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Workers, Warriors, and Criminals: Social Conflict in General Equilibrium

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Abstract

We analyze how economic shocks and policies affect the intensity of social conflict. We view conflict phenomena such as crime and civil war as involving resource appropriation activities. We show that not all shocks that could make society richer reduce conflict. Positive shocks to labor intensive industries diminish social conflict, while positive shocks to capital intensive industries increase it. The key requirement is that appropriation activities be more labor intensive than the economy. Our theory can explain the positive association between crime and inequality, and the curse of natural resources; it also offers guidance on how to integrate international trade policy with peace-keeping efforts. Including appropriation activities into a canonic general equilibrium model introduces a social constraint to policy analysis. This helps explain why reforms that appear efficiency-enhancing may be delayed and become unpopular when implemented, and why societies may sympathise with populist policies, apparently inefficient redistribution and "national development strategies."

JEL Classification: D72, D74, D78, F13, H23, K42, O1.

Keywords: conflict, civil war, crime, social constraint, populism, trade policy, inefficient redistribution.

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1 Introduction

One enduring aspect of social life is the conflict over the distribution of resources. The division of wealth among individuals is not solely determined by a price system operating on the basis of well defined, and perfectly enforced, property rights.[1] In reality, expropriatory efforts play an important role, and take various forms ranging from criminal activities to guerrilla groups that while motivated by ideology or ethnicity may also be fueled by the group's ability to appropriate resources.

Economics has historically analyzed phenomena like crime and revolts or civil wars separately.[2] But all these phenomena are symptoms of social conflict in the sense that they express individual and group pressures for the appropriation of resources. This paper incorporates social conflict seen as an appropriation-based phenomenon into two classic general equilibrium models for a small open economy (the Heckscher-Ohlin and the Ricardo-Viner setups). This allows us to study how economy-wide forces affect the extent of social conflict in the context of well known environments, as well as how economic policy prescriptions may be affected by the existence of conflict.

Both theoretical models and empirical evidence suggest that, all else equal, a lower opportunity cost in terms of wages in the labor market should increase the chance that an individual engages in activities such as rebellion or crime.[3] Yet real life shocks affecting the opportunity costs of conflict (e.g., wages) also tend to affect the returns to conflict and viceversa. Our theory provides an integrated view of how the costs and benefits to conflict activities move in response to economic shocks and policies. Thus, we can make predictions

[1] Even in highly developed countries property rights are not perfectly enforced. In the US for example, the total value of appropriated wealth in a year is beyond 5% of GDP and the total burden of crime is beyond 15% of GDP (Anderson 1999). In less develped countries social conflict can be more costly. During the typical year of a civil war, "the total income loss cumulates to around 60 percent of a year's GDP." (Collier et al. 2003).

[2] Classic references in the literature on crime are Becker (1968) and Ehrlich (1973). General equilibrium models of crime include Ehrlich (1981), Burdett et al. (2003) and Imrohoroğlu et al. (2000 and 2004). Various references to work on revolts are given below. Whether the fight for resources takes the form of atomistic criminals or large, politically organized factions will depend on many factors shaping what we could call the industrial organization of social conflict. In this paper we choose to abstract from all issues regarding the number and size of competing groups, as well as from strategic interactions, to focus on what we deem to be more basic aspects, such as the determinants of the relevant costs and benefits to the expropriatory efforts.

[3] There is evidence that a higher income per capita is associated with a lower likelihood of civil conflict (Collier and Hoeffler 1998, Elbadawi and Sambanis 2002, Fearon and Laitin 2003, Miguel, Satyanath and Sergenti 2004). MacCulloch (2001) finds that higher household income diminishes the propensity to express support for a revolt. Empirical studies on the relationship between wages and crime suggest that higher wages deter participation in criminal activities (see Grogger 1998, and Gould, Weinberg and Mustard 2002).

on how such shocks will affect social conflict and account for stylized facts of civil wars and crime. The model also helps explain the extensive use of apparently inefficient redistributive policies. In particular, this theory can explain how policy reforms that according to conventional wisdom should work well, may in fact be resisted and, when implemented, backfire.

Our general equilibrium model of a small open economy comprises two productive sectors and a third sector we call "appropriation." This last sector expropriates a fraction of what is produced in the two productive industries. Assuming that appropriation is labor intensive relative to the whole economy, we show that an exogenous increase in the price of the capital intensive good will cause the appropriation sector to expand. The reason is that an increase in the price of the capital intensive good will expand the capital intensive industry, and contract the labor intensive one which abundantly releases labor relative to capital. This lowers wages, resulting in a lower cost of the appropriation activity relative to the amount of appropriable resources. Technological progress, which makes society richer, has similar effects: neutral technical progress in the labor intensive sector will decrease conflict but progress in the capital intensive sector will increase it. We also show that the social backlash of appropriation activities can be so strong that shocks that would make a conflict-free economy richer will leave everybody worse off.

Using the Ricardo-Viner model where capital is industry-specific we can analyze situations where a natural resource is seen as an industry-specific capital for, say, an extractive industry. We show that increases in the endowment of such natural resource increases conflict, providing an explanation for the curse of natural resources, whereby a larger availability of a valuable resource increases conflict and may leave the entire economy worse off.

The theory explains empirical patterns in crime and civil wars such as, for example, the positive association between crime and inequality.[4] Our model can explain why reforms that increase income per capita may be associated with increasing crime and inequality, as were the sweeping market-friendly reforms introduced in Argentina in the 1990s.[5] Capital and labor in our model can be interpreted to represent differently skilled labor forces. Any favorable shock to the skilled labor intensive sector will increase the wage gap across skill

[4] Fajnzylber, Lederman and Loayza (2002) document this connection across countries. There is also evidence that income inequality increases individual propensity to express support for a revolution (see MacCulloch 2001).

[5] In the years following 1991 significant increases in income per capita, inequality, and crime took place in Argentina. GDP per capita increased by 40% between 1991 and 1998. The Gini coefficient went from 44.7 to 49.5 between 1992 and 1998 (this is a large change, equivalent to roughly one standard deviation in the distribution of coefficients for Latin America–see De Ferranti et al. 2003). The wage gap across skill levels also went up during the nineties (see Galiani and Sanguinetti 2003). Between 1991 and 1998, together with increasing GDP per capita and inequality, crimes against property increased by roughly 71%.

levels and will increase conflict wherever appropriation is relatively intensive in unskilled labor.

Our theory can also explain the paradoxical fact that conflict can be triggered both by income-diminishing circumstances, such as droughts, and income-augmenting ones, such as a higher availability of natural resources.[6] The explanation is that the effect of a shock depends not just on whether it raises income, but also on how it affects the relative scarcity of labor. This in turn depends on the relative use of factors in the sector initially affected by the shock.

Regarding the analysis of policies when there is conflict, we find that policies that protect labor decrease conflict. Subsidies to productive labor, departures from free trade such as the protection of labor intensive industries and subsidies to technical progress in labor intensive industries reduce conflict. This reduction can be so important so as to make both workers and capitalists better off. Thus, some forms of populism can be accounted for as rational responses to environments with social conflict.[7] These results may help rationalize the political support often enjoyed by policies that protect labor intensive industries and resonate with proposals by development theorists aligned with the Latin American structuralism (see for example Prebisch 1959, on how national development strategies could use selective interventions). Note that our model does not justify every possible state intervention. It rather isolates a benefit some interventions may have: they buy social peace. This suggests that different stances on state intervention across countries may reflect different approaches to maintaining social order.[8]

The fact that a "social constraint" could be relevant to policy analysis provides a novel angle on the political economy of reform. First, politicians may delay reforms because they fear the social backlash, and they only adopt them when the pressure from the media, the markets, and the international community becomes too strong.[9] Second, the identification of a social constraint informs the ongoing discussion about the performance of market-friendly reforms in emerging countries. Even when deregulation, privatization, and trade opening have the potential to promote various gains, their bringing along social costs could undermine their overall effect. This may in turn erode support both for the reforms and the reformers.[10]

[6] For evidence on the former see the references in footnote 3, and on the latter see Collier and Hoeffler (1998) and Ross (2003).

[7] See Coate and Morris (1995) and Dixit and Londregan (1995) for different explanations of inefficient redistribution mechanisms.

[8] The degree of state intervention varies widely across countries both in terms of the regulation of business (see Shleifer 2004 and references therein) and welfare institutions (see Lindert 2004). See also Di Tella and MacCulloch (2003) for a study of popular preferences on state intervention.

[9] For an account of such pressure in connection with reforms in Latin America, see Corrales (2002) and for explanations of delayed reforms, see Alesina and Drazen (1991), and Fernandez and Rodrik (1991).

[10] See Lora and Olivera (2004) for evidence compatible with the idea that market-friendly reforms have

The policy applications of the model are germane to the international efforts to stop violent conflict in the third world. Peace efforts may need to be coordinated with international trade agreements. Otherwise, the trade policies chosen by industrial powers may undermine their peace efforts abroad. To the best of our knowledge, our model provides the first framework with which to analyze the integration of policies toward peace and international trade.

Our approach abstracts from several factors that may affect conflict. Examples are income effects, unemployment, capital accumulation[11], and additional connections between natural resources and conflict.[12] Another example is the possibility of cooperation in repeated game settings where coercion is possible–see Garfinkel (1990), Powell (1993), and Acemoglu and Robinson (2001).[13] Skaperdas and Syropoulos (1996) study the incentives of countries to arm themselves and dispute a resource in the face of posterior opportunities for exchange. In a recent paper, Garfinkel, Skaperdas and Syropoulos (2004) analyze the effects of trade opening when factions can arm themselves to dispute a resource stock. The key element in the last two papers is the price of a contested stock relative to that of a produced good. In our theory goods' relative prices matter directly (through their impact on the value of disputable wealth), but also indirectly through their impact on the relative value of different production factors.

Our model can be applied to the phenomenon of rent-seeking. In particular, our appropriation sector could be thought to capture rent-seeking efforts under exogenous tariffs (see also Krueger 1974, and Bhagwati and Srinivasan 1980).[14] Besides differences in focus and modeling choices, our theory differs significantly from other rent-seeking accounts. Our model produces comparative statics that are driven by the relative use of factors across industries.

The plan for the paper is as follows. Section 2 presents the model. Section 3 characterizes

grown unpopular in Latin America, causing electoral costs to reformers.

[11]For conflict in growth models see Benhabib and Rustichini (1996) and González (2005). See Tornell and Velasco (1992) for a model of growth in an economy with weak institutions and international capital mobility.

[12]Extractive activities, for example, tend to be associated with monopolic rents. These in turn are associated with higher corruption, and the latter can be expected to damage the quality of institutions and economic performance. The end result may well be higher conflict. For the connection between rents and corruption see Ades and Di Tella (1999), and for the role of institutions see Acemoglu, Johnson and Robinson (2001). See also Tornell and Velasco (1992), Tornell and Lane (1996), and Torvik (2002) on resource abundance and rent seeking. Ross (2003) lists various connections between natural resources and conflict.

[13]See Grossman (1991), Skaperdas (1992), Hirshleifer (1995), Grossman and Kim (1995) and Esteban and Ray (1999) for other models where parties can attack each other.

[14]On the more removed case of endogenous tariffs, see Findlay and Wellisz (1982), and Magee, Brock and Young (1989).

the equilibrium after proving its existence. Then a comparison is made with the equilibrium in a conflict-free society. Section 4 studies how economic shocks affect the extent of social conflict. Section 5 discusses policy-making under the social constraint imposed by appropriation activities. Section 6 extends the basic model to the case of industry-specific factors. Section 7 concludes.

2 The model

Consider an economy comprising two productive sectors along the lines of the canonical 2x2 international economics model.[15] The productive sectors involve many firms which maximize profits and use technologies characterized by constant returns to scale. The two productive sectors or industries are labeled 1 and 2, and they use two inputs which we call capital and labor, respectively labeled K and L. Factors can move freely across industries. All firms in each industry share the same production function with the property that industry 1 is more capital intensive than industry 2. We denote with r and w the respective rental prices of capital and labor. The given primitives of the model are: the factor endowments, available in fixed amounts $\overline{K}$ and $\overline{L}$; the technologies; and the prices of output, which are internationally determined and are labeled p_1 for industry 1, and $p_2 = 1$ for industry 2. (Good 2 is the numeraire.)

In addition to the productive sectors, there exists an appropriation sector. This sector only uses labor (L_A) and produces a redistribution of output from the productive industries towards the appropriation sector.[16] The technology of appropriation is summarized by the continuous and concave function $A(L_A)$, with $A(0) \geq 0$ and $A\left(\overline{L}\right) \leq 1$. The function $A(L_A)$ specifies the fraction of the total production value that is appropriated when L_A units of labor are devoted to expropriatory activities. The concavity assumption reflects congestion effects in appropriation. Given production levels q_1 and q_2 in the two industries, and L_A units of labor devoted to appropriation, the amount appropriated is $A(L_A)[p_1 q_1 + q_2]$. Given that under constant returns to scale payments to factors exhaust the value of production, the appropriated amount can be written as $A(L_A)\left[r\overline{K} + w(\overline{L} - L_A)\right]$. For simplicity of exposition we assume that appropriators target factor owners and steal a fraction of their returns. But, as we discuss later, the equilibrium conditions and the results do not change if we assume instead that a fraction of their endowments is stolen or that appropriators

[15] See Stolper and Samuelson (1941) and Jones (1965).

[16] The extreme assumption that the appropriation sector uses no capital is made for simplicity only. The necessary and sufficient condition for our results to emerge is that the appropriation sector be more labor intensive than the overall economy. This allows for appropriation being less labor intensive than the labor intensive industry. See the appendix for a demonstration.

target the output or revenues of firms. In any case, r and w represent the gross (before appropriation) rental prices of capital and labor in the productive sectors.

Workers decide whether to enter the productive sectors or the appropriation sector. A worker in the latter earns $\frac{A(L_A)}{L_A}\left[r\overline{K} + w(\overline{L} - L_A)\right]$. We assume that each worker is infinitesimally small and that there is free entry into the appropriation sector. Therefore, the amount of labor in this sector is determined by the equality of the return to appropriation and the opportunity cost to appropriation (the net wage in a productive industry).[17]

An important clarification is due: our model abstracts from all loses that expropriatory activities may cause by way of destruction of life and property. Incorporating those is straightforward and would not affect our results.

3 The equilibrium

In this section we characterize conditions for existence of an equilibrium with appropriation in our economy. We then describe this equilibrium and compare it to that in an economy where social conflict is absent.

For most of the analysis it is useful to define the minimum unit-cost requirements of inputs in each industry: a_{ij} is the amount of input j used to produce one unit of output i at minimum cost (given r and w).

As is standard, we focus on equilibria without productive specialization (i.e. both q_1 and q_2 are positive). Given the technology, output prices (p_1) and factor endowments ($\overline{K}$ and $\overline{L}$), the equilibrium of the model determines the rental price of factors (r and w), the output production levels (q_1 and q_2), and the utilization of factors in each sector (K_1, K_2, L_1, L_2 and L_A).

Three sets of conditions must be satisfied in a competitive equilibrium. First, firms in the productive industries must earn zero profits:

$$ra_{1K} + wa_{1L} = p_1 \quad (1)$$

$$ra_{2K} + wa_{2L} = 1. \quad (2)$$

Second, the market for factors must clear:

$$q_1 a_{1K} + q_2 a_{2K} = \overline{K} \quad (3)$$

$$q_1 a_{1L} + q_2 a_{2L} = \overline{L} - L_A. \quad (4)$$

[17] For a derivation of this equilibrium condition for the similar problem of exploitation of a common resource see Dasgupta and Heal (1979).

Third, a no arbitrage condition must hold, in the sense that labor must obtain similar returns when engaging in appropriation as when it is employed by the productive industries:

$$\frac{A\left(L_A\right)}{L_A}\left[r\overline{K}+w(\overline{L}-L_A)\right]=[1-A\left(L_A\right)]w. \tag{5}$$

This last condition merely says that the individual payoff from appropriation in the left hand side of equation (5),the value of appropriated goods per unit of labor deployed to expropriation, must equal the returns from work net of appropriation losses in the right hand side. This expression is straightforward in the case that appropriation targets factor owners, but also applies to any of the other interpretations given before.[18] This formulation captures a competitive situation where workers can individually deploy their efforts in the appropriation sector. Similar results are obtained in the case where appropriation is not characterized by competition but rather by monopoly.[19]

3.1 Existence

Proposition 1 *If there exists an equilibrium without specialization for the economy without appropriation, $A(\overline{L})$ is sufficiently small and $A'(0)$ is sufficiently large, then in the economy with appropriation there is an equilibrium with positive levels of conflict.*

Proof. Note that L_A does not appear in equations (1) and (2). Thus, the existence of an appropriation sector does not affect the gross rental price of factors unless it results in specialization. The condition for no specialization in an economy without appropriation is $\frac{a_{2K}}{a_{2L}}<\frac{\overline{K}}{\overline{L}}<\frac{a_{1K}}{a_{1L}}$, while that in the economy with appropriation is $\frac{a_{2K}}{a_{2L}}<\frac{\overline{K}}{\overline{L}-L_A}<\frac{a_{1K}}{a_{1L}}$. In other words, the amount of L_A that solves equation (5) should be small enough (say L_A is below some level we label $\widehat{L}$). Simplifying equation (5) we have that $A\left(L_A\right)=\frac{w}{r\overline{K}+w\overline{L}}L_A$. If $A\left(0\right)=0$ and $A'\left(0\right)>\frac{w}{r\overline{K}+w\overline{L}}$ there is an equilibrium with positive L_A determined by

[18] In the case when it is the output of firms that is targeted, the value of production available for repaying factors will be affected by the same coefficient in both sectors. The reader might wonder whether the existence of appropriation should affect the first two equations in the system, which appear exactly as in the canonic model without appropriation. Firms would obtain net prices affected by a factor $1-A(.)$ in the right hand side, and we would get net equilibrium factor prices $\hat{w},\hat{r}$. Now note that the unitary input requirement coefficients are homogeneous of degree zero in factor prices. Then, because the system (1)-(2) has a unique solution, we must have $\hat{w}=(1-A)w$ and $\hat{r}=(1-A)r$. All factors $1-A$ disappear, and we are left with the same first pair of equations.

[19] In this case we could think that the appropriation monopolist hires labor and must pay each unit the equivalent to the (net of appropriation) wage they can earn in the productive industries $[1-A\left(L_A\right)]w$. The revenues for the monopolist are $A\left(L_A\right)\left[r\overline{K}+w(\overline{L}-L_A)\right]$, so he will choose L_A to maximize profits, yielding an analog to equation (5): $A'\left(L_A\right)\left(r\overline{K}+w\overline{L}\right)=w$. The resulting model yields identical comparative statics results to those we show in this paper.

the intersection of $A(L_A)$ with $\frac{w}{r\overline{K}+w\overline{L}}L_A$. If $A(0) > 0$ equilibrium is unique and L_A is positive. If $A(\overline{L})$ is sufficiently small the interior solution satisfies $L_A < \widehat{L}$, given that $A(L_A)$ is increasing, and the economy does not specialize. ■

In the remainder of the paper we restrict attention to economies with an active appropriation sector.

3.2 Comparison of economies with and without conflict

The economies with and without an appropriation sector can be easily compared. In the case of no specialization that we focus on, the existence of an appropriation sector does not affect the absolute gross rental prices of factors. These are solely determined by the characteristics of productive technologies, and the amount of labor engaging in appropriation is residually determined in equations (3) to (5) so that the market for factors will clear and no one will gain by reallocating labor units across activities.

The presence of appropriation activities, however, does affect the rental prices net of appropriation that factor owners actually receive. In fact, the existence of an appropriation sector hurts all agents, including those who go into the appropriation sector.

Proposition 2 *The existence of the appropriation sector makes the owners of capital and labor worse off.*

Proof. If there is no specialization, the rental price of factors are the values of r and w that solve equations (1) and (2). Then, total incomes to capital and labor without an appropriation sector are $r\overline{K}$ and $w\overline{L}$, respectively. With appropriation without specialization, the gross rental prices of factors do not change but the net rental prices are respectively $(1 - A(L_A))\, r$ and $(1 - A(L_A))\, w$. Therefore, total incomes to capital and labor with an appropriation sector are $(1 - A(L_A))\, r\overline{K}$ and $(1 - A(L_A))\, w\overline{L}$, respectively. ■

The possibility that workers may become criminals or warriors poses a paradox, in that they will end up worse off than if they could commit not to leave productive activities. The reason is that workers in the appropriation sector impose a negative externality on the rest of the economy.[20]

In addition, appropriation affects the relative importance of the productive sectors in the economy.

[20] Of course, with productive specialization, the existence of an appropriation sector would result in an increase in the wages paid by firms. If this increase is greater than the "appropriation tax", workers would be better-off with the existence of the appropriation sector.

Proposition 3 *The existence of the appropriation sector increases the production of the capital intensive good and reduces the production of the labor intensive good.*

Proof. If there is no specialization, the rental price of factors are the values of r and w that solve equations (1) and (2). These determine the values of a_{1K}, a_{2K}, a_{1L} and a_{2L} in equations (3) and (4). Given the amount of factors available for production ($\overline{K}$ and $\overline{L} - L_A$) these equations determine the levels of production in the two productive industries. It can be easily shown that:

$$\begin{aligned} q_1 &= \frac{a_{2L}\overline{K} - a_{2K}\left(\overline{L} - L_A\right)}{a_{1K}a_{2L} - a_{1L}a_{2K}} \\ q_2 &= \frac{a_{1K}\left(\overline{L} - L_A\right) - a_{1L}\overline{K}}{a_{1K}a_{2L} - a_{1L}a_{2K}}, \end{aligned}$$

so increments in L_A must increase q_1 and reduce q_2 when $\frac{a_{2K}}{a_{2L}} < \frac{a_{1K}}{a_{1L}}$. ■

This proposition is an application of Rybczynski's (1955) theorem, and it tells us that the presence of conflict enlarges the capital intensive sector. This has implications for the empirical study of the connection between conflict and natural resources. In countries where extractive industries are relatively capital intensive, they could account for a larger share of economic activity as a consequence–and not a cause–of conflict. As will be shown below, our theory also predicts a causality effect going in the opposite direction: shocks that favor and enlarge extractive, capital intensive activities will increase conflict. This two-way causation poses a challenge to empirical work trying to estimate the impact of natural resource availability on conflict.

4 Shocks and the intensity of social conflict

We study now how changes in the parameters of the model affect the level of conflict. We first study changes in output prices.

4.1 Changes in the terms of trade

Changes in the price of commodities affect the rental price of factors. In an economy with an appropriation sector, this effect is the same as in an economy without an appropriation sector.

Lemma 1 *(Stolper and Samuelson) An increase of the price of the capital intensive output results in an increase in the rental price of capital and a decrease in the rental price of labor* $\left(\frac{dr}{dp_1} > 0 \text{ and } \frac{dw}{dp_1} < 0\right)$.

Proof. Differentiating equations 1 and 2 and using the envelope theorem it is straightforward to show that: $\frac{dr}{dp_1} = \frac{a_{2L}}{a_{1K}a_{2L} - a_{1L}a_{2K}} > 0$, $\frac{dw}{dp_1} = \frac{-a_{2K}}{a_{1K}a_{2L} - a_{1L}a_{2K}} < 0$. ■

This fundamental result of international economics is key to two of the central results of this paper, captured in propositions 4 and 5.

Proposition 4 *An increase in the price of the capital intensive output results in an increase in conflict* $\left(\frac{dL_A}{dp_1} \geq 0\right)$.

Proof. The equilibrium condition for the appropriation sector can be written as $A(L_A) = \frac{1}{\frac{r}{w}\overline{K} + \overline{L}} L_A$. The conditions for the implicit function theorem are satisfied, so we can write L_A as a function of p_1. Differentiating the previous equality with respect to p_1 we obtain: $\frac{dL_A}{dp_1} = -\frac{\frac{\overline{K} L_A}{(\frac{r}{w}\overline{K} + \overline{L})^2} \frac{d(\frac{r}{w})}{dp_1}}{[A' - \frac{1}{\frac{r}{w}\overline{K} + \overline{L}}]}$.

The denominator is negative from the concavity of $A(L_A)$ and the equilibrium condition in the appropriation sector. Then, $\frac{dL_A}{dp_1}$ has the sign of $\frac{d(\frac{r}{w})}{dp_1}$, which is positive by Lemma 1 (Stolper-Samuelson). ■

The intuition for this result is as follows. In our model the level of conflict responds to a balance between the opportunity cost of expropriatory activities and the value of potentially appropriable resources (as captured in the right and left hand sides of equation (5), respectively). An increase in the price of the capital intensive good expands the capital intensive sector while the labor intensive sector contracts. The latter sector releases more labor per unit of capital than the former sector can absorb at the initial factor prices. This availability of labor lowers wages and with them the opportunity cost of the appropriation activity compared with the size of disputable wealth. The result is more conflict. The way this result arises from the model can be easily explained by means of Figure 1. A little manipulation of equation (5) shows that the amount of labor in the appropriation sector is determined by the intersection of the concave function $A(L_A)$ with the linear function $\frac{1}{\frac{r}{w}\overline{K} + \overline{L}} L_A$. By Lemma 1, an increase of p_1 results in an increase of r and a decrease of w. This, in turn, leads to a decrease in the slope of the linear function, resulting in an increase in L_A.

4.2 Changes in Technology

Technical progress unambiguously increases society's ability to create wealth. However, there are instances in which technical change will increase conflict. In what follows we call technical progress in an industry neutral if it does not affect the industry's ratio of marginal productivities given its capital to labor ratio- see Hicks (1932).

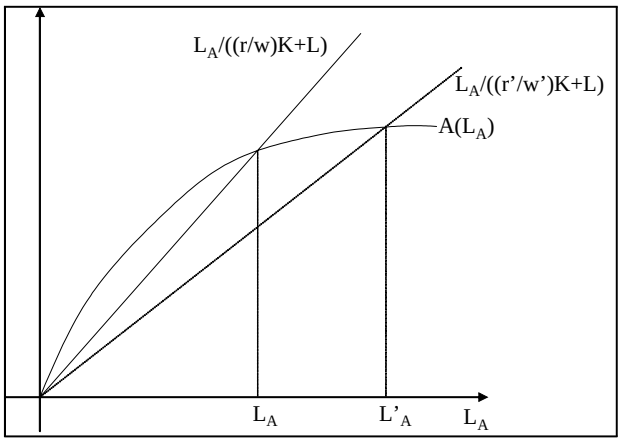

Figure 1: Prices and conflict

Proposition 5 *Neutral technical progress in the capital intensive sector results in an increase in conflict.*

Proof. Consider a neutral technical innovation that makes the capital intensive sector $1+\theta$ times more productive ($\theta > 0$). This implies that the zero profit condition in that sector can now be written as: $ra_{1K} + wa_{1L} = (1+\theta)\, p_1$. Therefore, technological progress in the capital intensive sector has the same effect on r and w as an increase of the price of the capital intensive good. The result then follows from Proposition 4. ■

Analogously, neutral technical progress in the labor intensive sector results in a decrease in social conflict. Note that the result that technical change will increase conflict does not rely on such change being of a labor-saving kind, which would of course yield the result more easily. Innovations can lead to more conflict even when being factor-neutral.

4.3 The enforcement of the law and the effect of shocks

Until now we have implicitly assumed that the amount of resources allocated to enforce property rights is given and does not react to economic shocks. We now study the possibility that the government may choose the amount of resources devoted to enforcing property rights, with the goal of minimizing the overall mass of resources that are driven away from production.

Assume that the fraction of production appropriated depends on both the amounts of labor devoted to the appropriation sector (L_A) and to an enforcement sector (L_E). The technology of appropriation is summarized by the function $A(L_A, L_E)$, which is increasing and concave in L_A and decreasing in L_E. The overall burden of conflict is then given by the

addition of criminals and enforcers, as they are all detracted from the labor force. Here we show that our previous results capture the behavior of the overall burden of conflict.

We assume that agents decide whether to join a productive industry or the appropriation sector given the level of enforcement the government has chosen. This means the government chooses the socially optimal level of enforcement given the parameters of the model, knowing that the amount of labor in the appropriation sector will depend on the level of enforcement. In other words, the government chooses L_E to minimize the total amount of labor allocated to non-productive activities $(L_A + L_E)$ where L_A depends on L_E. After this, workers make career decisions and production takes place. We assume that the government obtains the enforcement labor by either a draft, or by equally taxing capital and labor and devoting the revenues to pay public wages that enforcement agents will find attractive. Either assumption implies that equations (1) to (3) remain unaltered. The right hand side of equation (4) now reads $\overline{L} - L_A - L_E$, and equation (5) becomes $\frac{A(L_A,L_E)}{L_A}\left[r\overline{K} + w(\overline{L} - L_A - L_E)\right] = [1 - A(L_A, L_E)]w$. Whenever an interior solution for the government problem exists (conditions which we can characterize), the following holds:

Proposition 6 *Positive shocks to the capital intensive sector in terms of price and technology result in an increase in the burden of conflict.*

Proof. The equilibrium condition for the appropriation sector can be written as $A(L_A, L_E) = \frac{1}{\frac{r}{w}\overline{K}+\overline{L}-L_E}L_A$. Hence, in equilibrium L_A will depend on L_E. The first order condition of the government problem is $\frac{dL_A}{dL_E} + 1 = 0$. Since both an increase in p_1 and a neutral technology improvement of the capital intensive sector results in a greater $\frac{r}{w}$, we need to study the sign of $\frac{d(L_A+L_E)}{d\frac{r}{w}}$. Differentiating we obtain: $\frac{d(L_A+L_E)}{d\frac{r}{w}} = \frac{\partial L_A}{\partial L_E}\frac{dL_E}{d\frac{r}{w}} + \frac{\partial L_A}{\partial \frac{r}{w}} + \frac{dL_E}{d\frac{r}{w}}$. By the government's first order condition we have that $\frac{d(L_A+L_E)}{d\frac{r}{w}} = \frac{\partial L_A}{\partial \frac{r}{w}}$. It is straightforward to show that $\frac{\partial L_A}{\partial \frac{r}{w}}$ is positive. ■

5 Policy analysis with a social constraint

In this section we study how the existence of conflict introduces a "social constraint" to policy analysis. We first examine how subsidies to workers in the productive sectors, financed with taxes to capitalists, can reduce the level of social conflict and enlarge the total value of production in the economy. We analyze next the policy implications of our proposition that technical progress in the capital intensive industry will increase conflict. We show that this increase in conflict can be as large as to make everybody worse off, so policies affecting the adoption of technical innovations might be justified. Finally, we examine a rationale for trade policy intervention, both from a domestic and an international perspective. The

results of this section help explain how certain policy reforms that appear Pareto-improving in a frictionless model may be rendered inefficient by the social backlash to policy in a conflictive world. Once the social constraint is incorporated to policy analysis, policies that seem distortionary may instead be Pareto-improving. This is of course an instance of the theorem of the second best: in the presence of a distortion, another distortion may improve matters (see Lipsey and Lancaster 1956). In our model, the original distortion is given by the presence of expropriatory activities. The policies rationalized in this section fit the populist stereotype. The results in this section suggest that such policies could emerge, to certain degree, as a rational response to conflict, rather than as the result of clientelism, corruption, or a sheer taste for redistribution.

5.1 Taxes and social conflict

Consider a tax-subsidy scheme such that workers in the productive sectors receive a subsidy equal to a fraction s of the wage firms pay to them. To fund these subsidies, capitalists pay a tax equal to a proportion t of the rent to capital. Given taxes t and subsidies s, the equilibrium condition for the appropriation sector becomes:

$$\frac{A\left(L_A\right)}{L_A}\left[r\overline{K}+w(\overline{L}-L_A)\right]=\left(1-A\left(L_A\right)\right)\left(1+s\right)w. \tag{6}$$

In addition we ask that the government keep a balanced budget:

$$sw(\overline{L}-L_A)=tr\overline{K}. \tag{7}$$

The model is completed with equations (1) to (4).

Proposition 7 *Giving a subsidy to productive labor reduces the level of conflict* $\left(\frac{dL_A}{ds}\rfloor_{s=0}<0\right)$.

Proof. The equilibrium condition for the appropriation sector can be written as $A\left(L_A\right)=\frac{wL_A+(1-A(L_A))swL_A}{r\overline{K}+w\overline{L}}$. Differentiating this condition with respect to s, and evaluating the expression at $s=0$, we obtain: $\frac{dL_A}{ds}\left(s=0\right)=\frac{(1-A(L_A))wL_A}{A'(L_A)\left(r\overline{K}+w\overline{L}\right)-w}$. The denominator is negative from the concavity of $A\left(L_A\right)$ and the equilibrium condition in the appropriation sector without subsidies. Then, $\frac{dL_A}{ds}\left(s=0\right)<0$. ■

The intuition for this result is direct. Subsidizing productive labor increases the opportunity costs of engaging in appropriation, thus reducing the latter. A subsidy to productive labor results in a shift of labor away from appropriation activities and towards the productive sectors of the economy. Therefore, the tax-subsidy scheme has a positive effect on the total amount of output in an economy with an appropriation sector, providing an efficiency

rationale for a set of policies that are usually considered solely redistributive. If lump sum taxes and transfers were possible, then our tax-subsidy scheme would be Pareto optimal, because the total value of production could be increased while making sure capitalists are being left at least as happy as before paying any taxes. When dealing with the issue of social conflict, however, it may not be appropriate to assume that all transfers among agents are possible. For example, it might be impossible to tax the agents in the appropriation sector.

If we restrict ourselves to the case in which the government can only tax and subsidize agents in the productive sectors, the issue of the Pareto optimality of subsidies to productive labor becomes more complicated. We must study the effects of this policy in the net wages and rental price of capital. It is straightforward to see that a subsidy to productive labor always makes workers in the productive industries better off. The subsidy has two effects, 1) it has a direct positive effect in the gross total wage, and, 2) it reduces the appropriation sector and hence the expropriation suffered by workers. Both effects go in the same direction, increasing the net income of workers. Those in the appropriation sector must also be better off given that in equilibrium they are indifferent regarding their career decisions. In the case of owners of capital, the two effects go in opposite directions: under the tax-subsidy scheme, 1) they pay a tax, but 2) the "appropriation tax" diminishes. If the second effect overcomes the first, we have that the proposed scheme makes both workers and capitalists better off. We now show by example that there are economies where the tax-subsidy scheme proposed above is Pareto-improving.

Example 1 *Taxes, subsidies, and social conflict in a Cobb-Douglas economy:*

Consider an economy with production functions $q_1 = K_1^{\frac{2}{3}} L_1^{\frac{1}{3}}$ *for the capital intensive sector, and* $q_2 = K_2^{\frac{1}{3}} L_2^{\frac{2}{3}}$ *for the labor intensive sector. Let us set the total endowments of the two factors of production at levels* $\overline{K} = \overline{L} = 100$*. In this example we characterize the equilibrium both for the case without an appropriation sector* ($L_A = 0$) *and the case in which there is an appropriation sector with the following technology:* $A(L_A) = \frac{L_A}{150+L_A}$*. In the latter case we consider both the situation with no intervention* ($s = t = 0$) *and a situation with state intervention through a tax-subsidy scheme. In this case, we consider a subsidy to productive labor of 10%* ($s = 0.1$)*, which is funded through a tax on capital. The public budget is balanced in equilibrium.*

Figure 2 shows the output combinations that can be obtained in equilibrium for the three cases. The graph coincides with the production possibility frontier for the economy without an appropriation sector (given the Pareto optimality of equilibria). That is not the case under social conflict, where the set of production pairs that can be obtained is to the south-west of the pairs for the economy without social conflict. The existence of social conflict introduces a wedge between what it is technically feasible and what can be obtained in equilibrium.

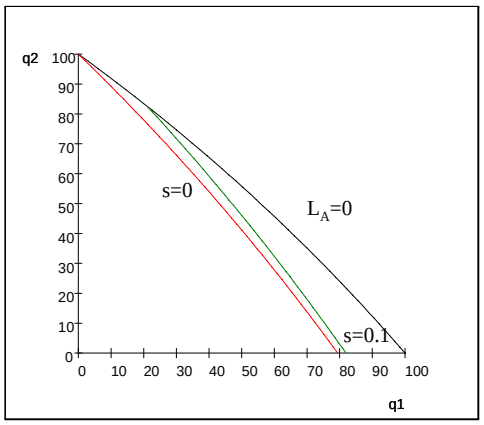

Figure 2: Equilibrium output pairs

Interestingly, a subsidy to productive labor moves the set of production pairs under conflict toward the ones without conflict. In fact, the subsidy allows for the total elimination of conflict in some cases, making both graphs coincide in the left upper part of the figure (when p_1 *is relatively small). While subsidies to productive labor make all workers better off, that is not necessarily the case with owners of capital. Figure 3 in the next page shows the net*

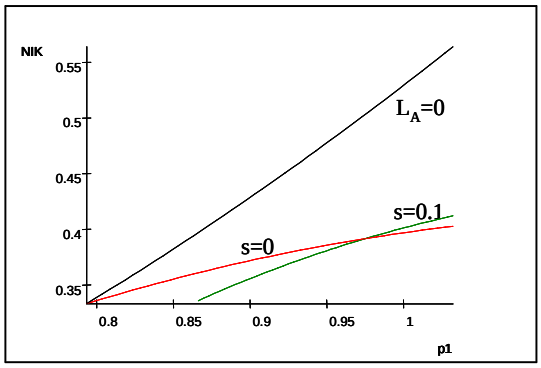

Figure 3: Net income of capital

income of capital (net of government taxes and appropriation losses, labeled with "NIK") as a function of p_1 *for the three different scenarios (*L_A*=0, s=0, s=0.1). The figure shows that social conflict results in a lower income for capitalists. For relatively high levels of* p_1*, and given the existence of the appropriation sector, capitalists are better off with a subsidy to productive labor (and a tax to capital) than without it.*

It should be noted that even when it is possible to redistribute resources through lump sum transfers, the optimal intervention pattern will have to be distorsive, because it is

necessary to increase the incentive to work, and decrease the incentive to loot. There is a literature in economics seeking to explain why income redistribution adopts inefficient forms. Explanations have been linked to asymmetric information or commitment problems (Coate and Morris 1995, Dixit and Londregan 1995). In our model, the apparently inefficient instruments may be in fact efficient, while distortion-free instruments will not achieve the goal of reducing conflict.

5.2 Trade policy intervention and social conflict

Domestic trade policy in the small economy

Here we explain how trade policy intervention in the small open economy can reduce social conflict, and how this intervention can be Pareto-improving. Imagine a country that is a net importer of goods produced in its labor intensive industry, and is a net exporter of goods produced in its capital intensive industry. Our Proposition 4 indicates that social conflict can be diminished through a raise in the price of the labor intensive good and a decrease in the price of the capital intensive good. Therefore, if the government desires to attain a reduction in conflict, it might consider imposing a tariff on imports. This protection will increase the price that domestic producers in the labor intensive sector can obtain for their goods, causing the expansion of the sector, an increase in wages, and a drop in social conflict. This drop could be large enough for both capitalist and workers to benefit from the protection of the labor intensive industry. A reduction in social conflict can also be attained by taxing the exports of the capital intensive sector. In the converse case that the country is a net exporter of labor intensive goods, and a net importer of capital intensive goods, a government that wishes to diminish conflict would impose subsidies on both the labor intensive exports and the capital intensive imports.

International trade policy and social conflict

In recent years the world has seen significant international policy efforts at preventing, controlling, and ending armed conflict. The peace-keeping branch of the UN, for example, carries initiatives in a large number of countries. Some of these–notably some countries in Africa–have been involved both in interstate and civil conflicts where appropriation is widely known to play an important role.[21]

[21] The pervasive presence of appropriation of goods and even human beings in the context of Africa's civil wars is well documented. Mentions to looting and banditry in official documents are ubiquitous. An example is provided by the UN Secretary-General's report S/1997/80, on 26 January 1997 (available at <http://www.un.org/Depts/dpko/unamsil/UnamsilR.htm>). Therein the Secretary-General stated how thousands of village hunters were being recruited to defend villages *"against looting from both the RUF and*

On the other hand, Western democracies and the global community as represented by the UN pursue development efforts in the Third World, which include a trade-related dimension. Organizations such as the UN's Conference on Trade and Development (UNCTAD) and the United Kingdom's Direction for International Development (DFID) are spearheads to various initiatives that seek to help developing countries increase their exports to richer nations. However, the policies discussed in the context of trade and development strategies are never linked to the initiatives that the same set of actors pursue regarding peace-keeping. Our model suggests that they should be connected, and how.

To see this, suppose we view access to first world markets for, say, processed agricultural products, as an improvement in the price for processed agricultural goods produced in a Subsaharan economy. Now note those goods are relatively labor intensive in the latter economies. Then our model predicts that better access to European markets for those goods would cause the labor intensive sector in Subsaharan economies to expand. This would make labor relatively scarcer, raising wages and diminishing conflict in Subsaharan Africa. Unfortunately, less developed countries face significant barriers to the markets in developed countries. Moreover, these barriers (tariff barriers especially) are biased against less technology intensive exports (see Meller 2003).

It follows from our model that when the possibility of lower protection to first world agriculture is discussed within the World Trade Organization, its benefits in terms of lower conflict in Africa might have to be taken into account. At the same time, higher European tariffs, subsidies and sanitary barriers to agricultural products may entail costs in terms of more painstaking peace efforts. Our model also warns that export oriented strategies as pursued by UNCTAD and DFID might have to focus on the fact that not every income-enhancing change may reduce conflict. Fostering the expansion of labor intensive industries could constitute a pacifying force. But the expansion of extractive, more capital intensive activities (that happen to attract significant Western involvement), on the contrary, may fuel conflict instead. See our discussion on "conflict diamonds" in the next section.

5.3 First world technological progress and third world conflict

One would think that developing nations will be helped by technology transfers from rich nations: better technologies expand the production possibility frontier and make a country unambiguously richer. However, if developed nations are more capital intensive than developing ones, the innovations the former make available to the latter might be biased towards the capital intensive industry. The problem with the adoption of such innovations is that, as

undisciplined RSLMF elements." (RUF means Revolutionary United Front and RSLMF means Republic of Sierra Leone Military Forces.)

shown in Section 4, neutral technical progress in the capital intensive industry will increase conflict. Moreover, the increase in conflict can overcome the direct effect of technical progress on the production possibilities of the economy, resulting in a decrease in total production. As shown in the example below, the decrease in production can be so significant that even capitalists are worse off by the adoption of a technological innovation in the capital intensive sector. Firms in the capital intensive sector have incentives to adopt a better technology and make profits. In equilibrium, all firms in the sector adopt the improved technology and make zero profits. The impact on factor prices increases conflict, and this increase can be as strong as to leave all owners of labor and capital worse off.

Example 2 *Technological progress and conflict:*

Consider an economy with production functions $q_1 = K_1^{\frac{2}{3}} L_1^{\frac{1}{3}}$ *for the capital intensive sector,* $q_2 = K_2^{\frac{1}{3}} L_2^{\frac{2}{3}}$ *for the labor intensive sector, and the following appropriation technology:* $A(L_A) = \frac{3}{260} + \frac{1}{260} L_A$. *Let us set the total endowments of the two factors of production at levels* $\overline{K} = \overline{L} = 100$ *and let* $p_1 = 1$. *Figure 4 shows the total value of production in the economy for different levels of technological progress (*θ*) in the capital intensive sector. While an increase of 5% in the productivity of sector 1 results in an increase of total production, further increases actually have a negative effect on the total production of the economy.*

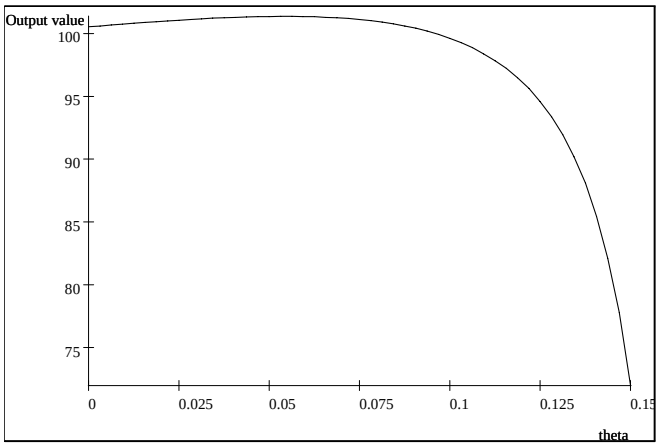

Figure 4: Technological progress and total production

Figure 5 (below) shows the net incomes of capital and labor (labeled NIK and NIL respectively). Technical progress in the capital intensive sector hurts labor. There are two reasons for this: first, technical progress in the capital intensive sector reduces the gross wage paid by firms; second, there is an increase in the appropriation losses brought by the increase in conflict. The two forces work in different directions for capitalists. While technical progress

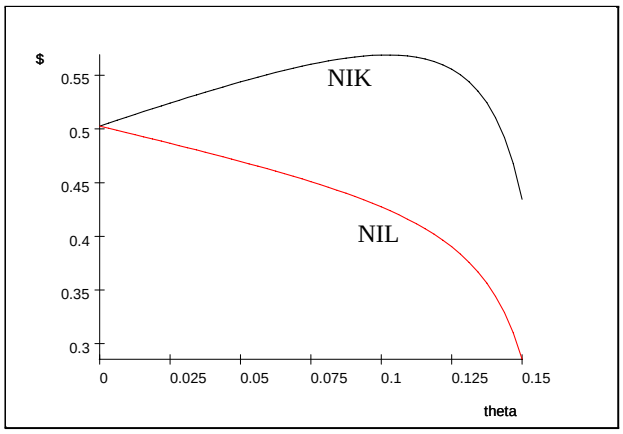

Figure 5: Technical progress and payments to factors.

in the capital intensive sector results in an increase in the gross rental price of capital, it also results in an increase in the appropriation they suffer. Figure 5 shows that the second effect overcomes the first one for relatively high rates of technical progress. As a result, both workers and capitalists are made worse off by technical progress.

The example suggests that developing nations with serious conflict issues may not want to adopt every technological improvement that richer countries make available to them, even if these come as a gift. In addition, a conflict-prone society may want to discourage innovation in the capital intensive sector, while encouraging it in the labor intensive sector. This course of action and the trade policies analyzed in the following subsection mirror the interventions proposed by Latin American structuralists (see for instance Prebisch, 1959) and other advocates of state-guided "national development strategies."

Another way to affect the relative productivity of sectors is through education. Basic education increases the productivity of labor and, hence, the productivity of the labor intensive sector relative to the capital intensive one. In this way, basic education increases wages relative to the return to capital and reduces conflict, as long as the impact of basic education on appropriation abilities is relatively weaker than on productive ones.[22]

6 Conflict and factor specificity

One might think that the predictions of our model are unrealistic in the short run, when some factors of production are fixed. For example, one might expect the Stolper-Samuelson

[22] For other theories on the interrelation of social struggle and education see Galor and Moav (2003) and references therein.

theorem to fail: a positive shock to the price of oil could generate an increase in wages–rather than a decrease–even when oil extraction is a relatively capital intensive sector. But if more valuable natural resources will raise wages, can we still account for the curse of natural resources, whereby the availability of more valuable natural resources increases conflict? If anything, it would seem that such phenomenon must be explained with a model that is compatible with delivering higher conflict *and* higher wages when, say, the price of a natural resource goes up. In this section we attain precisely this explanation. We study the well known Ricardo-Viner model with industry-specific factors and add the appropriation sector. Therefore, the model is as in section 3, with the difference that while labor is still mobile across sectors, capital is not. There are two kinds of capital (K_1 and K_2) which are specific to each productive industry. The respective endowments of capital are denoted with $\overline{K}_1$ and $\overline{K}_2$. The model with industry specific factors can be thought to capture short run movements (when capital is fixed), while our basic model in section 3 can be thought to capture long run effects (when all factors are mobile).

We show that natural resource shocks that raise wages are indeed compatible with higher, rather than lower, levels of conflict. The key aspect is that when extractive activities are relatively capital intensive, a shock to the price of natural resources will expand the returns to appropriation even more than it increases its opportunity costs.

Note that when there are industry specific factors of production, the definition of a sector as "labor intensive" is not too meaningful if one sticks with the definition used before, in terms of unit input requirement ratios. In the modified setup, we follow convention by saying an industry is relatively labor intensive when the participation of labor in that industry's income is relatively high. Using standard notation, let σ_i denote the elasticity of substitution between labor and capital in sector i (a negative number), and let $\theta_{L_i} \equiv \frac{wL_i}{wL_i+rK_i}$ be the distributive share of labor in the income of sector i. We can now state,

Proposition 8 *An increase in p_1 results in an increase in conflict $\left(\frac{dL_A}{dp_1} \geq 0\right)$ if and only if $\frac{\sigma_1\theta_{L1}}{1-\theta_{L1}} \geq \frac{\sigma_2\theta_{L2}}{1-\theta_{L2}}$. When elasticities of substitution are the same across industries (i.e., when $\sigma_1 = \sigma_2$), then an increase in p_1 results in an increase in conflict if and only if industry 1 is relatively capital intensive (i.e., when $\theta_{L1} < \theta_{L2}$).*

Proof: See Appendix.

This proposition provides a clear condition under which a change in international prices would result in an increase in conflict. For example, if the elasticities of substitution are the same in both productive sectors, an increase in p_1 results in an increase in conflict if, and only if, sector one is relatively capital intensive. In addition, if the payments to labor are equal in both sectors, an increase in p_1 results in an increase in conflict if, and only if, sector

one has, in absolute value, a lower elasticity of substitution than sector 2. The reason is that the lower (in absolute value) the elasticity of substitution of sector 1, the lower the positive impact of the increase of prices on wages.

This result holds regardless of the fact that an increase in p_1 will result in an increase in wages. The increase in p_1 results in an increase in the income of capital (the net effect of an increase in sector 1 and a decrease in sector 2) that is larger than the increase in wages. This causes the potential disputable wealth to rise more than wages, in turn making appropriation activities more attractive to workers. The model with specific factors makes clear that the main conclusions of this paper do not depend on the sign of the impact of shocks on wages. Instead, the results depend on the relative impact that shocks have on the retribution to capital and wages, as this governs the relative movements of the benefits and costs of conflict.

Is it also the case that an increase in the specific endowment of the diamond industry (i.e. rough diamonds) would result in an increase in conflict? While in this model it is difficult to characterize in general the effects of endowment changes on the level of conflict, we provide such results for a Cobb-Douglas economy.

Proposition 9 *In a Cobb-Douglas economy, an increase in the endowment of capital of the capital (labor) intensive sector results in an increase (decrease) of conflict.*

Proof: See Appendix.

If we see natural resources such as oil or diamonds as specific capital to extractive activities, this section gives an explanation for the curse of natural resources. Increases in the price and availability of diamonds, say, will increase conflict if diamond extraction is relatively capital intensive or displays a low elasticity of substitution between labor and capital. Thus, the model can be used to analyze the issue of "conflict diamonds." These are rough diamonds that are seen to fuel conflict because rebel factions have direct access to them and use the revenues to finance themselves (see Ross 2003). As a result, governments and parties concerned with the diamond trade have engineered a certification process within an initiative known as the Kimberley process.[23] The aim is to stamp out "conflict diamonds" and keep them away from the diamond market. The disturbing implication of our model is that every diamond may be a conflict diamond: perfectly legal diamonds that have not been handled by rebels may also increase conflict.

[23] See <http://www.kimberleyprocess.com>.

7 Conclusion

We consider appropriation activities in the context of two canonic 2x2 general equilibrium models of a small open economy. This yields a framework to analyze how economy-wide forces and policy interventions affect the extent of social conflict. Our setup highlights the role of the value of labor relative to the amount of disputable wealth in the determination of the costs and benefits to appropriation activities and the level of social conflict.

Although our model is simple, the effects we isolate generate a rich empirical profile. Our model can account for apparently paradoxical stylized facts concerning civil wars: both unfavorable circumstances (such as droughts) and favorable ones (such as higher availability of natural resources) increase the likelihood of civil war. The former can be explained by our model as the result of negative shocks affecting a labor intensive sector (subsistence-level agriculture), while the latter can be explained as the result of positive shocks affecting relatively capital intensive activities (extractive industries). Similarly, the model can explain how policies that increase income per capita but damage industries intensive in unskilled labor will generate an increase in both the wage gap across skills and conflict when appropriation is relatively intensive in unskilled labor. Although our model's prediction is compatible with the observed positive correlation between crime and inequality, it should be noted that our theory also predicts that reducing inequality without affecting the incentives to undertake productive activities may not diminish conflict (as with social programs that provide lump-sum redistributions).

Societies often implement policies that economists consider inefficient. Work on the political economy of endogenous policies (see, inter alia, Stigler 1971, Peltzman 1976, Becker 1983, and Coate and Morris 1995) has shown that such policies may be shaped by political constraints, and thus may be "politically efficient." A similar case can be made when a social constraint is incorporated to economic analysis: policies that make no sense in a socially frictionless world may become attractive to society (and its politicians) in the face of social conflict. Examples are populist measures such as taxing capital to subsidize labor, the protection of labor from international trade, and "national development strategies" that distort the profile of technical innovations that are adopted by the country's firms.

There are interesting paths for future research. One is to expand our analysis to dynamic settings where agents can accumulate capital. We expect that the effects we have identified will still be present, such as that of taxes to capital and subsidies to productive labor: if this policy reduces conflict so much as to reduce the overall burden on capitalists, it will increasing, rather than decrease, capital accumulation. Another extension could consider the possibility of factor mobility across countries. Future work could also take a new look at state intervention across countries. This presence varies widely both in terms of the regulation of

business and in terms of welfare institutions. This variety may embody different approaches to purchasing social peace.

8 Appendix

Proof of Proposition 11. Up to the addition of the appropriation sector, our way of solving the model is close to that in Mussa (1974). The equilibrium conditions of the model now are:

$$L_1^d\left(\frac{w}{p_1},\overline{K}_1\right)+L_2^d\left(w,\overline{K}_2\right)+L_A = \overline{L} \tag{8}$$

$$\frac{A\left(L_A\right)}{L_A}\left[p_1 f_1\left(L_1^d\left(\frac{w}{p_1},\overline{K}_1\right),\overline{K}_1\right)+f_2\left(L_2^d\left(w,\overline{K}_2\right),\overline{K}_2\right)\right] = \left[1-A\left(L_A\right)\right]w \tag{9}$$

where L_1^d and L_2^d are the demand functions of labor and f_1 and f_2 are the production functions in each productive sector.

Totally differentiating the equilibrium conditions with respect to p_1 (with w and L_A written as implicit functions of p_1) one gets a system of two equations and two unknowns, $\frac{dw}{dp_1}$ and $\frac{dL_A}{dp_1}$. Solving for $\frac{dL_A}{dp_1}$ (and using the fact that $\frac{df_1}{dL_1}=\frac{w}{p_1}$ and $\frac{df_2}{dL_2}=w$) we find that:

$$\frac{dL_A}{dp_1}=\frac{A(L_A)\left[\frac{1}{p_1^2}\frac{dL_1^d}{d\left(\frac{w}{p_1}\right)}\left(p_1f_1+f_2\right)-f_1\times\left(\frac{1}{p_1}\frac{dL_1^d}{d\left(\frac{w}{p_1}\right)}+\frac{dL_2^d}{dw}\right)\right]}{\left[A'\times\left(Y_K+w\overline{L}\right)-w(1-A)\right]\left(\frac{1}{p_1}\frac{dL_1^d}{d\left(\frac{w}{p_1}\right)}+\frac{dL_2^d}{dw}\right)-A\times\left[\frac{df_1}{dL_1}\frac{dL_1^d}{d\left(\frac{w}{p_1}\right)}+\frac{df_2}{dL_2}\frac{dL_2^d}{dw}\right]+(1-A)\,L_A} \tag{10}$$

where Y_K denotes the income of capital.

Given that $\frac{dL_1^d}{d\left(\frac{w}{p_1}\right)}$ and $\frac{dL_2^d}{dw}$ are negative, note the denominator is positive if and only if:

$$A'(L_A)\left(Y_K+w\overline{L}\right)-w\leq\frac{A(L_A)\left[\frac{df_1}{dL_1}\frac{dL_1^d}{d\left(\frac{w}{p_1}\right)}+\frac{df_2}{dL_2}\frac{dL_2^d}{dw}\right]-(1-A(L_A))\,L_A}{\left(\frac{1}{p_1}\frac{dL_1^d}{d\left(\frac{w}{p_1}\right)}+\frac{dL_2^d}{dw}\right)}-wA \tag{11}$$

The left hand side of equation (11) is negative by the concavity of A and the equilibrium condition of the appropriation sector. The right hand side of equation (11) can be shown to be positive doing some algebra and using the fact that $\frac{df_1}{dL_1}=\frac{w}{p_1}$ and $\frac{df_2}{dL_2}=w$. Hence, the denominator in (10) is positive. We now show the numerator is also positive. This requires that the term in between brackets be positive. This is shown to be true (using again the fact that $\frac{df_1}{dL_1}=\frac{w}{p_1}$ and $\frac{df_2}{dL_2}=w$) if and only if $\frac{1}{p_1^2}\frac{dL_1^d}{d\left(\frac{w}{p_1}\right)}f_2>f_1\frac{dL_2^d}{dw}$, which can be written as $q_2e_{L_1}\frac{L_1^d}{wp_1}>q_1e_{L_2}\frac{L_2^d}{w}$ (where $e_{L_1}=\frac{dL_1^d}{d\left(\frac{w}{p_1}\right)}\frac{w}{L_1^dp_1}$ and $e_{L_2}=\frac{dL_2^d}{dw}\frac{w}{L_2^d}$). This expression is equivalent to $e_{L_1}\frac{wL_1^d}{q_1p_1}>e_{L_2}\frac{wL_2^d}{q_2}$, which can in turn be written as $e_{L_1}\theta_{L1}>e_{L_2}\theta_{L2}$ (θ_{Li} represents the participation of labor in the income of industry i). Because of the fact that $e_{L_i}=\frac{\sigma_i}{1-\theta_{Li}}$, our expression becomes $\frac{\sigma_1}{1-\theta_{L1}}\theta_{L1}>\frac{\sigma_2}{1-\theta_{L2}}\theta_{L2}$ which is the condition in the proposition.■

Proof of Proposition 12. Let $q_1 = K_1^{\alpha} L_1^{1-\alpha}$ and $q_2 = K_2^{\beta} L_2^{1-\beta}$ be the production functions in the productive sectors. Then the equilibrium conditions in (8) and (9) become:

$$(1-\alpha)^{\frac{1}{\alpha}} \left(\frac{p_1}{w}\right)^{\frac{1}{\alpha}} \overline{K}_1 + \alpha^{\frac{1}{1-\alpha}} \left(\frac{1}{w}\right)^{\frac{1}{1-\alpha}} \overline{K}_2 + L_A = \overline{L}$$

$$A(L_A)\left((1-\alpha)^{\frac{1-\alpha}{\alpha}} \left(\frac{p_1}{w}\right)^{\frac{1}{\alpha}} \overline{K}_1 + (1-\beta)^{\frac{1-\beta}{\beta}} \left(\frac{1}{w}\right)^{\frac{1}{\beta}} \overline{K}_2\right) = (1-A(L_A))\, wL_A$$

From the equilibrium conditions it follows that multiplying p_1 for a factor Δ will have the same effect on the equilibrium value of the endogenous variables than multiplying K_1 for a factor $\Delta^{\frac{1}{\alpha}}$. Therefore, noting that in this case $\sigma_1 = \sigma_2 = -1$, $\theta_{L1} = \alpha$ and $\theta_{L2} = \beta$, the result follows from Proposition 11.■

The case when appropriation employs labor and capital

We now show that the results of the paper also hold when both capital and labor are used in the appropriation sector under the condition that this sector is labor intensive relative to the whole economy. Consider the economy from section 2 with the only difference that now the amount of appropriation is $A(L_A, K_A)[p_1 q_1 + q_2]$. We assume that the appropriation sector combines labor and capital in amounts that minimize the cost of a given amount of appropriation and that, as before, $A(L_A, K_A)$ presents decreasing returns to scale. In equilibrium, the returns from appropriation must equal the total value of the factors used in the sector:

$$A(L_A, K_A)\left[r\left(\overline{K} - K_A\right) + w(\overline{L} - L_A)\right] = [1 - A(L_A, K_A)]wL_A + [1 - A(L_A, K_A)]rK_A. \quad (12)$$

We study next how changes in prices affect the level of activity of the appropriation sector.

Proposition 10 *An increase in the price of the capital intensive output results in an increase in the level of activity of the appropriation sector* $\left(\frac{dA}{dp_1} > 0\right)$ *if and only if the appropriation sector is labor intensive relative to the economy* $\left(\frac{L_A}{K_A} > \frac{\overline{L}}{\overline{K}}\right)$.

Proof. The equilibrium condition for the appropriation sector can be written as $A = \frac{\frac{r}{w} K_A\left(A, \frac{r}{w}\right) + L_A\left(A, \frac{r}{w}\right)}{\frac{r}{w}\overline{K} + \overline{L}}$, where A is the level of appropriation and $K_A\left(A, \frac{r}{w}\right)$ and $L_A\left(A, \frac{r}{w}\right)$ are the demands of capital and labor of the appropriation sector given the level of appropriation and the ratio of factor prices.

Remember that by the Stolper-Samuelson theorem (Lemma 1) $\frac{d\frac{r}{w}}{dp_1}$ is positive and we can focus on the sign of $\frac{dA}{d\frac{r}{w}}$. Differentiating the equilibrium condition with respect to $\frac{r}{w}$ we obtain: $\frac{dA}{d\frac{r}{w}} = \frac{\frac{r}{w}\frac{dK_A}{d\frac{r}{w}} + \frac{dL_A}{d\frac{r}{w}} + K_A - \left(\frac{\frac{r}{w}K_A + L_A}{\frac{r}{w}\overline{K} + \overline{L}}\right)\overline{K}}{\frac{r}{w}\overline{K} + \overline{L} - \left(\frac{r}{w}\frac{dK_A}{dA} + \frac{dL_A}{dA}\right)}$. Using the Envelope theorem $\left(\frac{r}{w}\frac{dK_A}{d\frac{r}{w}} + \frac{dL_A}{d\frac{r}{w}} = 0\right)$ and the equilibrium condition we get: $\frac{dA}{d\frac{r}{w}} = \frac{K_A - \left(\frac{\frac{r}{w}K_A + L_A}{\frac{r}{w}\overline{K} + \overline{L}}\right)\overline{K}}{\frac{\frac{r}{w}K_A + L_A}{A} - \left(\frac{r}{w}\frac{dK_A}{dA} + \frac{dL_A}{dA}\right)}$. The denominator is

negative given that, because of $A(.)$ having decreasing returns to scale, the average cost is lower than the marginal cost. The numerator is negative if and only if $\frac{L_A}{K_A} > \frac{\overline{L}}{\overline{K}}$ and the result follows. ■

As in Section 4, changes in technology can be studied in a way analogous to the one just used to study price changes. The extension of the results in section 5 to the case in which both capital and labor are used in appropriation follows from the previous two propositions.

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