ &= T_0 \frac{N-1}{N}(c^G/r)^{-2}\left(\frac{pwc^G_w}{r}\right)\left(\frac{pr_p}{r} - \frac{pw_p}{w}\right) > 0.\end{aligned}$$

The inequality follows from our assumption that $l_B > l_O$, as it implies that $p\,r_p/r > 1$ and $w_p < 0$. Now note that (A.11) together with (A.8) determine p^*_A and $\bar{G}^*_A > 0$. (A.11) alone determines $\bar{G}^*_T > 0$. It should now be fairly clear how trade patterns where conflict is present compare with trade patterns in our hypothetical case.

(i). Suppose that $l < l_G$ for all $\bar{G} \in [0, \bar{G}^*_A]$, so that $p^*_A < p^n_A$. Then, for any world price $p \in (p^*_A, p^n_A)$ the country will import oil under "Nirvana" and export oil under conflict if it could trade freely in the world market.

(ii). Suppose that $l > l_G$ for all $\bar{G} \in [0, \bar{G}^*_A]$, so that $p^*_A > p^n_A$. Then, for any world price $p \in (p^n_A, p^*_A)$, the country will export oil under "Nirvana" but import oil under free trade with conflict.

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