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Migration and intergroup conflict

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Abstract

Two groups in conflict produce and appropriate internally generated consumable output in a two-stage game assuming equal within-group sharing and endogenous group sizes. It is shown how agents leave groups with high productive efficiency and migrate to groups with high appropriative and defensive capabilities.

Keywords: Within-group strategic choice; Allocation of endowment; Production; Appropriation; Free-riding; Between-group competition; Group decisiveness; Intergroup migration

If you can't beat them, join them. If you can't join them, beat them. What is the underlying principle by which agents decide to beat or join groups? This article answers the question allowing groups to differ w.r.t. productive efficiency, appropriative and defensive capability, allowing varying degrees of decisiveness in between-group competition. Assuming intergroup migration, this article extends two-level conceptions within three fields.[1] Agents often prefer to produce consumable output, but may have several reasons not to do so. First, production is costly. Second, produced output may be appropriated. Third, an agent may prefer to appropriate rather than to produce. Fourth, the agents may prefer to free-ride. These reasons are problematized when agents are allowed to migrate between groups.

[1]The first is collective rent seeking (Katz et al., 1990; Baik and Shogren, 1995; Hausken, 1995a,b, 1998; Baik and Lee, 1997; Lee, 1995; Nitzan, 1991a,b, 1994). The second is the analysis of the impact of product-market competition on managerial slack (Hart, 1983; Horn et al., 1995; Tirole, 1988; Vickers, 1995; Winter, 1971). The third involves conflict between actors (Grossman, 1991; Grossman and Kim, 1995; Hausken, 2000; Hirshleifer, 1995; Neary, 1997; Skaperdas, 1992; Skaperdas and Syropoulos, 1997; Usher, 1992; Usher and Engineer, 1987; Noh, 1998).

Consider two groups in competition. Agent j in group i is endowed with an initial resource endowment r_i which may either not be allocated (free-riding, leisure), or may be allocated w_{ij} to production and s_{ij} to appropriation and defense (appropriation for short), $0 \le w_{ij} + s_{ij} = r_i$, $i = 1,2$. Two groups with sizes n_1 and n_2 produce consumable output (products, goods, outcomes, prizes, benefits, rewards, payoffs)

$$B_1 \sum_{j=1}^{n_1} w_{1j} + B_2 \sum_{v=1}^{n_2} w_{2v},$$

where B_1 and B_2 specify how efficiently output is produced. Applying the conventional ratio form (Tullock, 1967) to determine each group's and each agent's ability to appropriate output, agent j's payoff in group 1 is[2]

$$P_{1j}(s_{1j}, S^{-1j}) = \frac{1}{n_1} \frac{F_1\left(\sum_{j=1}^{n_1} s_{1j}\right)^m}{F_1\left(\sum_{j=1}^{n_1} s_{1j}\right)^m + F_2\left(\sum_{v=1}^{n_2} s_{2v}\right)^m} \left[B_1 \sum_{j=1}^{n_1} (r_1 - s_{1j}) + B_2 \sum_{v=1}^{n_2} (r_2 - s_{2v}) \right], \tag{1}$$

where S^{-1j} is the set of all strategies by all agents in the two groups except agent j, m is the between-group decisiveness which specifies between-group sharing, and F_1 and F_2 specify how effectively output is appropriated (and defended). Allocation into production leads to enlargement of the size of the pie of output produced by the two groups, while allocation into appropriation increases the share of the pie accruing to each group.

We analyze a two-stage game, solve each agent's maximization problem and check when $P_{ij}(s_{ij}, S^{-ij}) > r_i$ to avoid free-riding. In the first stage agents decide which group to belong to, dependent on which group gives the highest payoff, suitably taking into account how the agents allocate their endowments between production and appropriation in the second stage. In so doing, each agent takes all the other agents' group membership decisions as given. Acknowledging equivalent agents, maximizing the aggregate group payoff is equivalent to maximizing the individual payoff in a symmetric equilibrium where each agent receives the same payoff. In so doing, agent j takes suitably into account how the agents allocate their endowments between production and appropriation in the second stage. In the second stage the agents make their choices simultaneously and independently, taking the group sizes n_1 and n_2 as given. Agent j in group 1 takes the production versus appropriation allocation of the other agents in group 1 as given, and also takes the production versus appropriation allocation w_{2v} versus s_{2v} of the agents in group 2 as given. He then chooses s_{1j} to maximize his payoff. We first consider the second-stage decision. Setting the derivative of $P_{1j}(s_{1j}, S^{-1j})$ in (1) w.r.t. s_{1j} equal to zero gives

$$\begin{aligned} \frac{\partial P_{1j}(s_{1j}, S^{-1j})}{\partial s_{1j}} &= \frac{1}{n_1} \frac{F_1 m\left(\sum_{j=1}^{n_1} s_{1j}\right)^{m-1} F_2\left(\sum_{v=1}^{n_2} s_{2v}\right)^m}{\left(F_1\left(\sum_{j=1}^{n_1} s_{1j}\right)^m + F_2\left(\sum_{v=1}^{n_2} s_{2v}\right)^m\right)^2} \left[B_1 \sum_{j=1}^{n_1} (r_1 - s_{1j}) + B_2 \sum_{v=1}^{n_2} (r_2 - s_{2v}) \right] \\ &\quad + \frac{1}{n_1} \frac{F_1\left(\sum_{j=1}^{n_1} s_{1j}\right)^m}{F_1\left(\sum_{j=1}^{n_1} s_{1j}\right)^m + F_2\left(\sum_{v=1}^{n_2} s_{2v}\right)^m} [-B_1] = 0. \end{aligned} \tag{2}$$

[2]It is straightforward to endogenize the within-group sharing rule and show that egalitarian sharing is an equilibrium. See Noh (1998) for a fuller treatment of within-group sharing rules.

In a symmetric Nash equilibrium identical agents devote the same amounts $w_{1j} = w_1$ and $s_{1j} = s_1$ to production and appropriation, respectively. (2) simplifies to

$$(n_1 s_1)^{m+1} F_1 B_1 + m(n_2 s_2)^{m+1} F_2 B_2 + (m+1) n_1 s_1 (n_2 s_2)^m F_2 B_1 - F_2 m (n_2 s_2)^m (n_1 r_1 B_1 + n_2 r_2 B_2) = 0. \tag{3}$$

Multiplying (3) by $F_1(n_1 s_1)^m / F_2(n_2 s_2)^m$ and subtracting from that version of (3) where the indices 1 and 2 are permuted, gives

$$\frac{s_1}{s_2} = \frac{n_2}{n_1}\left(\frac{F_2 B_2}{F_1 B_1}\right)^{1/(m+1)}, \tag{4}$$

$$s_1 = \frac{m F_2^{1/(m+1)} (n_1 r_1 B_1 + n_2 r_2 B_2)}{n_1 (m+1) B_1^{1/(m+1)} (F_2^{1/(m+1)} B_1^{m/(m+1)} + F_1^{1/(m+1)} B_2^{m/(m+1)})}, \tag{5}$$

$$s_2 = \frac{m F_1^{1/(m+1)} (n_2 r_2 B_2 + n_1 r_1 B_1)}{n_2 (m+1) B_2^{1/(m+1)} (F_1^{1/(m+1)} B_2^{m/(m+1)} + F_2^{1/(m+1)} B_1^{m/(m+1)})},$$

$$P_{1j}^* = \frac{F_1^{1/(m+1)} B_2^{m/(m+1)} (n_1 r_1 B_1 + n_2 r_2 B_2)}{n_1 (m+1) (F_2^{1/(m+1)} B_1^{m/(m+1)} + F_1^{1/(m+1)} B_2^{m/(m+1)})}, \tag{6}$$

$$P_{2v}^* = \frac{F_2^{1/(m+1)} B_1^{m/(m+1)} (n_2 r_2 B_2 + n_1 r_1 B_1)}{n_2 (m+1) (F_1^{1/(m+1)} B_2^{m/(m+1)} + F_2^{1/(m+1)} B_1^{m/(m+1)})}.$$

In the first stage, agent j chooses groups 1 or 2 to maximize his payoff. Agent j is indifferent w.r.t. group membership when $P_{1j}^* = P_{2v}^*$. Applying (4), (6), and $n_1 + n_2 = N$, gives

$$\frac{s_1}{s_2} = \frac{n_2}{n_1}\left(\frac{F_2 B_2}{F_1 B_1}\right)^{1/(m+1)} = \left(\frac{n_2}{n_1}\right)^{(m-1)/m}\left(\frac{F_2}{F_1}\right)^{1/m} = \left(\frac{n_2}{n_1}\right)^2 \frac{B_2}{B_1} = \left(\frac{F_2}{F_1}\right)^{2/(m+1)}\left(\frac{B_1}{B_2}\right)^{(m-1)/(m+1)}, \tag{7}$$

$$\left(\frac{n_1}{n_2}\right)^{m+1} = \frac{F_1}{F_2}\left(\frac{B_2}{B_1}\right)^m, \tag{8}$$

$$n_1 = \frac{F_1^{1/(m+1)} B_2^{m/(m+1)}}{F_1^{1/(m+1)} B_2^{m/(m+1)} + F_2^{1/(m+1)} B_1^{m/(m+1)}} N,$$

$$n_2 = \frac{F_2^{1/(m+1)} B_1^{m/(m+1)}}{F_2^{1/(m+1)} B_1^{m/(m+1)} + F_1^{1/(m+1)} B_2^{m/(m+1)}} N,$$

$$s_1 = \frac{n_2 m (n_1 r_1 B_1 + n_2 r_2 B_2)}{n_1 (m+1) N B_1}, \tag{9}$$

$$s_2 = \frac{n_1 m (n_2 r_2 B_2 + n_1 r_1 B_1)}{n_2 (m+1) N B_2},$$

$$P^*_{1j} = P^*_{2v} = \frac{n_1 r_1 B_1 + n_2 r_2 B_2}{(m+1)N} = \frac{F_1^{1/(m+1)} B_2^{m/(m+1)} r_1 B_1 + F_2^{1/(m+1)} B_1^{m/(m+1)} r_2 B_2}{(m+1)(F_1^{1/(m+1)} B_2^{m/(m+1)} + F_2^{1/(m+1)} B_1^{m/(m+1)})}. \tag{10}$$

Free-riding is avoided when $P_{ij}(s_{ij}, S^{-ij}) > r_i$, which gives

$$\frac{F_1^{1/(m+1)} B_2^{m/(m+1)} (n_1 r_1 B_1 + n_2 r_2 B_2)}{n_1 r_1 (m+1)(F_2^{1/(m+1)} B_1^{m/(m+1)} + F_1^{1/(m+1)} B_2^{m/(m+1)})} > 1, \tag{11}$$
$$\frac{F_2^{1/(m+1)} B_1^{m/(m+1)} (n_2 r_2 B_2 + n_1 r_1 B_1)}{n_2 r_2 (m+1)(F_1^{1/(m+1)} B_2^{m/(m+1)} + F_2^{1/(m+1)} B_1^{m/(m+1)})} > 1,$$

for fixed sized groups and

$$B_1 + \frac{n_2 r_2}{n_1 r_1} B_2 > (m+1)\left(1 + \frac{n_2}{n_1}\right), \tag{12}$$
$$B_1 + \frac{n_2 r_2}{n_1 r_1} B_2 > (m+1)\left(1 + \frac{n_2}{n_1}\right)\frac{r_2}{r_1},$$

for intergroup migration. An agent in group 1 prefers intergroup migration rather than fixed sized groups when (10) is larger than P^*_{1j} in (6), i.e.

$$\left(\frac{F_1}{F_2}\right)^{1/(m+1)} \left(\frac{B_2}{B_1}\right)^{m/(m+1)} < \frac{n_1}{n_2}. \tag{13}$$

The result in (4) is well known in the literature (Hirshleifer, 1991; Grossman and Kim, 1995; Skaperdas and Syropoulos, 1997). The results in (5)–(13) are not known and can be summed up in nine points. (1) If two groups can agree on equivalently increasing $B_1 = B_2$, the equilibrium mixture of allocation into production and appropriation remains unchanged, although their payoffs increase. (2) Increasing B_1 in group 1 causes higher productivity and payoffs in group 1, but causes considerably more appropriation and even higher payoffs in group 2. (3) Equivalently increasing $F_1 = F_2$ in the two groups does not alter the equilibrium and the payoffs. (4) Increasing F_1 in group 1 causes higher productivity and payoffs in group 1, and more appropriation and lower payoffs in group 2. (5) Increasing decisiveness m causes larger allocation to appropriation and lower payoffs. (6) The ratio of the payoffs in groups 1 and 2 is inversely proportional to the ratio n_1/n_2 of the group sizes, proportional to F_1/F_2 (in a manner approaching independence as m increases), and inversely proportional to B_1/B_2 (in a manner that approaches linear dependence as m increases). (7) Allowing intergroup mobility when $B_1 > B_2$ causes migration to group 2 in a manner that becomes more pronounced when m increases, and moderately large (and equivalent) payoffs in the two groups. (8) Allowing intergroup mobility when $F_1 > F_2$ causes migration to and more production in group 1 in a manner that becomes less pronounced when m increases, very high appropriation in group 2, and higher payoffs. (9) Intergroup migration causes the ratio s_1/s_2 of allocation into appropriation to be inversely proportional to F_1/F_2, inversely proportional to B_1/B_2 when $0 \leq m < 1$, and proportional to B_1/B_2 when $m > 1$.

The significance of the results lies in the non-trivial implications of the model for resource allocation (division of labor) for each agent, welfare between groups, intergroup migration, and adjustment of group size. Central to the model is the placement of consumable output in a common pool. This creates a benchmark for individual and group behavior where property rights are determined (Neary, 1997) by each group's ability to appropriate from the common pool. Determining property rights by other factors, e.g. closeness to production or judicial criteria for ownership, and allowing appropriated output not to be 100% exploitable (Grossman and Kim, 1995), suggest an opposite benchmark where appropriation is absent. The former benchmark causes agents up to a point to beat rather than join the group with higher productive efficiency. A group may cause movement toward, without reaching, the latter benchmark by increasing its appropriative capability, encouraging the other group to increase its productive efficiency, decreasing the between-group decisiveness, or forbidding emigration (implies higher payoff to the other group).

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