Identity, Economic Mobility and Conflict

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Abstract

The paper provides a theory that explains in what type of societies class conflicts are less frequent than ethnic conflicts. We posit the problem as one of alliance formation. In our model agents can form alliances either in the economic class line or in ethnic line. In case of ethnic alliance, one remains in the same ethnic group before and after the conflict. That is not the case for class identity that can change following an economic shock. Hence, even if someone wins a conflict fighting for one economic class, her class identity may change post-conflict and therefore, may not get the winner's pay-off. Such uncertainty discourages one to form alliance in the class line when the conflict prize is a private good. Similar issue does not arise in case of ethnic alliance making ethnic conflict a more likely outcome in equilibrium. We extend our model to the case where conflict prize is a group specific public good. We find that class conflict is more likely in the public good case.

1 Introduction

The identity dimension of conflict assumes a central position in the literature on conflict. One interesting stylized fact in this respect is the greater prevalence of ethnic conflict over class conflicts in the post-Cold War world (Brubaker and Laitin, 1998; Fearon and Laitin, 2003). If we broaden the definition of conflict to include electoral

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competition, the rise of right-wing populism triggered by immigration further attests to this general pattern (Dinas et al., 2019; Usta, 2022; Marbach and Ropers, 2018). In this backdrop, our paper provides a theory that explains the salience of ethnic conflicts.

The earliest paper explaining this phenomenon come from Esteban and Ray (2008). They explained the salience of ethnic conflict in terms of within group inequality. They argue that the *production* of conflict requires both labor and capital. While the economic classes are too homogeneous and supply only one of the inputs, ethnic groups consist of both rich and poor members who can supply both the inputs required to produce conflict. We, in this paper, propose a different mechanism. In our model, we have an economic shock which can change one's economic class (poor can become rich and vice-versa). No such mobility is possible for ethnic identities. This asymmetry between economic identity and ethnic identity drives our result. If a person decides to join a group to engage in conflict, she understands that their win is a probabilistic event; but once her group wins, she gets the prize. Besides the uncertainty of winning, class conflict in our model is associated with another layer of uncertainty. Besides the fact that one's economic group may lose the conflict with some probability, one's economic status may also change following the economic shock. Hence, for class conflict it is possible that after one fights for his class and his class wins the conflict, his economic status changes and he ends up in the losing side. No such scenario is possible for ethnic conflict. Winning remains a probabilistic event in ethnic conflict as well, but ones ethnic identity never changes post-conflict. So once a group wins, all its members get the prize. We show in our model that such asymmetry in mobility between economic status and ethnic identity makes ethnic conflict more probable than class conflict when the conflict prize is a private good.

Besides our paper, there are not many papers that focus on class vs ethnic conflicts. But mobility holds a key role in our mechanism and there are a few papers that focus on the role of mobility in creating conflicts. In such a paper, Caselli and Coleman (2013) examine the ethnic traits that make two ethnic groups likely to be involved in conflict. They argue that if the ethnic markers of two ethnic groups are such that the inter-group mobility is high (i.e. members of the losing group can easily join the winning group), they are less likely to engage in conflict. The issue of mobility across groups were further examined by Bhattacharya et al. (2015) who show how the cost of mobility across groups determine allocation of resources across groups in conflict environment. Our paper is different from these papers on two counts. First, unlike our paper, these papers do not model different dimensions for group formation and second, in our paper, mobility is triggered by shock while in the above mentioned papers, mobility is a costly choice.

In our framework, any individual can be characterized by two possible identities – class identity and ethnic identity. The class identity can assume two values – R and P. The ethnic identity can also also assume two values – H and M. Hence, any individual k can be characterized by a i, j pair where $i \in \{H, M\}$ and $j \in \{R, P\}$. Hence, there are four possible sub-identities that a person can assume: $\{HR, HP, MR, MP\}$. The problem of conflict is then essentially becomes the problem of coalition formation. If the coalition is formed in the class line – HR and MR on one side and HP and MP on the other – we call it class conflict. On the other hand, if the coalition is formed in the ethnicity line – HR and HP against MR and MP – we call it an ethnic conflict. The prize of the conflict is a redistribution budget G. In peace time, the budget is equally distributed among all the citizens irrespective of their identities. In case of conflict, the prize is distributed among the members of the winning coalition. Hence, a citizen can choose to join a coalition and upon joining can collectively decide whether to opt for peace or for conflict.

In our model, we analyze two cases – the one where the reward is a private good and the one where it is a group specific public good. We show that for the private good case, ethnic conflict is a more likely outcome in equilibrium than class conflict. In our case on public good however, class conflict is a more likely scenario. We also link the possibility of class conflict with the growth potential of a country. Note that the key driver of the results in our paper is economic mobility. In our structure, we characterize economic growth by economic mobility. We define a country as a growing one if the volume of upward mobility (i.e. the number of poor becoming rich) is more than the volume of downward mobility (i.e. the number of rich becoming poor). We show that class conflict is a more likely event in a non-growing economy. This result is consistent with the observation that the major socialist revolutions in recent history happened in stagnant economies, Russia and China being two leading example. We also link the nature of conflict in a society to nature of government spending. If the government budget is mainly used for private redistribution, ethnic conflict is the more likely form of conflict. But in case the budget is used mostly for group specific public goods, class conflict is more likely.

We have already mentioned that the mechanism in our paper works through the possibility of economic mobility. In terms of mobility, there is an asymmetry between the identity dimensions of class and ethnicity; ethnic identities are unchanging while economic identities may change. In other words, the status-quo of one's ethnic identity can never change while the economic identity can. In their seminal paper on institutional persistence, Fernandez and Rodrik (1991) argued that people prefer status-quo over a potentially efficient change in institutions which creates gainers and losers in the economy. This is because people are afraid that after the change, they may end up among the losers. In its essence, our paper, upholds a similar idea. The outcomes of all conflicts are uncertain. But there is an additional uncertainty in class conflicts that is not present in ethnic conflicts – class identities may change post-conflict, but ethnic identities are fixed. In essence, this second layer of uncertainty drives our theoretical predictions.

Our paper is also related to the section of the literature that empirically examines the effect of economic shocks on conflict. In a paper written using this approach, Bazzi and Blattman (2014) examines the effect of commodity price shock on conflict. In another paper, Mitra and Ray (2014), looks at the effect of inter-group economic difference on conflict. Set in the context of Hindu-Muslim riot in India, their paper shows that an increase in per-capita Muslim expenditure leads to a large and significant increase in Hindu-Muslim conflict. An increase in Hindu per capita expenditure, on the other hand, has either positive or no effect on conflict. While these papers examine the impact of economic factors on the possibility of conflict, papers such as (Miguel et al., 2004) examines the impact of civil conflict on growth which turns out to be negative.

In the next section we present our model and in section 3, we conclude.

2 The Model

2.1 Basic Structure

We consider a community with population normalized to 1. There are two ethnic groups - H and M - with sizes α and $1-\alpha$ respectively with $\alpha \geq \frac{1}{2}$. The community can also be divided into two economic classes - M and R - with sizes β and $1-\beta$ respectively with $\beta \geq \frac{1}{2}$. We assume that between two ethnic groups the economic classes are distributed uniformly and vice versa. In other words, the size of the subgroup HP consisting of individuals belonging to ethnic group H and economic class P is $\alpha\beta$ and so on for other subgroups.

In status quo, no group is engaged in conflict. We suppose that the state has a redistribution budget G. We discuss two separate scenarios. In one case, G is used for private benefits of individual citizens. In absence of any conflict, G is equally distributed among every member of the community and thus every individual gets G. In the other case, G is earmarked for providing community specific public good. Absent conflict, each group gets a share of G according to its relative group size.

Groups however can enter into a conflict. To engage in a conflict, a group must form an alliance. Alliances can be formed either along ethnicity or class dimensions. Once an alliance is formed between two subgroups either according to the ethnicity or class, the other two subgroups must also get organized and form an alliance to engage in the conflict. Otherwise, G would be won uncontested by the former.

The ethnic identity of each individual is always same. However, in our model, the class identity may change during the conflict. Resolution of conflict takes time. We assume that after the decision regarding joining an alliance is taken but before the redistribution prize is distributed, an individual's class identity may change. Specifically, we assume that a person who is poor (rich) before joining an alliance may become rich (poor) with probability p (q). We assume throughout that p and q are less than $\frac{1}{2}$. In our model, the changing class identity of an individual as opposed to unchanging ethnic identity creates different incentives for joining the class alliance vis-a-vis the ethnic alliance. Notice that pre and post conflict sizes of different ethnicity remain same, while the class sizes change during the conflict.

We assume that individuals are risk-neutral and maximizes their net expected earnings from the conflict. This enables us to ignore the income levels of individual agents and concentrate on their identities. Engagement in conflict is also resource-intensive. Once an alliance is formed, it is decided how much private resources an individual will contribute in the conflict. We assume that once an alliance is formed, a utilitarian alliance leader determines how much resources each member contributes towards the conflict over redistribution budget. This helps us to avoid within alliance free rider problem. We also assume the post-conflict share of the redistribution budget is distributed equally among the members of an alliance allowing us to ignore the withing group conflict over distribution of conflict prize.

To solve the model, we follow the standard procedure. We first solve the conflict game and look at the conflict equilibrium payoffs of individuals belonging to different alliances. Then we look back at incentives to join different alliances for different subgroups to examine which alliance would prevail.

2.2 Conflict over private good

2.2.1 Conflict and Peace Payoffs

Peace Payoff When the budget G is meant private good, each individual gets an equal amount in absence of conflict. Since the community size is normalized to 1, every individual receives G if peace prevails.

Ethnic Conflict In our model, subscript i is an index of ethnicity ($i \in \{H, M\}$), and subscript j is an index of class ($j \in \{P, R\}$). For the ethnic alliance i, the conflict payoff of an individual is given by

$$u_i^E = -x_i + \frac{X_i}{X_H + X_M} . \left(\frac{G}{n_i} \right)$$

for all $x_i > 0$ where x_i is the resource contribution of an individual in ethnic alliance i, n_i is the size of the alliance i and $X_i = n_i x_i$ is the total contribution made by all members of the alliance. The share of the redistribution budget won by alliance i is determined by the contest function $\frac{X_i}{X_H + X_M}$. The alliance leader maximizes u_i^E by choosing x_i.

Class Conflict For the class alliance j, writing the payoff of an individual from class conflict is more involved. The pre and post conflict classes of an individual may be different. Suppose the probability that an individual belonging to pre-conflict class j becomes a member of the post-conflict class $j' \neq j$ is $\theta_{jj'}$. Then, for the class alliance j, the expected conflict payoff is

$$u_j^C = -x_j + \frac{X_j}{X_P + X_R} . \frac{\left(1 - \theta_{jj'}\right) G}{\hat{n}_j} + \frac{X_{j'}}{X_P + X_R} . \frac{\theta_{jj'} G}{\hat{n}_{j'}}$$

for $j' \neq j$ where $\hat{n}_j$ is the post conflict size of class j. The alliance leader maximizes u_j^C by choosing x_j.

2.2.2 Equilibrium in the Conflict Game

Ethnic Conflict We first look at the ethnic conflict. For our contest function which determines share of the prize, the payoff function u_i^E is concave in x_i. Hence, it suffices to look at the first order optimality conditions. Notice that

$$\frac{\delta u_i^E}{\delta x_i} = -1 + \frac{X_{i'}}{\left(X_H + X_M\right)^2} . G$$

For any $X_{i'} \in (0, G)$, $\frac{\delta u_i^E}{\delta x_i} > 0$ at $x_i = 0$. Moreover, if $X_{i'} = 0$, there exists $x_i > 0$ such that $u_i^E > G$. This implies that alliance i will choose $x_i > 0$ at equilibrium. From the best responses of H and M alliances, we can find the equilibrium conflict contributions

$$X_i^* = \frac{G}{4}$$

This gives us the equilibrium payoff for every member of ethnic alliance i as

$$u_i^E = \frac{G}{4n_i}$$

where n_i is α or $1 - \alpha$ for $i = H$ or M.

Class Conflict Similarly in the context of class conflict, the best response function for alliance j is

$$\begin{aligned}
\frac{\delta u_j^C}{\delta x_j} &= -1 + \frac{\left(1 - \theta_{jj'}\right) G}{\hat{n}_j} . \frac{n_j X_{j'}}{\left(X_P + X_R\right)^2} - \frac{\theta_{jj'} G}{\hat{n}_{j'}} . \frac{n_j X_{j'}}{\left(X_P + X_R\right)^2} \\
&= \frac{n_j X_{j'}}{\left(X_P + X_R\right)^2} \left[\frac{\left(1 - \theta_{jj'}\right)}{\hat{n}_j} - \frac{\theta_{jj'}}{\hat{n}_{j'}} \right] G - 1 \\
&= 0
\end{aligned}$$

The best response for alliance j can be determined implicitly from[1]

$$\frac{n_j X_{j'}}{\left(X_P+X_R\right)^2}\left[\frac{\left(1-\theta_{jj'}\right)}{\hat{n}_j}-\frac{\theta_{jj'}}{\hat{n}_{j'}}\right] G=1$$

Given that $\hat{n}_j = n_j\left(1-\theta_{jj'}\right)+n_{j'}\theta_{j'j}$ and $\hat{n}_{j'} = n_j\theta_{jj'}+n_{j'}\left(1-\theta_{j'j}\right)$, the above simplifies to

$$\frac{X_{j'}}{\left(X_P+X_R\right)^2}\cdot\frac{n_j n_{j'}}{\hat{n}_j\hat{n}_{j'}}\left[\left(1-\theta_{jj'}\right)\left(1-\theta_{j'j}\right)-\theta_{jj'}\theta_{j'j}\right] G=1$$

Thus at equilibrium,

$$X_j^*=\frac{G}{4}\frac{n_j n_{j'}}{\hat{n}_j\hat{n}_{j'}}\left[\left(1-\theta_{jj'}\right)\left(1-\theta_{j'j}\right)-\theta_{jj'}\theta_{j'j}\right]$$

for $j = P, R$. The equilibrium conflict payoff under class conflict is

$$\begin{aligned}
u_j^C &= \frac{G}{4\hat{n}_j\hat{n}_{j'}}\left[2\left(\hat{n}_{j'}\left(1-\theta_{jj'}\right)+\hat{n}_j\theta_{jj'}\right)-n_{j'}\left(1-\theta_{jj'}-\theta_{j'j}\right)\right] \\
&= \frac{G}{4\hat{n}_j\hat{n}_{j'}}\left[\begin{array}{c} 2\left\{\left(n_j\theta_{jj'}+n_{j'}\left(1-\theta_{j'j}\right)\right)\left(1-\theta_{jj'}\right)+\left(n_j\left(1-\theta_{jj'}\right)+n_{j'}\theta_{j'j}\right)\theta_{jj'}\right\} \\ -n_{j'}\left(1-\theta_{jj'}-\theta_{j'j}\right) \end{array}\right] \\
&= \frac{G}{4\hat{n}_j\hat{n}_{j'}}\left[\begin{array}{c} 4n_j\theta_{jj'}\left(1-\theta_{jj'}\right) \\ +n_{j'}\left\{2\left(1-\theta_{j'j}\right)\left(1-\theta_{jj'}\right)+2\theta_{j'j}\theta_{jj'}-\left(1-\theta_{jj'}-\theta_{j'j}\right)\right\} \end{array}\right] \\
&= \frac{G}{4\hat{n}_j\hat{n}_{j'}}\left[4n_j\theta_{jj'}\left(1-\theta_{jj'}\right)+n_{j'}\left(1-\theta_{jj'}-\theta_{j'j}+4\theta_{j'j}\theta_{jj'}\right)\right]
\end{aligned}$$

for $j = P, R$ and $j' \neq j$.

2.2.3 Alliance Formation and Conflict

An alliance is formed only if, for at least two subgroups belonging to the same ethnicity or same class, the conflict payoff under the resulting alliance is at least as large as the no conflict payoff G for each member of the alliance. However, once an alliance is formed by any two subgroups either along class dimension or along ethnicity dimension, there will be conflict. If the other subgroups do not form an alliance to engage in conflict, the prize will be won uncontested by the subgroups

[1] If X_R is sufficiently high we the best response X_P may be zero and vice versa. But in equilibrium, that won't be the case. So we ignore the possibility.

forming the alliance. In such a situation, the subgroups without an alliance will not get any share from the redistribution budget.

We are now in a position to look at the possibilities of alliances. Given our specification, an ethnic alliance is formed only if the conflict payoff from the ethnic alliance exceeds the no conflict payoff for some ethnicity, i.e. $u_i^E = \frac{G}{4n_i} \geq G$ for some $i \in \{H, M\}$. This leads to our first Lemma. If any two subgroups form an alliance on ethnic dimension, the other two subgroups would form the opposing alliance to engage in the conflict because otherwise they would not receive any redistribution benefits.

Lemma 1 *An ethnic conflict may arise only if $\alpha \geq \frac{3}{4}$.*

Proof. Please see the Appendix. ■

Similar result holds for class conflict as well which we show in our following Lemma.

Lemma 2 *A class conflict may arise only if $\beta (1 - p) + (1 - \beta) q \geq \frac{3}{4}$.*

Proof. Please see the Appendix. ■

The two lemmas together give us our first proposition about conflict.

Proposition 1 *A conflict (class or ethnic) will occur if and only if either $\alpha \geq \frac{3}{4}$ or $\beta (1 - p) + (1 - \beta) q \geq \frac{3}{4}$.*

It is obvious that a class conflict may arise only if $\beta (1 - p) + (1 - \beta) q \geq \frac{3}{4}$. Notice that if $p \geq \frac{1}{4}$, then $\beta (1 - p) + (1 - \beta) q < \frac{3}{4}$ for all $q < \frac{1}{2}$. This leads to the following observation.

Remark 1 *If $p \geq \frac{1}{4}$, a class conflict will never occur in a society with economic mobility where the majority are poor to begin with.*

If the poor have a high enough chance of their class identity being changed, class conflict doesn't occur. In our model, the attractiveness of any conflict over peace depends on the per capita size of the conflict prize which in turn depends on the size of the alliance. In case of class conflict, the conflict is initiated by the rich, them being the smaller sized class alliance. Once the rich are organized in an alliance, the poor have to engage in conflict because otherwise they won't get any share of the redistribution budget. With large enough p, the post conflict size of the rich alliance becomes large enough to make class conflict unattractive for even the rich.

Notice that for $p \geq \frac{1}{4}$, peace and ethnic conflict are equally likely. However, for $p < \frac{1}{4}$, $\tilde{\beta}$ increases with p and decreases with q. Peace prevails when $\beta < \tilde{\beta}$ and $\alpha < \frac{3}{4}$. Thus total conflict (class plus ethnic) rises when $\tilde{\beta}$ falls. This is stated in our next proposition.

Proposition 2 *For $p < \frac{1}{4}$, conflict rises with when q increases and p decreases.*

Thus, the societies with lower upward and higher downward mobility will see conflict more often.

2.2.4 Class or Identity

So far we have looked at situations where conflict payoffs are more attractive than peace payoffs to induce alliances. We now need to analyze situations where both types of conflict possible. This happens only when $\alpha \geq \frac{3}{4}$ and $\beta(1-p) + (1-\beta)q \geq \frac{3}{4}$ with . For these parameter values, conflict payoff from the ethnic and class alliance are higher than the peace payoff for the minority and the rich respectively. So the crucial decision of which type of alliance will be formed depends on the minority rich subgroup which now is the pivotal group.

The pivotal group would enter into an ethnic alliance in such a situation if and only if

$$\frac{1}{1-\alpha} \geq \frac{4(1-\beta)q(1-q) + \beta(1-p-q+4pq)}{(\beta(1-p)+(1-\beta)q)(\beta p + (1-\beta)(1-q))}$$

We define the function $G(.)$ as

$$G(\alpha, \beta; p, q) = \frac{1}{1-\alpha} - \frac{4(1-\beta)q(1-q) + \beta(1-p-q+4pq)}{(\beta(1-p)+(1-\beta)q)(\beta p + (1-\beta)(1-q))}$$

Since $G_\alpha > 0$ and $G_\beta < 0$, $G(\alpha, \beta; p, q) = 0$ is positively sloped in the permissible domain of α and β, i.e. $\alpha \in \left[\frac{3}{4}, 1\right]$ and $\beta \in \left[\tilde{\beta}, 1\right]$ where $\tilde{\beta}$ is defined as

$$\tilde{\beta}(1-p) + \left(1-\tilde{\beta}\right)q = \frac{3}{4}$$

It is easy to see that at $G\left(\frac{3}{4}, \tilde{\beta}; p, q\right) = 0$. Moreover, $G(\tilde{\alpha}, 1; p, q) = 0$ where

$$\tilde{\alpha} = 1 - \frac{p(1-p)}{1-p-q+4pq} < 1$$

Finally, for any $a, \beta \in \left[\frac{3}{4}, 1\right] \times \left[\tilde{\beta}, 1\right]$ such that[2]

$$\frac{\beta - \tilde{\beta}}{1 - \tilde{\beta}} = \frac{\alpha - \frac{3}{4}}{1 - \frac{3}{4}},$$

$G(\alpha, \beta; p, q) > 0$. Hence, for all $a, \beta \in \left[\frac{3}{4}, 1\right] \times \left[\tilde{\beta}, 1\right]$, the level curve for $G(\alpha, \beta; p, q) = 0$ lies above the diagonal of the rectangle $\left[\frac{3}{4}, 1\right] \times \left[\tilde{\beta}, 1\right]$. All these together imply that we can now divide the parameter space into three different zones leading to different conflict outcomes. This is summarized in our next proposition.

Proposition 3 *Suppose* $\alpha, \beta \in (\frac{1}{2}, 1]$.

1. *Peace will prevail if and only if* $\alpha < \frac{3}{4}$ *and* $\beta(1-p) + (1-\beta)q < \frac{3}{4}$.
2. *There will be ethnic conflict if and only if either* $\alpha \geq \frac{3}{4}$ *and* $\beta(1-p) + (1-\beta)q < \frac{3}{4}$ *or* $\alpha \geq \frac{3}{4}$ *and* $G(\alpha, \beta; p, q) > 0$.
3. *There will be class conflict if either* $\alpha < \frac{3}{4}$ *and* $\beta(1-p) + (1-\beta)q \geq \frac{3}{4}$ *or* $\beta(1-p) + (1-\beta)q \geq \frac{3}{4}$ *and* $G(\alpha, \beta; p, q) < 0$.

The following picture depicts the different parameter zones leading to different outcomes.

What is more likely to occur? We need to compare the areas where two types of conflicts would occur over the complete range of parameters $\alpha, \beta \in (\frac{1}{2}, 1] \times (\frac{1}{2}, 1]$. We have already established that when both types of conflict are possible, the zone consisting of parameter values where ethnic conflict occurs is larger than the class conflict. Hence, the area representing ethnic conflict would definitely be larger than that representing class conflict if $\tilde{\beta} \geq \frac{3}{4}$. Notice that in our model a growing economy is characterized by falling number of poor, i.e. $\beta(1-p) + (1-\beta)q < \beta$. Since class conflict occurs only if $\beta(1-p) + (1-\beta)q \geq \frac{3}{4}$, therefore these together imply that in a growing economy class conflict can occur only if $\beta > \frac{3}{4}$. This is sufficient to argue that in a growing economy, the area representing the ethnic conflict is larger than the area representing class conflict. This is stated in our next proposition.

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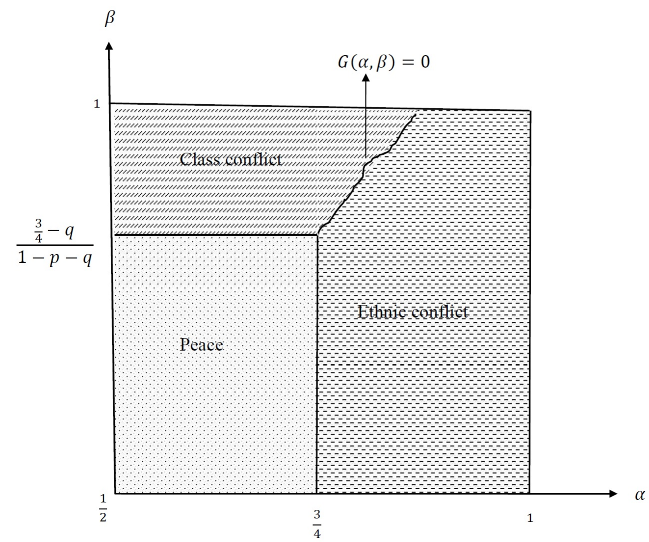
[2]Such points in the space $\left[\frac{3}{4}, 1\right] \times \left[\tilde{\beta}, 1\right]$ divides the space equally, i.e. they are on the line joining the points $\left(\frac{3}{4}, \tilde{\beta}\right)$ and $(1, 1)$.



Proposition 4 *In a growing economy with economic mobility, ethnic conflict is more likely to occur than class conflict.*

In what kind of economy, class conflict is more likely to prevail than ethnic conflict? Notice that in figure 1, the area representing class conflict lies in the region with $\beta \geq \tilde{\beta}$ and $G(\alpha, \beta; p, q) < 0$. Notice that $G(\alpha, \beta; p, q) < 0$ if and only if

$$\alpha < 1 - \frac{(\beta(1-p) + (1-\beta) q)(\beta p + (1-\beta)(1-q))}{4(1-\beta) q (1-q) + \beta(1-p-q+4pq)} = 1 - \phi(\beta, p, q)$$

Hence the area in figure 1 where class conflict prevails is represented by

$$\begin{aligned} C &= \int_{\tilde{\beta}}^{1} (1 - \phi(\beta, p, q))\, d\beta - \frac{1}{2}\left(1 - \tilde{\beta}\right) \\ &= \frac{1}{2}\left(1 - \tilde{\beta}\right) - \int_{\tilde{\beta}}^{1} \phi(\beta, p, q)\, d\beta \end{aligned}$$

Similarly, the area where ethnic confilict prevails can be represented by

$$\begin{aligned} E &= \frac{1}{4}\left(\tilde{\beta} - \frac{1}{2}\right) + \frac{1}{2}\left(1 - \tilde{\beta}\right) - C \\ &= \frac{1}{4}\left(\tilde{\beta} - \frac{1}{2}\right) + \int_{\tilde{\beta}}^{1} \phi(\beta, p, q)\, d\beta \end{aligned}$$

Hence,

$$C - E = \frac{5}{8} - \frac{3\tilde{\beta}}{4} - 2\int_{\tilde{\beta}}^{1} \phi(\beta, p, q)\, d\beta$$

where $\tilde{\beta} = \frac{\frac{3}{4} - q}{1 - p - q}$. Thus, we can write

$$C - E = H(p, q)$$

The next Lemma establishes the properties of $H(p, q)$.

Lemma 3 *For all $p \in [0, \frac{1}{4})$ and $q \in [0, \frac{1}{2})$, $H(p, q)$ is strictly increasing in q and strictly decreasing in p. Moreover, $H(0, 0) = 0$.*

Proof. See the appendix. ■

In our next Lemma we identify a critical p above which even though class conflict may happen, its likelihood is less than ethnic conflict for all values of p.

Lemma 4 *There exists a unique $\bar{p} < \frac{1}{4}$ such that for all $p \geq \bar{p}$, $H(p, q) < 0$ for all $q \in [0, \frac{1}{2})$.*

Proof. See the appendix. ■

Finally, in our next Lemma, we identify the mobility parameters under which class conflict may occur more often than ethnic conflict.

Lemma 5 *For any $p < \bar{p}$, there exists a unique $\bar{q} > p$ such that $H(p, q) \geq 0$, if and only if $q \geq \bar{q}$.*

Proof. See the appendix. ■

These Lemmas lead to the following proposition.

Proposition 5 *Consider an economy characterized by (p, q). For every $p < \bar{p}$, there exists a unique $\bar{q}(p) \in \left(0, \frac{1}{2}\right)$ such that for all $q > \bar{q}(p)$ class conflict is more likely than ethnic conflict.*

The last proposition shows that class conflict is less likely than ethnic conflict. The values of mobility parameters p and q for which ethnic conflict is more frequent form of conflict consist the set

$$S_E = \left\{ (p, q) : p \in \left(\bar{p}, \frac{1}{2}\right), q \in \left(0, \frac{1}{2}\right) \text{ or } p \in (0, \bar{p}), q \in (0, \bar{q}) \right\}$$

while the set of parameter values for which class conflict is more frequent is given by

$$S_C = \left\{ (p, q) : p \in (0, \bar{p}), q \in \left(\bar{q}, \frac{1}{2} \right) \right\}$$

Since $\bar{p} < \frac{1}{4}$, the measure of S_E is larger than that of S_E, and ethnic conflict is more frequent than class conflict in a larger number of societies.

2.2.5 Growth without mobility

Now consider an economy characterized by growth but there is no mobility. Growth in this case doesn't change the class identity of any individual. In terms of our model, this implies $p = q = 0$. For $p = q = 0$, $\tilde{\beta} = \frac{3}{4}$ and $\phi(\beta, p, q) = 1 - \beta$. Thus, $C - E = 0$ and the chances of class and ethnic conflicts are equal. Without mobility, both class and ethnic identities are fixed markers and thus both types of conflicts are equally likely.

2.3 Conflict over community specific public good

We next look at possibility of conflict when G is meant for expenditure on public good. We assume that if there is a conflict, the winning group must spend the prize on a public good. It is obvious that if the public good in question is a pure public good, there can't be any conflict because conflict participation is costly. So we restrict our attention to community specific public good.

2.3.1 Conflict and Peace Payoffs

We continue to assume that, if an alliance is formed, a utilitarian alliance leader chooses the conflict resources for each member. In case an alliance wins the conflict, the total budget is distributed among the two participating subgroups of the winning alliance according to their respective post conflict sizes.

Peace Payoff In absence of any conflict, the budget allocated to each subgroup for its community specific public group is in proportion to the size of the subgroup. Since the ultimate size of subgroup i, j is $n_i \hat{n}_j$, the peace allocation to subgroup i, j is $n_i \hat{n}_j G$. Thus, the expected peace payoff of an individual belonging to ethnicity i and class j initially is

$$u_{ij}^{P} = \left(1-\theta_{jj'}\right) n_i \hat{n}_j G + \theta_{jj'} n_i \hat{n}_{j'} G$$

for $j = P, R$, $i = H, M$ and $j' \neq j$, since with probability $\theta_{jj'}$ the individual's class identity changes from j to j'.

Payoff from Ethnic Conflict In case of an ethnic conflict, if ethnic alliance i wins, the prize is distributed between two classes within the ethnic group. An individual belonging to ethnicity i and class j remains in class j with probability $1-\theta_{jj'}$ and conditional on ethnicity i winning the conflict, this individual's expected payoff is

$$u_{ij}^{E} = -x_i + \frac{X_i}{X_i + X_{i'}} \left[\left(1-\theta_{jj'}\right) \hat{n}_j G + \theta_{jj'} \hat{n}_{j'} G\right]$$

for all $x_i > 0$ where x_i is the resource contribution of an individual in ethnic alliance i.The utilatarian alliance leader for ethnic alliance i maximizes $n_i \left(n_j u_{ij}^{E} + n_{j'} u_{ij'}^{E}\right)$ by choosing x_i.

Payoff from Class Conflict For the class alliance j, a member belonging to ethnicity i gets the positive payoff in proportion to the size of her ethnic group in two different circumstances. Either when class j wins the conflict and she remains in class j or when class j' wins and the individual's class identity changes to j'. Thus,The expected payoff of a member of class alliance j belonging to ethnicity i is

$$u_{ij}^{C} = -x_j + \frac{X_j}{X_j + X_{j'}} \left(1-\theta_{jj'}\right) n_i G + \frac{X_{j'}}{X_j + X_{j'}} \theta_{jj'} n_i G$$

The leader of class alliance j maximizes $n_j \left(n_i u_{ij}^{C} + n_{i'} u_{i'j}^{C}\right)$ by choosing x_j.

2.3.2 Conflict Equilibrium in the Public Good Game

Ethnic Conflict We first look at the ethnic conflict. The utilitarian alliance leader's objective function for ethnicity i is

$$U_i^{E} = -X_i + \frac{X_i}{X_i + X_{i'}} n_i G \left[n_j \left\{\left(1-\theta_{jj'}\right) \hat{n}_j + \theta_{jj'} \hat{n}_{j'}\right\} + n_{j'} \left\{\left(1-\theta_{j'j}\right) \hat{n}_{j'} + \theta_{j'j} \hat{n}_j\right\}\right]$$

As in the private good case, the optimality condition for ethnic group i is

$$\frac{\delta U_i^E}{\delta X_i} = -1 + \frac{X_{i'}}{\left(X_i + X_{i'}\right)^2} n_i G \Gamma = 0$$

where

$$\Gamma = n_j \left\{ \left(1 - \theta_{jj'}\right) \hat{n}_j + \theta_{jj'} \hat{n}_{j'} \right\} + n_{j'} \left\{ \left(1 - \theta_{j'j}\right) \hat{n}_{j'} + \theta_{j'j} \hat{n}_j \right\} > 0$$

Notice that Γ is independent of the ethnic identity i. Thus, in equilibrium,

$$\frac{X_i}{X_{i'}} = \frac{n_i}{n_{i'}}$$

Since $n_i + n_{i'} = 1$, the win probability of ethnic group i in an ethnic conflict is n_i. We can now write down equilibrium per capita resource mobilization in case of an ethnic conflict as

$$x_i^* = n_i n_{i'} \Gamma G$$

Class Conflict In case of class conflict, the alliance leader's objective for alliance j is to maximize

$$U_j^C = -X_j + \left(n_i^2 + n_{i'}^2\right) n_j \left[\frac{X_j}{X_j + X_{j'}} \left(1 - \theta_{jj'}\right) + \frac{X_{j'}}{X_j + X_{j'}} \theta_{jj'} \right] G$$

As in the private good case, the optimality condition for class j is

$$\frac{\delta U_j^C}{\delta X_j} = -1 + \left(n_i^2 + n_{i'}^2\right) n_j \frac{X_{j'}}{\left(X_j + X_{j'}\right)^2} \left(1 - 2\theta_{jj'}\right) G = 0$$

In conflict equilibrium,

$$\frac{X_j}{X_{j'}} = \frac{n_j \left(1 - 2\theta_{jj'}\right)}{n_{j'} \left(1 - 2\theta_{j'j}\right)}$$

Hence the equilibrium resource mobilization for class j in case of class conflict is

$$x_j^* = \left(n_i^2 + n_{i'}^2\right) n_j n_{j'} \frac{\left(1 - 2\theta_{jj'}\right)^2 \left(1 - 2\theta_{j'j}\right)}{\left[n_j \left(1 - 2\theta_{jj'}\right) + n_{j'} \left(1 - 2\theta_{j'j}\right)\right]^2} G$$

2.3.3 Alliance Formation and Conflict

We are now in a position to look at the possibilities of alliances. Given our specification, an ethnic (class) alliance is formed only if the conflict payoff from the ethnic (class) alliance exceeds the no conflict payoff for some ethnicity (class).

We first consider the possibility of an ethnic alliance. If the ethnic alliance for ethnicity i is formed, then in conflict equilibrium,

$$u_{ij}^{E} = -n_i n_{i'} \Gamma G + n_i \left[\left(1 - \theta_{jj'}\right) \hat{n}_j + \theta_{jj'} \hat{n}_{j'} \right] G = -n_i n_{i'} \Gamma G + u_{ij}^{P}$$

Since $\Gamma > 0$, $u_{ij}^{E} < u_{ij}^{P}$. This leads to the following proposition.

Proposition 6 *Ethnic conflict doesn't occur if the conflict is over community specific public good budget.*

The above proposition implies that if the conflict is over the community specific public good budget, the only type of conflict that may arise is the class conflict. Writing the probability of winning for class j as

$$\delta_j = \frac{n_j \left(1 - 2\theta_{jj'}\right)}{n_j \left(1 - 2\theta_{jj'}\right) + n_{j'} \left(1 - 2\theta_{j'j}\right)}$$

the equilibrium payoff from class conflict for an individual belonging to class j and ethnicity i is

$$u_{ij}^{C} = -\left(n_i^2 + n_{i'}^2\right) \delta_j \delta_{j'} \left(1 - 2\theta_{jj'}\right) G + \left[\delta_j \left(1 - \theta_{jj'}\right) + \delta_{j'} \theta_{jj'}\right] n_i G$$

The subgroup of class j and ethnicity i will be interested in alliance formation if and only if

$$u_{ij}^{C} \geq u_{ij}^{P}$$

holds. This requires that

$$\left[\delta_j \left(1 - \theta_{jj'}\right) + \delta_{j'} \theta_{jj'}\right] - \left[\left(1 - \theta_{jj'}\right) \hat{n}_j + \theta_{jj'} \hat{n}_{j'}\right] \geq \frac{\left(n_i^2 + n_{i'}^2\right)}{n_i} \delta_j \delta_{j'} \left(1 - 2\theta_{jj'}\right)$$

Notice that since $n_i + n_{i'} = 1$, whenever $n_i < \frac{1}{2}$, if the above condition holds for ethnic group i within class j, it will hold for ethnic group i'. Thus, we need to check the incentive for class conflict only for the minority ethnic group within class j. Moreover, since $\delta_j + \delta_{j'} = 1$ and $\hat{n}_j + \hat{n}_{j'} = 1$, the above condition simplifies to

$$\frac{1}{\left(1 - \delta_j\right) \delta_j} \left(\delta_j - \hat{n}_j\right) \geq \frac{\left(n_i^2 + n_{i'}^2\right)}{n_i}$$

In terms of the parameters of our model, the poor will induce class conflict if and only if

$$\frac{1}{(1-\delta_P)\,\delta_P}\left[\delta_P - \hat{n}_P\right] \geq \frac{\left(\alpha^2 + (1-\alpha)^2\right)}{1-\alpha}$$

where

$$\delta_P = \frac{\beta\,(1-2p)}{\beta\,(1-2p) + (1-\beta)\,(1-2q)}$$

and

$$\hat{n}_P = \beta\,(1-p) + (1-\beta)\,q$$

We denote the left and right hand side expressions of the above inequality as $\psi(\beta)$ and $\eta(\alpha)$ respectively. We now establish the properties of $\psi(\beta)$ and $\eta(\alpha)$ in the following Lemmas.

Lemma 6 *$\psi(\beta)$ is strictly increasing in β for all β. Moreover, $\psi(\beta; p, q) = 0$ at $\beta = \frac{1-2q}{2(1-p-q)}$ and $\psi(\beta; p, q) \to \infty$ as $\beta \to 1$.*

Proof. Please see the appendix. ■

Lemma 7 *$\eta(\alpha)$ is strictly rising in α.*

Lemma 6 allows us to state our main result in the following proposition which argues that for any given size of ethnic majority, there is a critical size such that there will be class conflict if the majority class size is above that critical value.

Proposition 7 *For every $\alpha \in \left(\frac{1}{2}, 1\right)$, there exists $\beta_\alpha(p, q)$ such that the poor will form an alliance to engage in class conflict if and only if $\beta \geq \beta_\alpha$. Moreover, β_α is strictly increasing in α.*

Proof. Please see the appendix. ■

If the class size of the poor is sufficiently large, there will be class conflict. But smaller the size of the ethnic minority, the more difficult it becomes to form a class alliance. We can also verify how the mobility parameters, p and q, affect the chance of class conflict. Following the same procedure as in the proof of Lemma 6, it is easy to verify that $\psi_p < 0$ while $\psi_q > 0$. Thus, β_α rises with p and falls with q. The chance of class conflict falls (rises) with higher upward (downward) mobility.

Our results show that when the potential conflict is over the budget for community specific public good, class conflict happens for some parameter values even though ethnic conflict doesn't. In fact if α is small enough (still greater than $\frac{1}{2}$) and q is sufficiently large relative to p (a society with high downward mobility) class conflict happens for all $\beta > \frac{1}{2}$.

To establish the result mentioned above, we need to prove following Lemma.

Lemma 8 *For every $p \in \left(\frac{1}{2}, 1\right)$ there exists $\tilde{q}(p) \in (p, 1)$ such that $\lim_{\beta \to \frac{1}{2}} \psi(\beta; p, q) \geq \frac{1}{2}$ if and only if $q \geq \tilde{q}(p)$.*

Proof. Please see the appendix. ■

We now formally state the result mentioned earlier in the following proposition.

Proposition 8 *Consider an economy characterized by (p, q) such that $q > \tilde{q}(p)$. Then, there exists $\alpha_c > \frac{1}{2}$, such that for all $\alpha \in \left(\frac{1}{2}, \alpha_c\right)$, there will be class conflict for all $\beta > \frac{1}{2}$.*

Proof. Please see the appendix. ■

The last proposition predicts that if the economy is characterized by relatively high downward mobility and the ethnic groups are close in size, there will be class conflict irrespective of relative class sizes. However, in our model, there won't be any ethnic conflict in case the conflict is over the budget for public good. This finding warrants a discussion. We argue that just the pecuniary payoffs are not enough to justify ethnic conflict in the public good case since the win probability in an ethnic conflict is proportional to the class size while there is positive conflict cost. However, an individual belonging to a specific group may get some extra payoff when the prize is won over in a conflict rather than handed down by the government. This benefit is essentially non-pecuniary in nature and one may call it community pride. Our model can incorporate this by introducing an additional payoff conditional on winning a conflict. If this payoff is high enough, our model can predict ethnic conflict even in the public good case. We also expect the payoff due to community pride to be higher for ethnic groups than economic classes since pre and post conflict ethnic identity of an individual remains same while the class identity may change. If the pride payoff from ethnic conflict is sufficiently higher than that from class conflict, our model can predict higher incidence of ethnic conflict than class conflict even in the public good case.

3 Conclusion

It has been observed that ethnic conflicts are more frequent than class conflicts. Our paper provides a theory that explains this empirical regularity. In our theory, each individual is characterized by their class identity (rich and poor) and ethnic identity (eg. Hindu and Muslim). Any conflict is fought between alliances formed on either the class line or the ethnicity line. In an ethnic conflict, Hindu rich and Hindu poor form an alliance against the Muslims (rich and poor alike). In a class conflict, on the other hand, Hindu rich and Muslim rich form an alliance against Hindu poor and Muslim poor. In our set up, one's class identity can change between the period when the alliance is formed and the period when conflict pay-offs are distributed. Ethnic identities however, remain constant. In our theory this asymmetry between the class identity and ethnic identity drive the result. In presence of high economic mobility, one's class identity can change and therefore, even if one's alliance wins (say, poor) one may end up in the losing side (say, rich). This mechanism disincentivises class conflict. No such problem exists in case of ethnic conflict – one's ethnic identity does not change. In our paper, we elaborate this mechanism with two cases – private and community specific public goods. We find that for private good case, ethnic conflict is a more likely scenario. For community specific public good however, class conflict is more likely than ethnic conflict.

Our theory is based on a fundamental asymmetry between ethnic identity and economic class. Ethnic identity, in our paper, cannot change. Economic status on the other hand, may change as a result of an economic shock. This treatment of identity change is a crucial difference between our paper and other papers that look into the effect of identity mobility on conflict. In our paper, identity dimensions are not a choice – one cannot choose their ethnicity or economic class. What agents choose in our paper is the coalition for conflicts. Even though one's economic identity may change in our model, it comes as a result of economic shock rather than one's active choice. Using this structure, we can link conflict with macro-development. Specifically, we show that mobility triggering economic growth works as a deterrent factor for class conflict. No such mechanism works for ethnic conflict. However, growth may affect ethnic conflicts as well if economic status and ethnic identities overlap – if fraction of poor is higher for a certain ethnicity.

Appendix

Proof of Lemma 1

Under our specification, $n_H = \alpha$, $n_M = 1 - \alpha$ and $\alpha \geq \frac{1}{2}$. Hence, $\frac{G}{4n_H} < G$ for all α. However, $\frac{G}{4n_M} \geq G$ if and only if $\alpha \geq \frac{3}{4}$.

Proof of Lemma 2

In our specification, $n_P = \beta, n_R = 1-\beta, \hat{n}_P = \beta(1-p)+(1-\beta)q, \hat{n}_R = \beta p+(1-\beta)(1-q)$. Moreover, $\theta_{PR} = p$ and $\theta_{RP} = q$. Hence, $u_P^C \geq G$ if and only if

$$\frac{1}{4}\frac{4\beta p(1-p)+(1-\beta)(1-p-q+4pq)}{(\beta(1-p)+(1-\beta)q)(\beta p+(1-\beta)(1-q))} \geq 1$$

$$\begin{aligned} \Leftrightarrow &\quad 4\beta p(1-p)+(1-\beta)(1-p-q+4pq) \\ \geq &\quad 4(\beta(1-p)+(1-\beta)q)(\beta p+(1-\beta)(1-q)) \end{aligned}$$

$$\begin{aligned} \Leftrightarrow &\quad 4p(\beta(1-p)+(1-\beta)q)+(1-\beta)(1-p-q) \\ \geq &\quad 4(\beta(1-p)+(1-\beta)q)(\beta p+(1-\beta)(1-q)) \end{aligned}$$

$$\Leftrightarrow 4(\beta(1-p)+(1-\beta)q)(p-(\beta p+(1-\beta)(1-q)))+(1-\beta)(1-p-q) \geq 0$$

$$\begin{aligned} \Leftrightarrow &\quad 4(\beta(1-p)+(1-\beta)q)(1-\beta)(p+q-1)+(1-\beta)(1-p-q) \geq 0 \\ \Leftrightarrow &\quad (1-\beta)(1-p-q)(1-4(\beta(1-p)+(1-\beta)q)) \geq 0 \end{aligned}$$

For any $\frac{1}{2} \leq \beta < 1$, $1-4(\beta(1-p)+(1-\beta)q) < 0$ for any $p, q < \frac{1}{2}$. Hence, $u_P^C < G$ for all $\frac{1}{2} \leq \beta < 1$. However, similar argument shows that $u_R^C \geq G$ if and only if

$$1-4(\beta p+(1-\beta)(1-q)) \geq 0$$

$$\Leftrightarrow \beta p+(1-\beta)(1-q) \leq \frac{1}{4}$$

$$\begin{aligned} \Leftrightarrow &\quad \beta(1-p)+(1-\beta)q \geq \frac{3}{4} \\ \Leftrightarrow &\quad \beta \geq \tilde{\beta} = \frac{\frac{3}{4}-q}{1-p-q} \end{aligned}$$

Proof of Lemma 3

Notice that

$$\frac{\delta H(p,q)}{\delta q} = -\frac{3}{4}\frac{d\tilde{\beta}}{dq} + 2\phi\left(p,q,\tilde{\beta}\right)\cdot\frac{d\tilde{\beta}}{dq} - 2\int_{\tilde{\beta}}^{1}\phi_q(\beta,p,q)\,d\beta$$

Since $\phi\left(p,q,\tilde{\beta}\right) = \frac{1}{4}$,

$$\frac{\delta H(p,q)}{\delta q} = -\frac{1}{4}\frac{d\tilde{\beta}}{dq} - 2\int_{\tilde{\beta}}^{1}\phi_q(\beta,p,q)\,d\beta$$

It can be shown that $\int_{\tilde{\beta}}^{1}\phi_q(\beta,p,q)\,d\beta < 0$. Since $\frac{d\tilde{\beta}}{dq} < 0$, $\frac{\delta H(p,q)}{\delta q} > 0$.

Similar argument shows that $\frac{\delta H(p,q)}{\delta p} < 0$.

Proof of Lemma 4

From Lemma 3, we know that $H(p,q)$ is monotonically rising in q and falling in p. Notice that

$$\lim_{p\to\frac{1}{4},q\to\frac{1}{2}} H(p,q) < 0$$

since $\lim_{p\to\frac{1}{4}} C = 0$ while $\lim_{p\to\frac{1}{4}} E = \frac{1}{8}$. It can also easily be verified that

$$\lim_{p\to 0,q\to\frac{1}{2}} H(p,q) > 0$$

Since $H(p,q)$ is continuous and strictly decreasing in p, there exists $\bar{p} < \frac{1}{4}$, such that $\lim_{q\to\frac{1}{2}} H(p,q) < 0$ if and only if $p > \bar{p}$. Since $H(p,q)$ is strictly increasing in q, $H(p,q) < 0$ for all $q \in \left(0,\frac{1}{2}\right)$ for all $p > \bar{p}$.

Proof of Lemma 5

Consider and $p < \bar{p}$. It is easy to verify that for any $p < \frac{1}{4}$, $\lim_{q\to 0} H(p,q) < 0$. Since for any $p < \bar{p}$, $\lim_{q\to\frac{1}{2}} H(p,q) > 0$, there exists $\bar{q}(p) \in \left(0,\frac{1}{2}\right)$ such that $H(p,q) \geq 0$ for all $q \geq \bar{q}(p)$. This completes the proof of the lemma.

Proof of Lemma 6

Totally differentiating δ_P and $\hat{n}_P$ with respect to β, we can write

$$\frac{\delta\delta_P}{\delta\beta} = \frac{(1-2p)(1-2q)}{[\beta(1-2p)+(1-\beta)(1-2q)]^2} = \frac{\delta_p(1-\delta_P)}{\beta(1-\beta)}$$

and

$$\frac{\delta\hat{n}_P}{\delta\beta} = 1-p-q$$

Now,

$$\begin{aligned}
\frac{\delta\psi}{\delta\beta} &= \frac{1}{\delta_p(1-\delta_P)}\left[\frac{\delta\delta_P}{\delta\beta}-\frac{\delta\hat{n}_P}{\delta\beta}\right]+(\delta_P-\hat{n}_P)\left[\frac{1}{(1-\delta_P)^2\delta_P}-\frac{1}{(1-\delta_P)\delta_P^2}\right]\frac{\delta\delta_P}{\delta\beta} \\
&= \frac{1}{\delta_p(1-\delta_P)}\left[\left\{1+(\delta_P-\hat{n}_P)\left(\frac{1}{1-\delta_P}-\frac{1}{\delta_P}\right)\right\}\frac{\delta\delta_P}{\delta\beta}-\frac{\delta\hat{n}_P}{\delta\beta}\right] \\
&= \frac{1}{\delta_p(1-\delta_P)}\left[\{\delta_p(1-\delta_P)+(\delta_P-\hat{n}_P)(2\delta_P-1)\}\frac{1}{\delta_p(1-\delta_P)}\frac{\delta\delta_P}{\delta\beta}-\frac{\delta\hat{n}_P}{\delta\beta}\right] \\
&= \frac{1}{\delta_p(1-\delta_P)}\left[\left\{\delta_P^2-2\delta_P\hat{n}_P+\hat{n}_P\right\}\frac{1}{\beta(1-\beta)}-(1-p-q)\right]
\end{aligned}$$

where in the last step we use the expression for $\frac{\delta\delta_P}{\delta\beta}$. Hence, $\frac{\delta\psi}{\delta\beta}>0$ if and only if

$$\delta_P^2-2\delta_P\hat{n}_P+\hat{n}_P > \beta(1-\beta)(1-p-q)$$

$$\Leftrightarrow (\delta_P-\hat{n}_P)^2+\hat{n}_P(1-\hat{n}_P) > \beta(1-\beta)(1-p-q)$$

$$\Leftrightarrow (\delta_P-\hat{n}_P)^2+(\beta(1-p)+(1-\beta)q)(\beta p+(1-\beta)(1-q)) > \beta(1-\beta)(1-p-q)$$

$$\Leftrightarrow (\delta_P-\hat{n}_P)^2+\beta^2p(1-p)+(1-\beta)^2q(1-q)+2\beta(1-\beta)pq > 0$$

which holds for all β.

At $\beta = \frac{1-2q}{2(1-p-q)}$,

$$\begin{aligned}
\hat{n}_P &= \beta(1-p)+(1-\beta)q \\
&= \beta(1-p-q)+q \\
&= \frac{1-2q}{2}+q \\
&= \frac{1}{2}
\end{aligned}$$

while

$$\begin{aligned}
\delta_P &= \frac{\beta\left(1-2p\right)}{\beta\left(1-2p\right)+\left(1-\beta\right)\left(1-2q\right)} \\
&= \frac{1}{1+\frac{1-\beta}{\beta}\cdot\frac{1-2q}{1-2p}} \\
&= \frac{1}{2}
\end{aligned}$$

This proves that $\psi\left(\beta\right)=0$ at $\beta=\frac{1-2q}{2(1-p-q)}$.

Notice that as $\beta\to 1$, $\hat{n}_P\to 1-p$ while $\delta_P\to 1$ implying $\left(\delta_P-\hat{n}_P\right)\to p$. These together imply that that as $\beta\to 1$, $\psi\left(\beta\right)\to\infty$.

Proof of Lemma 7

$\eta\left(\alpha\right)$ is strictly increasing in α for $\alpha\in\left(\frac{1}{2},1\right)$ since

$$\begin{aligned}
\eta'\left(\alpha\right) &= \frac{2\alpha-2\left(1-\alpha\right)}{\left(1-\alpha\right)}+\frac{\left(\alpha^2+\left(1-\alpha\right)^2\right)}{\left(1-\alpha\right)^2} \\
&= \frac{4\left(\alpha-\frac{1}{2}\right)}{1-\alpha}+\frac{\left(\alpha^2+\left(1-\alpha\right)^2\right)}{\left(1-\alpha\right)^2} \\
&> 0
\end{aligned}$$

Proof of Proposition 7

For any $\alpha\in\left(\frac{1}{2},1\right)$, $\eta\left(\alpha\right)$ is finite and positive. Since $\psi\left(\beta\right)$ is continuous in β, by Lemma 6 we know that there exists $\beta_\alpha\in\left(\frac{1-2q}{2(1-p-q)},1\right)$, such that $\psi\left(\beta\right)\geq\eta\left(\alpha\right)$ for $\beta\geq\beta_\alpha$. $\eta\left(\alpha\right)$ increases with α by Lemma 7. Since $\psi\left(\beta\right)$ is increasing in β, β_α increase with α.

Proof of Lemma 8

We know from Lemma 6 that $\psi\left(\beta;p,q\right)=0$ at $\beta=\frac{1-2q}{2(1-p-q)}$. For $p\geq q$, $\frac{1-2q}{2(1-p-q)}\geq\frac{1}{2}$. Since $\psi\left(\beta;p,q\right)$ is strictly increasing in β, this implies that $\lim_{\beta\to\frac{1}{2}}\psi\left(\beta;p,q\right)\leq 0$. Thus for the statement in the condition to hold we need $q>p$. For $q>p$, $\frac{1-2q}{2(1-p-q)}<\frac{1}{2}$ and thus $\lim_{\beta\to\frac{1}{2}}\psi\left(\beta;p,q\right)>0$.

Using the expression for $\psi(\beta; p, q)$,

$$\lim_{\beta \to \frac{1}{2}} \psi(\beta; p, q) = \frac{2\left(q^2 - p^2\right)(1 - p - q)}{(1 - 2p)(1 - 2q)}$$

Notice that at $q = p$, $\lim_{\beta \to \frac{1}{2}} \psi(\beta; p, q) = 0$ while as $q \to \frac{1}{2}$, $\lim_{\beta \to \frac{1}{2}} \psi(\beta; p, q) \to \infty$. Moreover, $\lim_{\beta \to \frac{1}{2}} \psi(\beta; p, q)$ is strictly increasing in q since $\left(q^2 - p^2\right)$ and $\frac{1-p-q}{1-2q}$ are both strictly increasing in q. By continuity of $\lim_{\beta \to \frac{1}{2}} \psi(\beta; p, q)$ in q, there exists $\tilde{q}(p) \in \left(p, \frac{1}{2}\right)$ such that

$$\lim_{\beta \to \frac{1}{2}} \psi(\beta; p, q) \geq \frac{1}{2}$$

if and only if $q \geq \tilde{q}(p)$.

Proof of Proposition 8

From Lemma 8, for any $q > \tilde{q}(p)$, $\lim_{\beta \to \frac{1}{2}} \psi(\beta; p, q) > \frac{1}{2}$. Notice that $\eta(\alpha)$ is strictly increasing in α and $\lim_{\alpha \to \frac{1}{2}} \eta(\alpha) = \frac{1}{2}$ and $\lim_{\alpha \to 1} \eta(\alpha) = \infty$. Hence, there exists $\alpha_c \in \left(\frac{1}{2}, 1\right)$ such that $\lim_{\beta \to \frac{1}{2}} \psi(\beta; p, q) \geq \eta(\alpha)$ for all $\alpha \leq \alpha_c$. Since $\psi(\beta; p, q)$ is strictly in β, this proves that $\psi(\beta; p, q) \geq \eta(\alpha)$ for all $\beta > \frac{1}{2}$. This completes the proof of the proposition.

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