The Economics of Child Soldiering

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Abstract:
This paper presents a model of conflict which allows belligerents to recruit both adults and children as soldiers. Warlords fight over the country's productive (i.e. non-military) output, and are aware of the tradeoff involved in recruitment: anyone who becomes a soldier cannot produce output. In equilibrium, child recruitment is determined by children's productivity relative to adults in both war and civilian production. The model's findings have implications for arms traffic control and bans on child labor.

1 Introduction

One feature of recent civil wars that has drawn much attention is the participation of children (people under 18 years of age) as combatants. In 1998 it was believed that over 300,000 children were involved in civil conflicts (Brett and McCallin, 1998). No comprehensive estimate has been made since then.

The practice of recruiting minors for military service has met with concern and protest by the international community. Protocol I of the Geneva Convention, an amendment which went into effect in 1979, states the following:

> The parties to the conflict shall take all feasible measures in order that children who have not attained the age of fifteen years do not take a direct part in hostilities and, in particular, they shall refrain from recruiting them into their armed forces.

The United Nations Convention on the Rights of the Child (CRC), signed a decade later, contains a nearly identical stipulation. An optional protocol on the involvement of children in armed conflicts was added to the CRC in 2002, raising the age limit from fifteen to eighteen.

That same year, the International Criminal Court (ICC) declared that conscripting children under the age fifteen was a war crime. So far, however, only six people have been convicted, all in Sierra Leone.

Non-governmental organizations have also reacted. In 1998 several of them, including Amnesty International and Human Rights Watch, formed the Coalition to Stop the Use of Child Soldiers, an advocacy group.

Scholars from various fields — political science, law, psychology, but not yet economics — have addressed the issue of child soldiering. They discuss the motives and methods of child recruitment, as well as the rehabilitation prospects for former child soldiers. Their studies offer valuable insights, but lack a theoretical framework which might be used to predict the consequences of policies, events or trends. My paper's main objective is to provide such a framework.

The key decision-maker in such a model has to be the recruiter, not the child. Most child soldiers are recruited by abduction or coercion. Those few who volunteer could be turned away, but are not. Therefore the recruiter, whether he is a warlord or an officer of a legitimate government army, makes a conscious decision whether or not to have children in his army. For this reason, children will be treated in this paper as resources rather than as decision-makers.

Warlords (as all recruiters will be called henceforth) do not recruit children out of any particular desire to expose them to harm. They do so because it is convenient. Children are more malleable than adults. They are more easily abducted and drugged. If taken sufficiently far away from their home, they have greater difficulty finding their way back, and so may not even try. In other words, they are a low-cost input. But any attempt to explain why children are recruited must begin with one

simple fact: children would not be recruited if they could not get the job done. Their effectiveness as soldiers relative to that of adults is a key factor. The availability of lightweight assault rifles has in recent times made this relative effectiveness high.

Recruiting adults typically means taking them away from some productive activity, such as farming. In many developing countries, the same is true of children.[1] Recruitment of both adults and children, then, reduces local economic activity. But it is control over this economic activity which is at stake in the conflict. This is the familiar guns-and-butter tradeoff: recruitment increases one's chances of obtaining the prize, but reduces the *value* of the prize. This tradeoff was formalized by Hirshleifer (1988) and forms the centerpiece of many conflict models published afterward: for example, Garfinkel (1990), Hirshleifer (1991), Powell (1993), Neary (1997), Skaperdas and Syropoulos (2001). See Garfinkel and Skaperdas (2007) for an overview.

A complete model, then, must take into account what adult and child soldiers *could* have produced had they not been recruited. That is to say, adult and child productivities in civilian life play a role. By comparing children to adults, both as soldiers and as laborers, we may begin to understand the incentives behind child recruitment. And if we can understand these incentives, we may be better able to design policies to stop this recruitment from taking place.

In the model, two warlords face each other in a guns-and-butter conflict, with the following elements: (i) each warlord has a pool of adults and children from which to recruit soldiers, who are paid a subsistence wage; (ii) all non-combatants produce a single consumable good, the output, and are also paid a subsistence wage; (iii) war is fought for control of the output.

Adult and child productivities (both military and civilian), together with wages, determine the recruiting strategies used by warlords, i.e. whether they will hire adults or children, and how many of each. It will be seen that some specialization always takes place, i.e. that one age group (adults or children) is employed exclusively in that activity (soldiering or civilian production) for which it has a comparative advantage. The likelihoods of the various scenarios are discussed in light of the known characteristics of modern weapons and of the countries where civil wars have occurred in recent times. In this way the model may help explain why child recruitment takes place in some countries but not in others.

There are major simplifications here. We know that children do not abruptly become adults at age 18 or at any other age: in terms of productivity and subsistence requirements the change is gradual. There is not a single non-military industry, but several. Moreover, war is complex, civil war particularly so. Many of its features have been left out deliberately. Foreign intervention or influence is not modeled. Nor do I allow for any reticence from using child soldiers on moral or political grounds.

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[1] In fact, the age at which adulthood begins is contested on that account. In Africa, people are sometimes considered adults at age 14, because that is when they are expected to begin working (Wessells, 2006).

There is no distinction between governments and insurgents. I model each military leader as a pure *homo economicus*, a rent-seeker. Some might say the motive for war is often ethnic, religious or ideological — "politics by other means" — but I believe that at bottom there is always an economic dimension.

Because of this economic dimension and in spite of the omissions it was necessary to make, I think the model can tell us some important things about the recruitment of children: the relative importance of the factors which make them valuable as combatants (high productivity and low cost), and the need to know how children perform in other activities. In other words, the model can help us understand how children, as factors of production, influence the tradeoff between war and production.

In addition to the works already mentioned, other relevant literature will be introduced when relevant throughout the rest of the paper.

2   The Model

The model depicts an episode of appropriative conflict. At first I model a symmetric conflict between two warlords in identical environments. Subsequently I consider the case where two warlords recruit individuals from two different economic environments (say, one urban and the other agrarian).

The population is divided into two *groups*, each controlled by one warlord. Each group is composed of A adults and C children. Children here are defined as individuals under the age of 18, old enough to work or fight, but less productive than adults generally.

There are two occupations: soldiering and a non-military productive activity, which I call farming for simplicity. Adults and children are not decision-makers in this model. Their participation in either warfare or farming can be secured by paying them a fixed wage, w_A for adults and w_C for children. This should be understood as the cost of feeding the individual, as well as training and outfitting him for the work in question, soldiering or farming, as the case may be. In modern civil wars, many soldiers, particularly children, are actually coerced into fighting.

Formally, each warlord i raises an army composed of A_i adult soldiers and C_i child soldiers. These choices are subject to availability; that is to say, we must have $A_i \leq A$ and $C_i \leq C$. Effectiveness in combat is given by two productivity parameters: ϕ_{AS} and ϕ_{CS}. These parameters operate linearly, so that warlord i's effective fighting strength is

$$S_i \; = \; \phi_{AS} A_i + \phi_{CS} C_i \quad . \tag{1}$$

Basically the parameters ϕ_{AS} and ϕ_{CS} are used to tally efficiency units of labor in warfare. Thus a child on the battlefield is equivalent to a fraction ϕ_{CS}/ϕ_{AS} of an adult. The parameters do not directly express any notion of marginal contribution to output, because "output" in war is not the same thing as in other activities.

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In the economics of conflict, resources used in warfare do not produce goods, but rather help the spender appropriate goods which already exist or are produced by others. This is a form of rent-seeking. To characterize how recruitment contributes to a warlord's payoff, we must invoke a *technology of conflict*, a function which translates both sides' recruitment decisions into a military outcome. Let us say, then, that warlord i's probability of winning the war is

$$P_i \; = \; \frac{S_i}{S_1 + S_2} \quad . \tag{2}$$

In other words, it is the ratio of his own fighting strength to the total fighting strength deployed. If no soldiers are recruited on either side, this fraction is assumed to be one half. The right-hand side of (2) is a contest success function, a standard way to model the outcome of conflicts, pioneered by Tullock (1980). This is a simple form of it, weighted by productivities; see Garfinkel and Skaperdas (2007) for an overview of the several variations commonly used.

Individuals who do not become soldiers automatically become farmers. In the farming sector, adults have productivity ϕ_{AF} and children have productivity ϕ_{CF}. These are also linear operators, so that group i's farming output is

$$H_i \; = \; \phi_{AF}(A - A_i) + \phi_{CF}(C - C_i) \quad . \tag{3}$$

Net output is computed by subtracting wages from this:

$$\tilde{H}_i \; = \; (\phi_{AF} - w_A)(A - A_i) + (\phi_{CF} - w_C)(C - C_i) \quad . \tag{4}$$

Total net output $\tilde{H}_1 + \tilde{H}_2$ is the only thing of real value in the economy; in a sense it *is* the economy. Consequently it is over this that the war is fought. Warlord i's expected payoff can be written as

$$\pi_i \; = \; P_i \, (\tilde{H}_1 + \tilde{H}_2) - w_A A_i - w_C C_i \quad . \tag{5}$$

The last two terms are the wages paid to adult and child soldiers respectively. They must be paid by the warlord regardless of the outcome of the conflict, so they are not multiplied by the probability of victory. Warlord i chooses A_i and C_i to maximize π_i, taking A_j and C_j as given ($j \neq i$) and subject to the constraints $0 \leq A_i \leq A$ and $0 \leq C_i \leq C$. Equation (5) exemplifies the tradeoff between military and productive activities during war. The more resources one devotes to fighting, the higher one's chances of winning (higher P_i), but the lower the value of the prize (lower H_i).

The foregoing equations imply a certain timing of events for logical consistency: warlords recruit, then economic activity (farming) occurs, then the output accrues to the winner of the war. This is consistent with reality: war is a fairly protracted event, so that by the time the issue of a conflict is settled, a substantial amount of non-military economic activity has taken place. Mathematically nothing is lost in assuming that these events all take place within a single period.

2.1 Equilibrium

The relative values of the model's parameters (A, C, w_A, w_C, ϕ_{AS}, ϕ_{CS}, ϕ_{AF} and ϕ_{CF}) will determine the structure of equilibrium. Before begining the analysis, however, I wish to rule out the two extreme outcomes: total peace and total war.

Total peace is a situation where there are no soldiers on either side. In that case, farming output is quite high, and each warlord can expect one half of it. This is the most efficient outcome possible, but it is not an equilibrium. If one of the warlords were to raise even a very small army, farming output would go down a little bit, but that warlord would get all of it, not just one half. This is a clear gain for him over the preceding outcome. Therefore total peace cannot be an equilibrium.

Total war is the opposite situation, in which all individuals become soldiers. Here there is no farming ouput, and so each warlord's payoff is zero. The parties fight over nothing. Either warlord can make his payoff positive by recruiting fewer individuals, thereby allowing some farming to take place. Therefore total war is not an equilibrium either.

Equilibrium is found by looking at the net marginal value of hiring adult and child soldiers, i.e. the derivatives of π_i with respect to A_i and C_i. These are

$$\frac{d\pi_i}{dA_i} \;=\; \frac{\partial P_i}{\partial A_i}\,(\tilde{H}_1 + \tilde{H}_2) \;-\; (\phi_{AF} - w_A)\,P_i \;-\; w_A \quad; \tag{6}$$

$$\frac{d\pi_i}{dC_i} \;=\; \frac{\partial P_i}{\partial C_i}\,(\tilde{H}_1 + \tilde{H}_2) \;-\; (\phi_{CF} - w_C)\,P_i \;-\; w_C \quad. \tag{7}$$

Equilibrium is necessarily symmetric, with $A_1 = A_2$ and $C_1 = C_2$. Using these equalities and the definition of P_i, equations (6) and (7) become

$$\frac{d\pi_i}{dA_i} \;=\; \left(\frac{\phi_{AS}}{2}\right)\left(\frac{\tilde{H}_i}{S_i}\right) - \left(\frac{\phi_{AF} + w_A}{2}\right) \quad; \tag{8}$$

$$\frac{d\pi_i}{dC_i} \;=\; \left(\frac{\phi_{CS}}{2}\right)\left(\frac{\tilde{H}_i}{S_i}\right) - \left(\frac{\phi_{CF} + w_C}{2}\right) \quad. \tag{9}$$

The derivative $d\pi_i/dA_i$ must be zero if adults are to participate in both soldiering and farming; it can only be negative if no adults are recruited, and positive if all adults are recruited. The same logic applies to $d\pi_i/dC_i$ in the case of children.

Inspection of (8) and (9) reveals that an interior solution, in which both derivatives are equal to zero, can only occur if $\phi_{CS}/\phi_{AS} = (\phi_{CF} + w_C)/(\phi_{AF} + w_A)$, This will not be the case in general; in fact, for convenience, I will assume it does not hold. We must therefore look for corner solutions. A corner solution is one in which at least one of the two age groups, adults or children, is engaged exclusively in one of the two activities, either soldiering or farming. In other words, some specialization takes place.

scenario	parameter values	who is recruited?	
1	$\dfrac{\phi_{CF}+w_C}{\phi_{AF}+w_A} \ < \ \dfrac{\phi_{CS}}{\phi_{AS}} \ < \ \gamma\!\left(\dfrac{A}{C}\right)$	$0 < A_i < A$ $C_i = C$	some adults all children
2	$\dfrac{\phi_{CF}+w_C}{\phi_{AF}+w_A} \ \leq \ \gamma\!\left(\dfrac{A}{C}\right) \ \leq \ \dfrac{\phi_{CS}}{\phi_{AS}}$	$A_i = 0$ $C_i = C$	no adults all children
3	$\gamma\!\left(\dfrac{A}{C}\right) \ < \ \dfrac{\phi_{CF}+w_C}{\phi_{AF}+w_A} \ < \ \dfrac{\phi_{CS}}{\phi_{AS}}$	$A_i = 0$ $0 < C_i < C$	no adults some children
4	$\dfrac{\phi_{CS}}{\phi_{AS}} \ < \ \dfrac{\phi_{CF}+w_C}{\phi_{AF}+w_A} \ < \ \delta\!\left(\dfrac{A}{C}\right)$	$0 < A_i < A$ $C_i = 0$	some adults no children
5	$\dfrac{\phi_{CS}}{\phi_{AS}} \ \leq \ \delta\!\left(\dfrac{A}{C}\right) \ \leq \ \dfrac{\phi_{CF}+w_C}{\phi_{AF}+w_A}$	$A_i = A$ $C_i = 0$	all adults no children
6	$\delta\!\left(\dfrac{A}{C}\right) \ < \ \dfrac{\phi_{CS}}{\phi_{AS}} \ < \ \dfrac{\phi_{CF}+w_C}{\phi_{AF}+w_A}$	$A_i = A$ $0 < C_i < C$	all adults some children

TABLE 1. Correspondence between parameter values and occupations of adults and children in equilibrium.

Total peace and total war have already been ruled out. There remain six possibilities. These are outlined in Table 1 and detailed in the appendix. The two constants that appear therein are defined as follows:

$$\gamma \ \equiv \ \frac{\phi_{AF}-w_A}{\phi_{AF}+w_A} \qquad ; \qquad \delta \ \equiv \ \frac{\phi_{CF}+w_C}{\phi_{CF}-w_C} \quad . \tag{10}$$

The six scenarios cover all possibilities. Equilibrium always exists and is always unique. So if we know how the parameters are related to each other, we can identify the appropriate scenario and equilibrium configuration.

Some important results emerge from the analysis. These are stated without formal proofs, since they are taken almost directly from the table.

Proposition 1. *Children will be recruited if*

$$\frac{\phi_{CS}}{\phi_{AS}} \ > \ \frac{\phi_{CF}+w_C}{\phi_{AF}+w_A} \quad . \tag{11}$$

The left-hand side of (11) is the child-to-adult productivity ratio in the military. It is, more specifically, the adult equivalent of a child soldier. The right-hand side is a

wage-adjusted productivity ratio for the farming sector. Basically this ratio compares the marginal benefits of taking a child and an adult out of the army and setting them up as farmers. Wages figure positively in this accounting, since the warlord pays a soldier with certainty but receives the net product of a farmer (productivity minus wage) only with probability P_i (equal to one half in equilibrium).

The significance of the result is that the recruitment of children occurs not just because it is less costly to recruit a child than an adult (w_C compared to w_A). It depends fundamentally on how well a child can do a soldier's job (ϕ_{CS} compared to ϕ_{AS}), and how well he can do *other* jobs (ϕ_{CF} compared to ϕ_{AF}). In essence, the proposition states that children will be recruited if they have a comparative advantage in soldiering.

Note also that the parameters A and C play no part in this result. We will see below that A and C influence the degree to which child recruitment occurs, i.e. whether all or only some of the children are recruited; but if (11) holds, then children will be recruited regardless of population figures.

Proposition 2. *All children will be recruited if (11) holds and*

$$\gamma\Big(\frac{A}{C}\Big) \; > \; \frac{\phi_{CF} + w_C}{\phi_{AF} + w_A} \quad . \tag{12}$$

The left-hand side of (12) is the adult-to-child population ratio, multiplied by a constant. All other things being equal, children are more likely to specialize in soldiering if they are few in number.

Proposition 3. *Armies will be composed exclusively of children if (11) holds and*

$$\frac{\phi_{CS}}{\phi_{AS}} \; > \; \gamma\Big(\frac{A}{C}\Big) \quad . \tag{13}$$

Here we see another effect of the population ratio, namely that an abundance of children may crowd adults out of the military.

These results concern scenarios 1, 2 and 3 in Table 1. For reasons which will be explained shortly, scenarios 5 and 6 are not very realistic. That leaves scenario 4 as the main case without child recruitment. In the following section, I will attempt to establish links between these algebraic inequalities and real conflicts.

2.2 Assault rifles, population pyramids, and diamonds

Proposition 1 identifies the condition which leads to child recruitment. This is condition (11), which makes use of all four productivity parameters and both wages. To my knowledge there do not exist reliable estimates for any of these. Nevertheless, several factors lead me to conjecture that (11) does hold in many countries.

In most civilian economic activities in which children participate, children are usually given the easiest jobs. But the easiest jobs are generally not the ones which

generate the most revenue. So the value-added of child labor is much lower than that of adults, who benefit from greater physical strength, endurance, and experience, and can therefore do the more economically important work.

Throughout most of history, adults have held these advantages over children in warfare as well. It may or may not have been deemed morally objectionable to send children to war, but the question never really came up, since children were simply unable to perform the tasks required of a soldier. In recent times, however, the gap between adult and child effectiveness in soldiering has been closed considerably, due to advances in weapons technology and the changing nature of war itself.

By far the most important change has been the development and large-scale manufacture of assault rifles such as the AK-47 and the M16, particularly the former. These weapons are lightweight, easy to use, and deadly. Teenagers can handle them almost as well as adults. Although designed and originally manufactured in Russia, the AK-47 was not patented and has been freely copied. Finding out where a particular AK-47 was made is virtually impossible. Furthermore, these weapons have become more affordable. In Africa, the purchase price of an AK-47 fell from $235 in 1990 to $139 in 2000 (Killicoat, 2007).

Increasingly engagements are fought at close range, in urban or forested areas; this makes the assault rifle the weapon of choice. Also, modern conflicts in developing areas involve many confrontations between soldiers and civilians. These take the form of raids, conducted by militias for the purposes of looting, punishing, or abducting new recruits. Such raids can be entrusted to child soldiers, since they generally do not involve an armed adversary.

The conjecture that (11) holds, at least in some countries, is supported by anecdotal evidence. Ishmael Beah, a former child soldier in Sierra Leone, recounted his war experience in the book *A Long Way Gone*, published in 2007. Beah partook in both farming and soldiering, and was able to gauge his performance relative to adults in each of them. Prior to his becoming a soldier in the government army, he was asked to help clear some land for the inhabitants of a village through which he was passing. He wrote of the experience,

> Gibrilla's uncle assigned each of us a portion of bush to be cut down. We spent three days cutting down our portions. He was done in less than three hours. (...) I spent restless minutes swinging the cutlass with all my might at trees that he would cut with one strike. (pp. 41-42)

Once he was recruited, he learned his new trade very quickly, to the point that "killing had become as easy as drinking water" (p. 122). In some situations, Beah explains, children actually had an edge over adults:

> We went to work, killing everyone in sight. We didn't waste a single bullet. We had all gotten better at shooting, and our size gave us an advantage, because we could hide under the tiniest bushes and kill men who wondered where the bullets were coming from. (p.143)

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Proposition 2 states that if (11) and (12) hold then all children will be recruited. In reality it is never the case that *all* children are recruited. The correct interpretation is that under those circumstances warlords will recruit as many children as they can. In this they are limited by the number of children they can successfully abduct, the number they consider fit for soldiering, and the availability of weapons with which to arm them.

To see if (12) holds, one needs to estimate the value of the constant γ and the population ratio A/C. Let us define children as individuals under the age of 18 able to work or fight, say all individuals aged 10 to 17. And let us define adults as individuals who are 18 and over and able to work or fight. This includes minimally everyone aged 18 to 39.

The US Census Bureau has yearly population estimates for most countries, arranged by age groups 0-4, 5-9, 10-14, and so on. Note that the 15-19 group contains both children and adults. Therefore if we add the 10-14 and 15-19 groups together for a given country in a given year, we get a number which overreports C. And if we sum up the populations of age groups 20-24, 25-29, 30-34, and 35-39, we should get a number which underreports A. Yet for the years 1990 to 2008 and the countries where the use of child soldiers has been the most significant (Afghanistan, Angola, Chad, Democratic Republic of Congo, Liberia, Mozambique, Myanmar, Sierra Leone, Somalia, Sri Lanka, Sudan and Uganda), there was not a single case in which the former number exceeded the latter. This was true despite the fact that many of these countries have very high percentages of youngsters in their population, relative to other countries, due to birth rates in the vicinity of 4%. The population pyramid for Sierra Leone in 1990 (the year in which the civil war began there) is shown in Figure 1 by way of example.

There is strong evidence, therefore, that the ratio A/C is greater than 1. As for γ, this is a number between 0 and 1. It measures, in a sense, the value to the entrepreneur of using adult labor in the civilian activity. The more valuable the output, over and above the wage paid to the laborer, the higher is γ. In an area where agriculture is the main activity, γ is relatively low. But if labor is exploited to extract a valuable natural resource, such as diamonds in Sierra Leone or coltan[2] in the Democratic Republic of Congo, γ would be much closer to 1.

The other two ratios, ϕ_{CS}/ϕ_{AS} and $(\phi_{CF} + w_C)/(\phi_{AF} + w_A)$, are clearly less than 1, since children are less productive than adults generally, and are less costly to employ. When comparing these with $\gamma(A/C)$, then, scenario 1 emerges as very likely for resource-rich countries, particular if the extraction of the resource is physically demanding and so generally left to adults.

Proposition 3 says that under some conditions armies will be made up of children only. Naturally any real army will have a contingent of adults, at least enough to oversee operations. Nonetheless, the proportion of children in some armies *can* be

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[2]Coltan (columbite-tantalite) is a mineral used in the production of laptops, cell phones and DVD players.
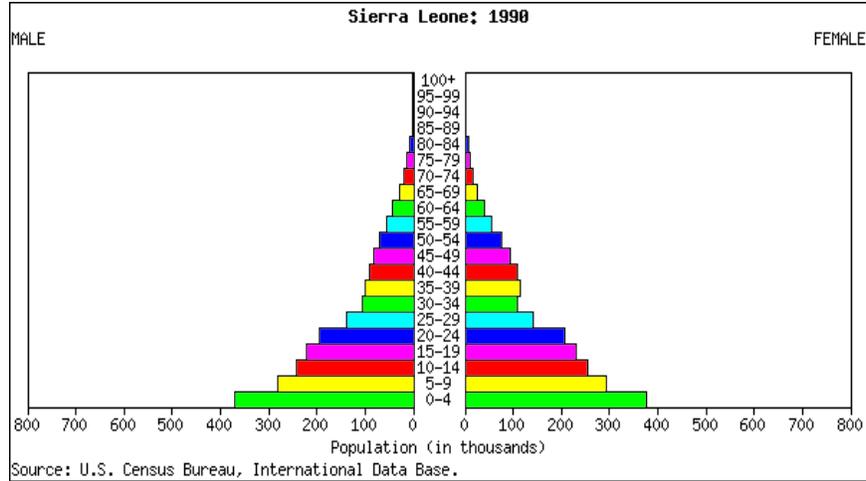
FIGURE 1. Population pyramid for Sierra Leone at the outset of the war. The distribution is heavily skewed towards low age groups, but A/C is still greater than 1.

quite remarkable: according to some reports, children made up as much 70% of all fighting forces in Liberia's most recent civil war, 80% of the Revolutionary United Front in Sierra Leone, and almost all of the Lord's Resistance Army in Uganda (Singer, 2005).

The constant δ is greater than 1. Since, as I have argued, A/C is also greater than 1, scenarios 5 and 6 are unrealistic.

2.3 Asymmetric equilibrium

Thus far I have assumed that the two groups fighting each other are symmetric. For this reason recruitment patterns were always the same on both sides. But a conflict may arise between two dissimilar groups.

I have found that if the two groups differ in size but not productivities, then qualitatively the results will be the same as before.[3] In particular, if (11) holds, all children in both groups will be recruited.

What could bring about an asymmetry in recruitment is a productivity difference between the two groups. This would be the case if the two groups were habitually (in peacetime) engaged in different economic activities, for example if one of them inhabits a rural area while the other is mostly city-based.

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[3]This is true as long as the difference between group sizes is not too lopsided. If one local population is greatly outnumbered by the other, that population's warlord will commit all his resources (all children and adults) to war, since he has so much to gain and so little to lose.

To examine this possibility, let us continue to assume that each group has A adults and C children; that the parameters ϕ_{AS}, ϕ_{CS} and ϕ_{AF} are the same for both groups; but that children's productivity in civilian life is ϕ_{CF1} in the first group and ϕ_{CF2} in the second, with $\phi_{CF1} < \phi_{CF2}$. Net output in group i becomes

$$\tilde{H}_i = (\phi_{AF} - w_A)(A - A_i) + (\phi_{CFi} - w_C)(C - C_i) \quad . \tag{14}$$

All other elements of the model are the same.

Under these circumstances, it may be the case that one warlord decides to recruit children while the other does not — all in the pursuit of self-interest. In one scenario, warlord 1 recruits all children in his group, warlord 2 recruits no children at all, and both warlords recruit some of the local adults. That is the equilibrium we obtain if $A > C$ and

$$\frac{\phi_{CF1} + w_C}{\phi_{AF} + w_A} < \frac{\phi_{CS}}{\phi_{AS}} < \frac{\phi_{CF2} + w_C}{\phi_{AF} + w_A} \quad . \tag{15}$$

More details on this equilibrium appear in the appendix. Condition (15) explains once again, this time with asymmetric adversaries, how comparative advantage leads to specialization. Children in warlord 1's group have a comparative advantage in soldiering, so he recruits them. Those in warlord 2's purview have an advantage in civilian production, therefore they are left to perform that activity.

Despite the asymmetry in recruitment, the two warlords have equal fighting strengths in this equilibrium, i.e. $S_1 = S_2$. And consequently they have equal expected payoffs, i.e. $\pi_1 = \pi_2$. Therefore group 2's higher civilian productivity does not give it an advantage over group 1.

3   Policy

In 2007 the Special Court for Sierra Leone (SCSL) convicted four military leaders on various charges, including child recruitment. Two more convictinos followed in 2009, on similar charges. Charles Taylor, former president of Liberia, is still on trial at the SCSL; he is charged with war crimes, including child recruitment, at the SCSL. (SCSL 2007, 2008, 2009). Thomas Lubanga, leader of the rebel group Union des patriotes congolais (UPC), is also on trial for child recruitment at the International Criminal Court (ICC) in The Hague (ICC, 2009). However, given the pervasiveness of child recruitment, these are very small steps. The very nature of war makes it extremely difficult to monitor compliance with international law and to identify and apprehend offenders. For this reason, efforts to stop child recruitment through legal action seem destined for limited and at best symbolic success.

If the international community wishes to stop the recruitment of children, it needs to remove or at least decrease the incentives for armies and militias to recruit them. In our model, this means changing the productivity parameters that warlords take as given when deciding whom to recruit.

3.1 Reducing child productivity in soldiering

Arms control is the most obvious and perhaps the only feasible way to affect the parameters ϕ_{AS} and ϕ_{CS}. By curbing the inflow of weapons to military groups, one decreases those groups' effectiveness in combat. The model makes some clear predictions about the consequences of such a measure. [This discussion refers to the symmetric model.]

Suppose that the current situation is scenario 1. Each side's army has

$$A_i \; = \; \frac{\phi_{AS}(\phi_{AF} - w_A)A \; - \; \phi_{CS}(\phi_{AF} + w_A)C}{2\phi_{AS}\phi_{AF}} \tag{16}$$

adult soldiers and C child soldiers, for a fighting strength of

$$S_i \; = \; \left(\frac{\phi_{AF} - w_A}{2\phi_{AF}}\right)(\phi_{AS}A + \phi_{CS}C) \quad . \tag{17}$$

If the nature of the embargo is to decrease both adult and child military productivity in roughly the same proportions, so that the ratio ϕ_{CS}/ϕ_{AS} remains essentially unchanged, then the following will happen: fighting strength S_i will decrease on both sides, from which we *may* expect a lower intensity of conflict; but the number of adults and children recruited will remain the same as before.

It is *relative* productivity, i.e. the ratio ϕ_{CS}/ϕ_{AS}, which must be altered if anything is to happen to recruitment. Let us suppose that a campaign to stop small arms traffic is successful enough to produce a drop in ϕ_{CS}/ϕ_{AS}. The question is whether this ratio decreases enough, i.e. whether it falls below $(\phi_{CF} + w_C)/(\phi_{AF} + w_A)$ or remains above it. If it remains above it, then the effect of the change will be to decrease each side's fighting strength S_i, *increase* adult recruitment, and leave child recruitment the same. This is a logical outcome: children continue to have a comparative advantage in soldiering, so they are all recruited; because of the change in productivity, each child can do less than before; to compensate, warlords hire more adults.

To make *any* impact on child recruitment, it is necessary to bring ϕ_{CS}/ϕ_{AS} down until (11) no longer holds. When this is done, child recruitment will fall to zero. Adult recruitment will increase, as warlords substitute older soldiers for younger ones. A rather aggressive initiative on small arms control would be needed. Unfortunately, small arms are the most difficult to control. Because of their size, they are easily smuggled; and because of their simplicity, they can be produced cheaply and discreetly, almost anywhere. The United Nations Programme of Action[4] tries to engage member states in such an effort, but progress has been slow.

In addition to tracking new weapons, managing existing stocks is essential. In 1997, about 643,000 small arms disappeared from Albanian government stockpiles

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[4] The full name is Programme of Action to Prevent, Combat, and Eradicate the Illicit Trade in Small Arms and Light Weapons, in All Its Aspects (UN Document A/CONF.192/15).

(Small Arms Survey, 2002). After the fall of the Hussein government in Irak in 2003, between 7 and 8 million small arms were looted from the government arsenal (Small Arms Survey, 2004). Other sizeable transfers of this sort have been reported in Russia, Uganda, Somalia, and eleswhere. Most of these weapons probably entered the international black market very quickly.

3.2   Some remarks on child labor bans

One of the built-in assumptions of this model is that children will be employed no matter what. They will be either soldiers or civilian workers. A richer model might offer them a third activity, namely education. But schoolchildren contribute very little to civilian output in the short run. So according to the logic of this model, they would be prime targets for forced recruitment. This has in fact been observed: Brett and McCallin (1998) speak of recruitment raids in Myanmar schoolyards.

The surest way for a child to avoid direct participation in war is to be more productive in something else. In this light, civilian child labor, being the lesser of two evils, has its attractive side.

Movements to ban child labor in all its forms have received mixed responses from the academic community. Scholars agree with the overall intent of the ban's advocates, but caution that the possible consequences of such a policy should be carefully studied before it is implemented. Basu and Van (1998) show that a ban on child labor, because of its effect on household incomes, could make children worse off. Basu (1999) reviews other arguments against a ban raised in the literature. Dessy and Pallage (2005) point out that a ban on *harmful* child labor (what the ILO calls the worst forms of child labor) would cause children to switch to *non-harmful* labor, thereby lowering the wage in that sector and possibly causing an overall decrease in welfare.

This paper provides a different warning. A ban on child labor would reduce ϕ_{CF} dramatically. This could affect what happens to children if war breaks out. If a country has developed an industry in which children are highly productive, then that country might be in scenario 4 at the onset of war, provided there is no ban on child labor. Condition (11) would not be satisfied, and children would not be recruited. But if there is a ban, the country will assuredly find itself in scenario 1, 2 or 3. Thus a ban on child labor might, quite inadvertently, contribute to the problem of child soldiering. Children who could have worked in civilian production become soldiers instead. Since soldiering is probably *the* worst form of child labor, the switch occurs in the opposite direction as that considered by Dessy and Pallage. Could the ban be abandoned in wartime? At that point it might be too late to reintroduce children to the industry, because of the training and equipment involved.

4 Conclusion

From an economic standpoint, civil war is a struggle to control a country's domestic product. But war also diverts resources away from production. This is the essential tradeoff of conflict. In this model, adults and children are considered inputs in both production and war. In that light, the decision whether to recruit adults or children as soldiers is a managerial one, based on the two age groups' productivities in both sectors.

I find that if children have a comparative advantage in soldiering, i.e. if their productivity relative to that of adults is higher in soldiering than in civilian production (adjusting for wages), then there will be child recruitment. Putting an end to the recruitment of children is therefore a matter of removing their comparative advantage in soldiering. Controlling the traffic of small arms, though admittedly a difficult proposition, could produce dramatic results in the right direction. However, a ban on child labor may actually *give* children a comparative advantage in soldiering where none existed before.

Appendix A: Symmetric equilibrium

The following identifies the six corner solutions and the parameter ranges which give rise to them. Since π_i is strictly concave in (A_i, C_i), there cannot be multiple equilibria. Proposition 1 follows from scenarios 1, 2 and 3. Proposition 2 follows from scenarios 1 and 2. And Proposition 3 follows from scenarios 2 and 3.

Scenario 1: Suppose $\frac{\phi_{CF}+w_C}{\phi_{AF}+w_A} < \frac{\phi_{CS}}{\phi_{AS}} < \gamma\left(\frac{A}{C}\right)$. Then equilibrium is given by:

$$A_i = \frac{\phi_{AS}(\phi_{AF}-w_A)A - \phi_{CS}(\phi_{AF}+w_A)C}{2\phi_{AS}\phi_{AF}} \quad ; \quad C_i = C \quad . \tag{18}$$

This satisfies $d\pi_i/dA_i = 0$, $d\pi_i/dC_i > 0$ and $0 < A_i < A$.

Scenario 2: Suppose $\frac{\phi_{CF}+w_C}{\phi_{AF}+w_A} \leq \gamma\left(\frac{A}{C}\right) \leq \frac{\phi_{CS}}{\phi_{AS}}$ (with one strict inequality). Then equilibrium is given by:

$$A_i = 0 \quad ; \quad C_i = C \quad . \tag{19}$$

This satisfies $d\pi_i/dA_i \leq 0$ and $d\pi_i/dC_i \geq 0$.

Scenario 3: Suppose $\gamma\left(\frac{A}{C}\right) < \frac{\phi_{CF}+w_C}{\phi_{AF}+w_A} < \frac{\phi_{CS}}{\phi_{AS}}$. Then equilibrium is given by:

$$A_i = 0 \quad ; \quad C_i = \frac{(\phi_{AF}-w_A)A - (\phi_{CF}-w_C)C}{2\phi_{CF}} \quad . \tag{20}$$

This satisfies $d\pi_i/dA_i < 0$, $d\pi_i/dC_i = 0$ and $0 < C_i < C$.

Scenario 4: Suppose $\frac{\phi_{CS}}{\phi_{AS}} < \frac{\phi_{CF}+w_C}{\phi_{AF}+w_A} < \delta\left(\frac{A}{C}\right)$. Then equilibrium is given by:

$$A_i \; = \; \frac{(\phi_{AF}-w_A)A \; - \; (\phi_{CF}-w_C)C}{2\phi_{AF}} \quad ; \quad C_i \; = \; 0 \quad . \tag{21}$$

This satisfies $d\pi_i/dA_i = 0$, $d\pi_i/dC_i < 0$ and $0 < A_i < A$.

Scenario 5: Suppose $\frac{\phi_{CS}}{\phi_{AS}} \leq \delta\left(\frac{A}{C}\right) \leq \frac{\phi_{CF}+w_C}{\phi_{AF}+w_A}$ (with one strict inequality). Then equilibrium is given by:

$$A_i \; = \; A \quad ; \quad C_i \; = \; 0 \quad . \tag{22}$$

This satisfies $d\pi_i/dA_i \geq 0$ and $d\pi_i/dC_i \leq 0$.

Scenario 6: Suppose $\frac{\phi_{CF}+w_C}{\phi_{AF}+w_A} < \frac{\phi_{CS}}{\phi_{AS}} < \gamma\left(\frac{A}{C}\right)$. Then equilibrium is given by:

$$A_i \; = \; A \quad ; \quad C_i \; = \; \frac{\phi_{CS}(\phi_{CF}-w_C)C \; - \; \phi_{AS}(\phi_{CF}+w_C)A}{2\phi_{CS}\phi_{CF}} \quad . \tag{23}$$

This satisfies $d\pi_i/dA_i > 0$, $d\pi_i/dC_i = 0$ and $0 < C_i < C$.

Appendix B: Asymmetric equilibrium

Here I describe only the equilibrium mentioned in Section 2.3. There are many other possibilities. The condition $A > C$ mentioned in the text is stronger than necessary and used for brevity.

Suppose that (15) holds and that

$$2\left(\frac{A}{C}\right) \; > \; \gamma\left(\frac{\phi_{CS}}{\phi_{AS}}\right) + \left(\frac{\phi_{CF2}-w_C}{\phi_{AF}+w_A}\right) \quad . \tag{24}$$

Then in equilibrium

$$A_2 \; = \; \frac{(\phi_{AF}-w_A)\,(2\phi_{AS}A+\phi_{CS}C) \; + \; \phi_{AS}(\phi_{CF2}-w_C)C}{4\phi_{AS}\phi_{AF}} \quad ; \tag{25}$$

$$A_1 \; = \; A_2 - \left(\frac{\phi_{CS}}{\phi_{AS}}\right)C \quad ; \tag{26}$$

$$C_1 \; = \; C \quad ; \quad C_2 \; = \; 0 \quad . \tag{27}$$

This satisfies $d\pi_i/dA_i = 0$ and $0 < A_i < A$ for both values of i, as well as $d\pi_1/dC_1 > 0$ and $d\pi_2/dC_2 < 0$.

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