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Battlefields and Marketplaces

By
Halvor Mehlum and Karl Ove Moene

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Battlefields and Marketplaces[1]

Halvor Mehlum and Karl Ove Moene

5th June 2002

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Abstract

Divided societies in the developing world experience wasteful struggles for power. We study the relationship between political stability and resources wasted in the struggle within a model of competitive power contests. The model of power contests is similar in structure to models describing oligopolistic market competition. This analogy helps us in deriving results that are new to the conflict literature. We show, for example, that the Herfindahl-Hirschman index can be interpreted as a measure of power concentration and that a peace treaty between fighting groups have a parallel in tacit collusion between firms in a market.
JEL code: C70, D23, D74
Key words: Violent conflicts, Rent-seeking games, Herfindahl-Hirschman index, Oligopolistic competition.

> ... the efforts of men are utilized in two different ways: they are directed to the production or transformation of economic goods, or else to the appropriation of goods produced by others. War, especially in ancient times, has enabled a strong nation to appropriate the goods of a weak one; within a given nation, it is by means of laws and, from time to time, revolution, that the strong still despoils the weak. [...] It is obvious that the maximum economic advantage for society is not obtained in this way.
> Vilfredo Pareto: *Manuale di economia politica*, 1906 (transl. 1972 p. 341)

1 Introduction

How does the violent contest between MPLA (Movimento Popular de Libertação de Angola) and UNITA (União Nacional de Indepêndencia Total de Angola) in Angola differ from the market contest between McDonalds and Burger King? In theory at least, one may wonder whether a civil war, in which groups fight over rents, is strategically any different from oligopolistic market competition between producers. In both arenas the contenders incur costs in order to capture the highest expected payoffs. They engage in a strategic game where higher effort by one lowers the return to the other.

By addressing this question we may better understand the logic of conflicts and hopefully also the determinants of the violence that plagues poor countries today. There is a tradition in the conflict literature[1] of modelling violent conflicts as strategic contests that formally have similarities to models of oligopolistic competition. Even though the strategic interaction in markets and in battlefields are similar to each other, the major normative conclusions are diametrically different. In markets contenders compete by supplying commodities, which enhance social welfare. In the battlefield contenders compete by supplying violence which harms social welfare. Hence, while a tough market competition implies low social waste, a tough competition in the battlefield implies high social waste.

More specifically, in the marketplace welfare is best served by many contenders that are equally efficient and never collude. In the battlefield such a competitive structure spells serious trouble. For a given number of contenders the social waste is highest when all contenders are equal. Thus, what we want to prevent in the marketplace is exactly what we want to see in the battlefield. This is especially true for the phenomenon of collusion, which prevents efficient competition in markets. In the battlefield collusion among all the contenders implies peaceful sharing of the rents without wasted lives and resources.

In this paper we explore some analogies and contrasts between games of market competition and games of power struggles. Well-known results from the conflict literature appear in a new perspective. In particular, we find that the Herfindahl-Hirschman index of market concentration has a parallel in the conflict model as a measure of dominance of one group over the others. This measure is both directly related to the amount of resources wasted in the fight and to the turnover of winners in the contest. Moreover, entry and exit, which play an essential role in theories of market behavior, have unexplored implications for the theory of power struggles.

[1] See for example the contributions by Tullock (1980), Hirshleifer (1991 and 1995b), Skaperdas (1992) Grossman (1994), Grossman and Kim (1995), Konrad and Skaperdas (1998), Clark and Riis (1998), Mehlum and Moene (2000), and Tangerås and Lagerlöf (2002).

We are interested in several questions in this connection. Does a more fractionalized society imply that a larger or a smaller number of the groups participate in the fightings? Does a larger number of war-efficient groups drive the least war-efficient groups from the battlefield? Incorporating endogenous participation, or simply entry and exit of fighting groups, casts doubt on the generality of some of the established results in the conflict literature. Finally, the implications of group heterogeneity may also change once collusion possibilities are allowed. Equity among groups, which tends to maximize the extent of fighting once it is started, reduces the chance that the fighting starts in the first place.

The type of conflict model that we consider was first discussed in a little recognized contribution by Haavelmo (1954), who in turn was inspired by the remark made by Pareto, cited above. We use a simple version of the model where contenders fight over a fixed rent. The contest success function (or allotment function as Haavelmo called it) is of ratio form where the probability that group k wins is equal to this group's fighting effort relative to that of the other groups. Using this specification we get a closed-form solution where the parallel to an oligopolistic market with unit demand elasticity is immediate.

2 The basic model

There is a given number of groups N that in each period compete for power. The winner receives a rent R. The rent includes for example the value of natural resources under government control and the inflow of aid and loans from abroad. Each period starts with all groups deciding on their fighting effort y_k. When fights are violent, y_k includes armaments, mercenaries, and field rations. (When fights are non-violent, y_k may capture resources used for vote buying, election rigging, and favoritism). The problem for each group $k = 1 \dots N$ is to maximize each periods expected pay-off, v_k, given by

$$v_k = \rho_k R - \alpha_k y_k, \quad \text{where } \rho_k = \frac{y_k}{Q} \text{ and } Q = \sum_{i=1}^{N} y_i \tag{1}$$

In (1), the probability of winning the rent, ρ_k is given as group k's fighting effort, y_k, relative to the total fighting effort of all groups, Q. The value of Q includes the total resources (armaments and soldiers) brought to the battlefield. Thus, Q measures the extent of the fight. If fights are non-violent, Q then measures the total flow of payments and favors within political networks and cliental structures.

In (1) α_k captures group k's opportunity costs of providing one unit of fighting to the battle. Generally, α_k measures group k 's efficiency in production *relative* to fighting. One unit of fighting costs α_k units of foregone production. Hence, the opportunity cost α_k is low when group k either is an efficient fighter or has a low alternative productivity. These fighting costs may depend on the size of the groups. For instance, if smaller groups are more cost efficient in fighting, they would have a low α coefficient.

In the following we assume that the α coefficients are constant and we refer to them as the fighting costs with the interpretation just given. Moreover, we also assume, for now, that all groups are sufficiently efficient to chose to participate in the fight. In the Nash equilibrium of the game the first-order condition for each group is given by

$$\frac{\partial v_k}{\partial y_k} = \frac{Q - y_k}{Q^2} R - \alpha_k = 0. \tag{2}$$

Hence, we assume an interior solution to the problem. Realistically, there are some resource constraints on each group's fighting y_k. We return briefly to consequences of a binding resource constraint for instance for the smaller and deprived groups (see footnotes 5 and 6), but in most of the presentation we assume that the resource constraints are not binding. Combining (2) with the definition of ρ_k yields the equilibrium probability of winning

$$\rho_k = 1 - \frac{\alpha_k Q}{R}. \tag{3}$$

Inserting (3) in (1) yields the expected net payoff in equilibrium[2]

$$v_k = \rho_k^2 R. \tag{4}$$

Summing both sides of (3) over the number of groups and using the identity $\sum_{i=1}^{N} \rho_i = 1$ give

$$Q = \frac{R}{P}, \tag{5}$$

where

$$P = \frac{N\bar{\alpha}}{N-1}. \tag{6}$$

Using the identity $P = R/Q$ from (5), equation(3) can be expressed as

$$\rho_k = 1 - \frac{\alpha_k}{P}, \tag{7}$$

which, in turn, combined with the definition $\rho_k = y_k/Q$, yields

$$y_k = \frac{R}{P}\left(1 - \frac{\alpha_k}{P}\right). \tag{8}$$

Thus, the extent of the fight Q, the effort y_k of group k and the expected pay-off v_k of group k are proportional to the contested rent R. Group k's fighting effort y_k and its chance of winning the prize ρ_k are higher, the lower the cost α_k relative to the average $\bar{\alpha}$.[3] The value of P measures the average gross return to fighting, since from (5) $P = R/Q$. This definition of P establishes the bridge between conflicts and markets as discussed below.

Fighting is detrimental to social welfare because it diverts resources from production and causes suffering. Concentrating on the opportunity costs, we offer a conservative

[2]Note that (1) can be written $v_k = (1 - \alpha_k Q/R)\,\rho_k R$.

[3]We have explicitly assumed that all y_k are positive in equilibrium. As we discuss below, (8) represents a participation constraint, such that group i withdraws from the fight if $\alpha_i > P$. The analytical solution (8) would otherwise yield a negative fighting effort, which of course is nonsense.

measure of the social waste:

$$W = \sum_{i=1}^{N} \alpha_i y_i. \tag{9}$$

Surely the sum of opportunity costs, W, underestimates the total social waste, because we do not account for the destruction of resources and the loss of lives among the civilian population. In addition, complementarity in production implies that a shift of resources away from productive activities lowers the income also of non-fighting groups. Stark examples of the cost imposed on the third party are the war-related famines in Biafra (1967), Ethiopia (periodically from 1970's to the present), and Somalia (1991-95). All these costs are positively related to W and in the following we stick to the conservative measure of resources wasted. The fraction of the rent that is wasted in the contest – the waste ratio ω – is given by the waste relative to the size of R. Based on (5)-(9), it follows after some manipulations, that

$$\omega = \frac{W}{R} = \frac{N-1}{N} - \frac{(N-1)^2}{N}\gamma^2, \tag{10}$$

where γ^2 is the coefficient of variation $(\gamma^2 = \text{var}(\alpha_i)/\overline{\alpha}^2)$.

The discussion above can be summarized in the following proposition (part of which is discussed in Nitzan 1994):

Proposition 1 *i) The extent of the fight, Q, is greater when either the prize is larger or the fighting costs $\bar{\alpha}$ are lower. The extent of fighting is, however, independent of γ, which measures the heterogeneity of the groups' fighting costs. The fight is harder, the higher the number of groups N involved in the battle. ii) The social waste W is greater when a larger prize is at stake, but is independent of the fighting costs $\bar{\alpha}$ and declines with the heterogeneity of the groups' fighting costs. If the heterogeneity γ is low, social waste goes up with the number of groups. If $\gamma > (N^2-1)^{-1/2}$, however, the social waste goes down as the number of fighting groups rises.*

Proof. Part i) follows from (5) where a low $\bar{\alpha}$ captures a low opportunity cost of fighting. Part ii) follows directly from (10) ■

The fighting becomes more intense when the average opportunity cost of fighting $\bar{\alpha}$ declines. Even a small prize may therefore produce intensive fights if the fighting groups have little to lose. Striking examples of low $\bar{\alpha}$ are the mobilization of unemployed kids in rebellion armies and civil wars throughout Africa. "They need less food than adult soldiers, take up less space and can do without a wage" (The Economist 1999). According to Save the Children(1998) there are 31,000 children soldiers in Sudan, 20,000 in Rwanda and 5-10,000 in Uganda, Congo, Sierra Leone, Angola, and Burundi. In the model, adding a group with the average cost $\bar{\alpha}$ increases the extent of the fight but at a declining rate. The more intense the fighting, the lower is the incentive to fight for an additional group.[4]

[4] As pointed out, we assume that all groups are free to adjust their fighting at fixed opportunity cost α_k. If one group's fighting were limited by a resource constraint ($y_k \leq \bar{y}_k$), say because of its small size, the solution to the model would change. It is straight forward to show that if one group is constrained to a level of fighting below its optimal level, the other groups would fight somewhat harder. Total fighting would anyhow be below the unconstrained case.

Greater cost differences across groups implies that less resources are wasted in the struggle for power. When one group obtains lower costs of fighting, it becomes relatively stronger than its challengers. Faced with a more potent opposition, other groups reduce their spending on unproductive fighting. When high-cost groups spend less, it is optimal also for low cost groups to reduce their spending; hence, total waste declines with group heterogeneity. Paradoxically, efficiency requires one dominant group. Waste declines, the stronger is one group relative to the others. "Fair fights," where each group is equally strong, produces the maximum level of social waste. It should be noted, however, that the concept of social waste that we use has a rather narrow interpretation in which no weight is put on distributional aspects. A society with a powerful dictator who is able to collect all the rent into his pocket without any fighting, has a low level of waste in this conception.

From (7) it follows that for the average group (the group with $\alpha = \bar{\alpha}$) the probability of winning is $1/N$ which yields an expected net return of only R/N^2. When all groups are equal, each of them only gets a share $1/N^2$. The social waste ratio in this case is simply $(N-1)/N$ which is increasing in the number of groups but at a decreasing rate. When N is large the waste ratio approaches one.

Fractionalized societies have many groups. Fights in fractionalized societies are therefore particularly intense. Whether fractionalization implies a high social waste or not, however, depends on how different the groups are with respect to productive opportunities, as captured by the value of γ. Note that for a positive γ the expression (10) is a hump-shaped function of N.

3 Parallels to oligopoly theory

In his overview of economic theories of conflict, Hirshleifer (1995a) points out several analogies between markets and conflicts but without exploring them further. In this section we want to take a closer look at these analogies. The results in Proposition 1 are derived from a model that is similar to the Cournot model of oligopoly. To see this, consider a market with unit demand elasticity, $Q = R/P$, where Q is the total demand, P the price and R the value of total sales in the market. A number of firms N supply identical goods y_k with constant marginal cost α_k. Hence, supply is $Q = \sum y_k$ and y_k/Q denotes firm k's market share. Applied to such an oligopoly model equation (1) describes firm k's profit and the Nash equilibrium is described by equations (4)-(6). All the results we have derived can therefore be translated directly to the oligopoly market case. Conversely, several results from the theory of oligopolistic markets can be translated to the case of violent conflicts.

In the oligopolistic market, the equilibrium price is determined by (6), the marketed quantity by (5), and each firm's return by (4). In the oligopoly model, ρ_k, given by (7), has two interpretations; it represents firm k's market share as well as the Lerner measure of monopoly power:

$$\rho_k = \frac{y_k}{Q} = \frac{P - \alpha_k}{P}. \tag{11}$$

In spite of analytical similarities, the welfare implications of oligopolistic competition are diametrically different than conflict on the battlefield. In an oligopolistic market, $Q = \sum y_k$ is a private good brought to the market, while, in the case of war, Q is a public bad brought to the battleground. This important distinction shows up as we now turn to

a comparison of power dominance to market dominance.

Dominance and the Herfindahl-Hirschman Index.

From Cowling and Waterson (1976), we know that in oligopolistic markets the ratio of profits to revenue $\sum v_k/R$ is directly related to the Herfindahl-Hirschman index of market concentration. Such a connection between dominance and payoff also exists in the conflict model. By definition the Herfindahl-Hirschman index of concentration μ is

$$\mu \equiv \sum_{k=1}^{N} \left(\frac{y_k}{Q}\right)^2.$$

In markets μ measures the concentration of firms' market shares. Here, μ measures the concentration of groups' relative fighting effort. Using the definition $\rho_k = y_k/Q$ and (4), we have that

$$\mu = \sum_{k=1}^{N} \rho_k^2 = \sum_{k=1}^{N} v_k/R, \tag{12}$$

which shows that the Herfindahl-Hirschman index of fighting effort equals the ratio of total net returns to total rents. The second equality of (12) demonstrates that μ is also a measure of concentration of the winning probabilities of the warring groups. In fact, μ is the probability that the same group is the winner in a hypothetical case of two subsequent battles. A high μ is therefore equivalent to a situation with a high stability of winners, or simply power dominance. In Mehlum and Moene (2000), we undertake an explicit analysis of stability in a dynamic model of violent conflict, where we also include the feature that the incumbent has an edge.

The measure of power dominance μ is directly related to the waste ratio ω. As ω is the fraction of the rents that is wasted in the contest, while μ is the fraction not wasted, it is immediate that

$$\omega = 1 - \mu. \tag{13}$$

Combining these observations, we get the following proposition

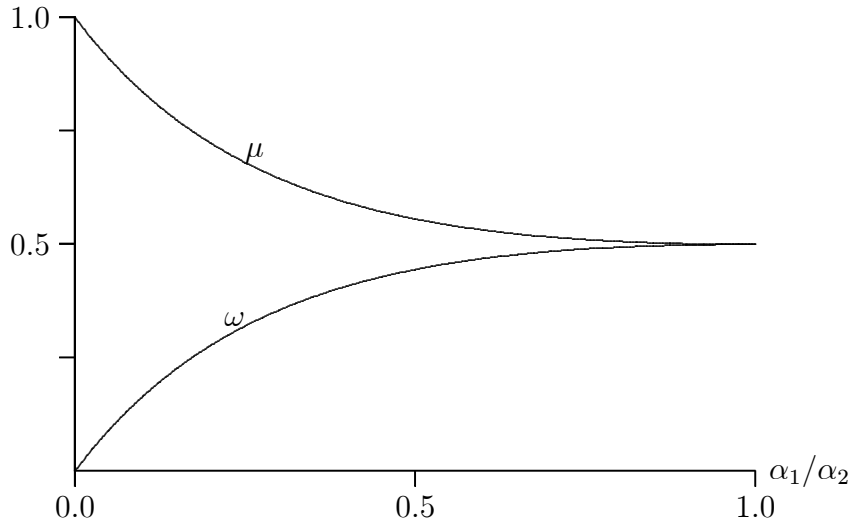
Proposition 2 *The power dominance is high when the heterogeneity of the groups' fighting costs is high. Dominance and social waste are inversely related.*

Proof. The proof follows directly from (10) and (13) ■

Fractionalized societies with groups of equal strength have particularly wasteful power struggles and a high turnover of winners. The average frequency of each group k being the incumbent is of course equal to ρ_k. Thus on average the groups with the lowest fighting costs are most likely to be the winner. If the cost of fighting for one particular group approaches zero, while the costs of the others remain fixed, the group that can fight for free will be the incumbent forever and none of the potential challengers are willing to take up the fight.

One example is illustrated in Figure 1, where there are two groups, with $\alpha_1 \leq \alpha_2$. In the two group case $\gamma = (1 - \alpha_1/\alpha_2) / (1 + \alpha_1/\alpha_2) < 1$. When the two groups are equal the waste is 1/2 and stability is 1/2 ($\alpha_1/\alpha_2 = 1$ and $\gamma^2 = 0$). When the cost for the

Figure 1: Stability and social waste



superior group declines the political stability increases while the waste decreases. In the limit where the superior group has zero cost ($\alpha_1/\alpha_2 = 0$ and $\gamma^2 = 1$) stability is absolute and waste is zero.

In oligopolistic markets the variable ω reflects the degree of market power. By using (5), (9), and (13), we can show that

$$P = \left(1 + \frac{\mu}{\omega}\right) c, \quad \text{where} \quad c = \frac{W}{Q} = \frac{\sum_{k=1}^{N} \alpha_i y_i}{\sum_{k=1}^{N} y_i}. \tag{14}$$

Here, c is the market-wide average cost and μ/ω is, therefore, the average profit margin. Figure 1 thus illustrates that this profit margin rises sharply and approaches infinity as one firm captures the market dominance due to declining costs. To rephrase Proposition 2 to the context of the marketplace: *The index of dominance μ is high when the heterogeneity of firms' unit costs is high. The average profit margin ($\mu/(1-\mu)$) rises when the index of dominance goes up.* Note, however, that the price itself depends only on the average cost $\bar{\alpha}$ and the number of firms, according to (6).

3.1 Entry and Exit

So far the number of fighting groups in the battlefield has been exogenously fixed. Entry and exit are of course equally important in battlefields as it is in the marketplace. Proposition 1 states that social waste goes down as the heterogeneity of the groups' strengths increases for a fixed number of groups. However, the premise that the number of groups is fixed, while the heterogeneity increases (or that the number of groups increases while the heterogeneity is constant) is unrealistic. In order to have a more meaningful analysis, one has to incorporate a participation constraint. For example, as the heterogeneity of costs goes up, the least efficient groups will choose to withdraw from the fight altogether. The analytical solution of the model with exogenous participation implies that such a marginal group contributes with negative fighting effort, which of course is nonsense.

The condition for participation of group k is that the marginal fighting effort has a positive effect on expected returns. Let P_k be the value of $P = R/Q$ evaluated in the Nash equilibrium where all groups but k participate. Then the condition for group k to

want to participate in the fighting is that its gain from participation is larger than the associated opportunity cost,

$$P_k > \alpha_k. \tag{15}$$

If this condition is not fulfilled, the group becomes a non-participant by setting its fighting effort y_k equal to zero. In the language of market competition, a positive price-cost margin is required to enter the market. Hence, as long as there is some degree of heterogeneity in the α's, there is a limit for the growth in the number of groups/firms. From (6) we see that as N goes up, the variable P gets arbitrarily close to $\bar{\alpha}$ and for a sufficiently large number of groups, condition (15) is not fulfilled for the group with the highest cost α.[5]

The relationship between the number of groups and social waste can be strongly affected when there is endogenous participation. This is demonstrated by the following example, where we must distinguish between the total number of groups M and the number of participating groups N. In the example, we vary M and keeps the heterogeneity of groups γ the same.

- **Example:** Let the total number of potential groups be M. Let 1/3 of these be efficient with $\alpha_k = 1$ and let 2/3 be inefficient with $\alpha_k = 2$. In that case the coefficient of variation for all groups is $\gamma_M^2 = 2/25$. Based on (15), it follows that:

  1. If $M \leq 6$, all groups participate and, from (10),it follows that $\omega = \dfrac{M-1}{M} - \dfrac{(M-1)^2}{M}\gamma_M^2$.
  2. If $M > 6$, only the efficient groups participate and N is therefore equal to $M/3$. Hence, from (10), it follows that $\omega = \dfrac{M/3-1}{M/3} = \dfrac{M-3}{M}$.

Waste as a function of potential groups M is illustrated in Figure. 2 Note that in the figure waste is a continuous function of M, given by (10).

The most important feature is the kink at $M = 6$. As the number of groups grows the least efficient groups eventually choose to leave the fight - i.e., at $M = 6$. When $M > 6$, only the $M/3$ efficient groups, all equally efficient, participate in the fight. In the example, the effect of decreasing group heterogeneity dominates the drop in number and the slope of the waste ratio curve turns positive when $M > 6$.

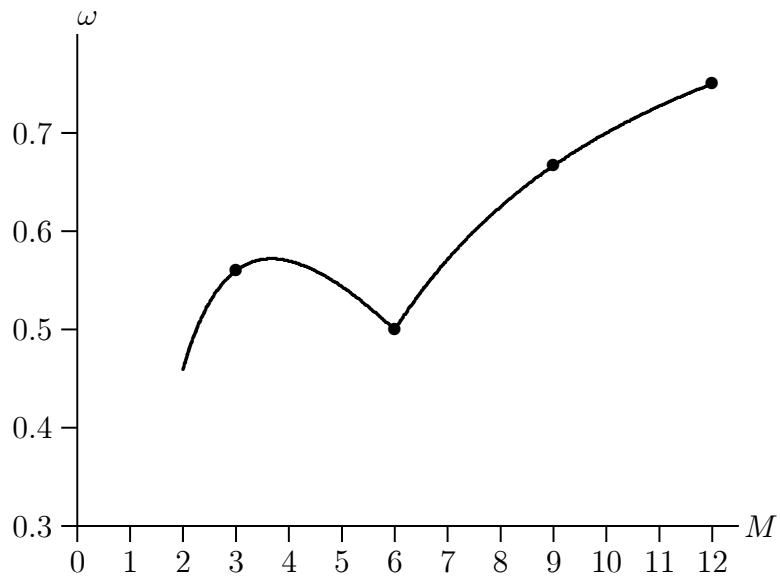
Figure 2 also illustrates the hump associated with Proposition 1, ii). When $M < 6$, all groups participate ($N = M$) and the waste is determined by (10), which has its maximum for $N = \sqrt{27/2} \approx 3.7$. The waste curve increases to the left and decreases to the right of $M = 3.7$.[6] In the example, the waste in the case of 6 groups is below the waste in the case of 3 groups, even though γ is the same in both cases.

The intuition is as follows: In the case of 6 groups the two efficient ones do all the fighting and the inefficient groups are indifferent between participating or not (condition

[5]Note that if some of the participating groups had their fighting limited by a resource constraint, P_k would increase and a larger number of less efficient groups could choose to participate in the fighting. In the case where groups are resource constrained, a larger variety of groups could therefore be taking part in the fighting.

[6]Note that for $M \leq 6$ Figure 2 illustrates all cases where $N = M$ and $\gamma^2 = 2/25$.

Figure 2: The relationship between waste and numbers, an example



(15) holds with equality). When the number of groups is 3, only one of them is efficient. This invites fighting by the less efficient groups so that waste goes up. The net returns accruing to efficient groups go down because the waste ratio goes up at the same time as the least efficient groups obtain a positive share of the rents. The intuition is similar to that behind the possibility that a merger in an oligopolistic market may lead to a loss for the merging firms (see Salant, Switzer and Reynolds 1983 who call the result "bizarre"). In both the battlefield and the marketplace the result hinges on the assumption that the contenders cannot commit to a certain level of supply. If commitment were possible, Stackelberg-like situations may arise. We now turn to the possibility of a peaceful outcome were all groups implicitly or explicitly agree not to fight.

3.2 Collusion or Warfare

One of the early contributions in the literature on collusion in markets (Bishop 1960) is titled "Duopoly: Collusion or Warfare," which could not have been more appropriate in the present context. As we show above, fights over resource rents imply waste. Just like suppliers in a market sometimes collude to extract the monopoly rents, fighting groups could gain much if they agreed not to fight and share the rent.[7] Collectively, the groups then avoid the waste of resources, realizing a peace dividend of ωR.

Consider the case where the groups split the rent R such that each group gets a share of the rent $\sigma_k R$ as long as they do not fight. If in the case of deviation there is an instant Nash reversion, all M groups would participate if

$$\left(\sigma_k - \rho_k^2\right) R > 0, \quad k = 1 \ldots M, \quad \text{where} \quad \sum_{k=1}^{M} \sigma_k \leq 1. \tag{16}$$

[7]In the language of realpolitik this could be labeled a non-aggression pact. See Sandler and Hartley (2001) for an overview of the economics of alliances and Skaperdas (1992) for an alternative view on cooperation.

Condition (16) is similar to the condition for collusion in oligopolistic markets backed by trigger strategies (Friedman 1971).[8] The main difference is that we assume instant Nash-reversion.

In markets, collusions are fragile arrangements. In the literature, effective collusion is less likely when monitoring is difficult or when the authorities are actively penalizing collusion. These problems are not as relevant in the case of a treaty bringing peace instead of violent conflict. All parties have an interest in transparency and the collusion need not be a clandestine arrangement.

That all groups have a gain is obviously feasible for many combinations of the σ's. One possibility is that the shares σ_k are determined by the relative strengths of the groups. e.g., distributing according to the expected shares of the rents ($\sigma_k = \rho_k$), or according to expected net gains ($\sigma_k = \rho_k^2 / (1-\omega)$). In these cases, collusion would be an attractive possibility for all fighting groups. The rules are robust to small stochastic shocks to the parameters as all groups have a strictly positive gain compared to fighting.

Several peaceful sharing arrangements of the rents are always possible. An equal sharing based on relative group size, however, may not always satisfy the conditions for peace. The risk that such equal sharing breaks the condition for sustained peace is high when either a large part of the population is not part of any potentially fighting groups or there are some groups that are small in number but efficient in fighting.

Alternatively, σ_k can be determined by economic strength, such that groups with high private earnings (high α_k) obtain a high share of the rents as well. In this case, groups with low α_k may find it worthwhile to fight as their gain from peace easily becomes negative ($\sigma_k - \rho_k^2 < 0$).

The outbreak of violent conflicts may be affected by additional factors. Group k's narrowly calculated expected net gain from peace relative to conflict is $(\sigma_k - \rho_k^2) R \geq 0$. This inequality may be reversed by incorporating additional factors such as mistaken perceptions, hatred, or vengeance. Since it only takes one group to start a violent conflict, the peace is more secure the larger is the expected net gain for each group. When, however, the expected net gain for a group is low, the inclusion of other factors may easily change the inequality and trigger a conflict. A policy of pragmatic conflict prevention could then be to maximize the minimum expected net gain among all groups. Or formally

$$\max_{\sigma_1 \ldots \sigma_M} \left(\min_k \left(\sigma_k - \rho_k^2 \right) \right), \quad \text{subject to} \quad \sum_{k=1}^{M} \sigma_k = 1 \tag{17}$$

$$\Rightarrow \sigma_k = \frac{\omega}{M} + \rho_k^2 \quad k = 1 \ldots M. \tag{18}$$

With this rule all groups get an equal expected net gain from sustained peace by adding equal shares of the peace dividend $\omega R/M$ to their conflict return $\rho_k^2 R$.[9] The principle behind (17) has a Rawlsian flavor of distributive justice, but our justification is somewhat different. One interpretation of Rawls is that inequalities should only be accepted as long as they contribute to a better outcome for the worst-off group. Our pragmatic policy (17) maximizes the probability of peace and therefore minimizes the probability that the

[8] We use M to indicate the number of groups. In order for an agreement to work, all groups must benefit from it, also the least efficient that would not participate in a full fight. These groups have $\rho = 0$ and need only a small share σ as compensation.

[9] Note that this sharing arrangement also benefits the non-fighting groups who have $\rho = 0$.

worst-off group is left with its conflict payoff only. By maximizing the probability of peace, the pragmatic policy can be interpreted in utilitarian terms since it maximizes the expected peace dividend.

The peace dividend is high in societies in which fighting would have been particularly wasteful. Equal societies, with an equal distribution of α's, would have the most costly violent conflicts once conflicts start. Therefore, the peace dividend is high and the risk of conflict is low as long as the peace dividend is distributed equally. Thus, by its enforcement of peace, equity may in itself constitute a valuable social capital in egalitarian societies.

4 Conclusion

Violent conflicts kill and destroy and produce other long term bads. "Over recent decades, the presence of civil conflict appears to be one of the major causes of underdevelopment: six of the worst ten performers in the world, judged by HDI and GNP per capita are countries which currently have, or have recently had, severe civil wars" (Stewart and O'Sullivan, 1998).

A portion of the economics conflict literature explains such fighting as a game between groups, where each group optimize its use of resources, in appropriation and production as Pareto said, in order to maximize expected returns. These models are similar to models of market competitions and, not surprisingly, many of the results are the same, but with novel interpretations. The Herfindahl-Hirschman index, for example, have an interpretation in the case of conflict as the power concentration. Both in battlefields and marketplaces, contests are more intense when the contenders are many and more equally paired than when the contenders are few and diverse. Also entry and exit affect the structure of fighting. As we demonstrate, conflict models that do not account for the obvious participation constraint easily produce nonsensically comparative statics.

The similarities highlighted here, stem from the bold, but questionable assumption that profit motives are the guiding principle for behavior both in the marketplace and in the battlefield. There is, however, one important difference between the two models. Their welfare implications are obviously diametrically different. In the market the effort by each firm is transformed to a private good, while, in the case of conflict, the effort by each group transforms to a public bad brought to the battleground. Fortunately, groups that agree to reap the peace dividend in an explicit agreement may have less problems than producers who try to reap the monopoly gains in a tacit collusion. Thus, collusion may be more easily achieved when it is good for society than when it is bad.

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