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ABSTRACT

The Optimal Size for a Minority [*]

We investigate a setting in which members of a population, bifurcated into a majority and a minority, transact with randomly matched partners. All members are uniformly altruistic, and each transaction can be carried out cooperatively or through a market mechanism, with cooperative transactions saving on transaction costs. Externalities are introduced, whereby cooperation by members of one group and the *relative* size of that group, affect the incentives to cooperate by members of the other group. Under these conditions, we determine the optimal size of the minority from the minority's perspective, and consider the conditions under which such a size might be attained. The model provides insights on social conflicts both between groups and within groups.

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1. Introduction

The economic role of ethnic and religious minorities in various contexts and times is well documented. The performance of Protestants in Catholic countries, Catholics in Protestant countries, Muslims in India, Balts in Northern Italy, Armenians in the Ottoman Empire, and Jews and Chinese almost everywhere, has undergone extensive scrutiny.[1] Work by economic historians in this field has recently been reinterpreted through the prism of institutional economics, showing that minorities have a comparative advantage in a wide range of economic activities characterized by pervasive informational imperfections and, consequently, high transaction costs. Apparently, the advantages of minorities stem from their ability to enforce trust and to credibly sanction opportunistic behavior, resulting in more cooperation within minorities than within majorities.

The economic explanations for this phenomenon can be roughly divided into four categories. The first is differences in preferences – a higher degree of altruism or of "morality" could be assumed to exist within minorities, sometimes, presumably, because minority members have not yet been "contaminated" by the market mentality (Bowles, 1998). Another reason could be that minorities invest more in the shaping of their members' preferences and beliefs (Guttman, Nitzan and Spiegel, 1992). Second, the essence of the interactions may vary across groups, with economic transactions within the minority being embedded in overlapping social networks. As a result, interactions within a minority are analyzed within the framework of a repeated game, while the majority is seen as carrying out a series of one-shot interactions. A third category (related to the previous one) deals with informational issues; for example, minority groups may incur lower informational costs when

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[1] See the proceedings of a conference on "The Economic Role of Minorities in Europe, XIII-XVIII", *Il Datini Lectures*, Firenze, April 1999. For an interdisciplinary perspective, see Brezis and Temin (1999), and, for a reassessment of the role of Chinese networks in international trade, Rausch (1999).

checking for the reputation of an agent (Greif, 1989, 1993).[2] Finally, the mere difference in group size may be of consequence. Because a minority is, by definition, relatively small, and because organizational costs have often been incurred by these smaller groups for other (such as cultural or social) purposes, the occurrence of free riding can be expected to be less prevalent since a potential defector would incur high costs from being excluded from the group's social and economic networks (Olson, 1965).

Along the lines of this last category, the present paper investigates the performance and incentives of members of a population that is bifurcated into a minority and a majority. Members of both groups partake in a series of transactions with both members of their own group and with members of the other group, and all transactions can be made either cooperatively or non-cooperatively. The only difference between members of the minority and members of the majority is group affiliation - all members of society have the same preferences, costs are identical, and transaction frequencies are the same for all. Individuals are all equally altruistic towards all members of society, and are randomly matched in transactions with other individuals. We show why there may be differences in performance, how such differences can give rise to intergroup externalities, and derive implications regarding endogenous changes in group affiliation.

Our results are driven by two non-standard assumptions. First, we assume that the relative size of a group is what determines the incentives to cooperate, and not the absolute size, as assumed in prior research. The result of this assumption is that an increase in the relative size of the minority (which leads to an automatic decrease in the relative size of the majority) can spark cooperation *within the majority*. The second assumption is that the payoff from non-cooperative transactions is positively dependent on the number of non-cooperative

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[2] In the framework of evolutionary economics, which deals with the transmission and reproduction of types of individuals, characterized by their genetic makeup, cooperation can also be sustained through the use of informational devices (see e.g. Stark, 1995, Chapter 5).

transactions that occur, because larger markets are more competitive and consequently more efficient.

The first of these assumptions, in particular, requires justification. The justification we offer is not particularly economic in nature – it is taken mostly from the fields of social psychology and of the sociology of intergroup relations (especially the economic sociology of immigration).[3] A central finding of social psychology is that the activation of group identities requires confrontation between groups. The "minimal group" experience, as presented in Brewer (1979), illustrates this nicely. In that experiment, people were artificially divided into two groups according to a "heads or tails" procedure, and were then asked to distribute gifts to other participants. It was found that the amounts distributed to members of the group were robustly and significantly higher when there was another group present than when there was no other group. Even when groups were identified, there were no behavioral implications until its members were confronted with the presence of another group. More often than not, behavior within a group is affected not only by the mere existence of another group, but also by the composition, size, etc. of that other group. For example, numerous sociological studies provide extensive evidence that the relative size of a minority is critical in determining racial attitudes of the majority (Giles, 1977; Fossett and Kiecolt, 1989) and between minorities (Cummings and Lambert, 1997).[4] These studies demonstrate the importance of the relative size of an ethnic minority as a key factor for understanding a majority's attitudes and behaviors. Obviously, such experimental and empirical evidence cannot be accounted for by the absolute size hypothesis.

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[3] For collections of articles in these fields, see Austin and Worchel (1986) on the psychology of intergroup relations, and Portes (1995) on the economic sociology of immigration.

[4] See Dustmann and Preston (1998) for both a survey of the sociology of racial attitudes and a convincing methodological appraisal of that literature. Their results for the United Kingdom show that high concentrations of ethnic minorities are indeed associated with more hostile attitudes.

The main idea behind the relative size hypothesis is that contact with other groups can have important behavioral implications both within one group (identity can be activated) and outside of it (intergroup hostility may arise). The only economic analysis of this type of issue we are aware of is the insightful paper by Carlton (1995). In that paper, Carlton considers the possibility of conflict between groups and discusses ways of internalizing the "hostility externality" (see also the comments by Masten, 1995, and Franke, 1995). Although we do not consider hostility or conflict directly, our model can be interpreted as being pertinent for these issues precisely because of the relative size hypothesis.

A notable innovation of this research is to endogenize the size of the minority within the strategic framework of intergroup relations. While most of the literature on minorities takes group size as exogenous (with the exception of Iannaccone, 1992), there is no a priori reason for this to be so. On the contrary, in many instances, the choice of identity or affiliation may well be the most important economic decision people make (Akerlof and Kranton, 2000). Members of one group may decide that they would prefer switching affiliation to a different group, because of pecuniary or non-pecuniary incentives. Members of a minority may decide that the existing restrictions are too onerous, and leave the minority, or there may be a stigma attached with membership in the minority, which will discourage others from joining. Furthermore, groups may be able to take steps to enhance the desirability of joining the group, or, even, to make joining less desirable. For example, a group of immigrants can set-up a network that will make future migration easier, thus increasing the base of potential immigrants. Similarly, a religious order can make joining desirable because of positive intragroup interactions, or make it less desirable by legislating religious restrictions that make joining highly costly, and, hence, unattractive.[5] Thus, the size of the minority could change as

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[5] See Iannaccone (1992) on how sacrifices, prohibitions and stygma can be used as a self-election device for membership in religious clubs and sects, and Berman (2000) for a striking application to ultra-orthodox Jews in Israel.

a result, say, of natural reproduction or defection, or through the actions of some central body (an organization or religious board) that takes decisions that affect incentives.

Note that the justifications just given are equally appropriate for endogenizing the absolute or the relative size of any group. Indeed, Iannaccone (1992) studies the determinants of the absolute size of a religious club or sect. The use of relative size instead of absolute size, however, has a number of benefits. First, when determining the optimal size for the minority, one needs to consider the environment in which the minority finds itself. One important characteristic of this environment is the existence of the majority, and the use of relative sizes in our model takes this characteristic into consideration in a clear and direct manner. Second, an immediate consequence of the use of relative size is that what is done within one group has effects on the other. Since members of both groups recognize these effects, the use of relative size allows us to account for the strategic dimension at work in intergroup relations. Therefore, we believe that the use of relative size is both analytically convenient and methodologically appropriate.

Our model yields the following results. First, cooperation requires social segmentation. As a result, there will never be intergroup cooperation. Second, bigger is not necessarily better, and the minority will often be interested in limiting its size. It will, however, never be optimal for the minority to totally assimilate itself into the majority. Third, there are instances in which the minority will be interested in promoting cooperation within the majority despite the ensuing negative externality on its own members' welfare. The model also provides insights on social conflicts both between groups and within groups.

The remainder of the paper is organized as follows. Section 2 presents the model and details the main assumptions made. In Section 3 we show how the optimal size of the minority is determined. Section 4 considers how the size of the minority is likely to evolve as

a result of spontaneous departures or arrivals and as a result of actions by minority leaders. Section 5 suggests some extensions and concludes.

2. A simple model

We consider a population containing two groups: N members of a majority and M members of a minority. For illustrative purposes, we assume that the majority is a group of Natives, and the minority is comprised of a group of Migrants, although this interpretation is not essential. The proportion of migrants is thus:

$$\pi_M = \frac{M}{N + M},$$

with $N>M>0$. Hence, by definition, $\pi_M<\frac{1}{2}$.

Every period, each individual engages in a number of economic transactions, with the number of transactions being the same for all individuals in both groups. Transactions take place both within the group to which the individual belongs and outside the group, with the individual being randomly matched with other individuals.[6] Thus, a proportion π_i of the transactions consummated by an individual belonging to group i, $i=M,N$ are carried out within the group to which she belongs. Exchanges take place without recognition costs, i.e., when a transaction is entered into, the individual immediately knows the group affiliation of his trading partner.

Each transaction can be carried out through a market mechanism, henceforth denoted a non-cooperative transaction, or via a cooperative agreement between the sides. Transacting through the market involves significant transaction costs that can be saved through a

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[6] While there would seem to be some justification for assuming that the individual would choose to transact relatively more with people in his own group, we assume randomness for two reasons. First, there is the opposing effect that people in the same group may have similar comparative advantages and thus be employed in similar occupations. In this case, intragroup trade would be relatively marginal. Secondly, including a bias towards relatively more (or less) intragroup trading would not change the essence of the results.

cooperative agreement.[7] The feasible outcomes of each interaction can therefore be described by a non-cooperative one-shot Prisoner's Dilemma game. For a given member of group i, $i=N,M$, the payoff matrix for each transaction is as presented in Table 1, with $A>B>C>D$ and $2B>A+D$. A result of (B,B) is the cooperative, non-market based result, and a result of (C,C) is the payoff from interacting via the market.

Table 1: The payoff matrix for each transaction

	Cooperation	No Cooperation
Cooperation	(B,B)	(D,A)
No Cooperation	(A,D)	(C,C)

We now proceed to set values for each of these potential payoffs.

Without loss of generality, we assume that $D=0$.

As stated above, C denotes the return from transacting via the market. We assume that this payoff is dependent on the density of market transactions – the more market transactions that occur, the greater the payoff from dealing through the market (for an early exposition of this argument, see Smith, 1776). The justification for such an assumption is immediate, as the greater the number of players, the closer the economy is to the ideal of perfect competition, and, hence, the more efficient is the market. One consequence of this is that the reward for a market (non-cooperative) transaction is negatively affected by the incidence of cooperative

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[7] For example, because of informational imperfections, it might be that market transactions require the writing of a contract by a lawyer, a cost that can be avoided if the parties agree via handshake, and each party keeps his side of the agreement.

transactions.[8] Holding total population constant, cooperative transactions reduce the size of the market and, consequently, increase the transaction cost that are incurred, thereby decreasing the gains from market exchanges.

Assume each individual carries out X transactions, with random matching. The total number of transactions in this instance will be $X(M+N)/2$.[9] If all of these transactions are carried out via the market, the market will reach its maximal level of efficiency, and C attains its maximum value. We normalize the maximal market payoff to be equal to 1. We further assume, for simplicity, that the payoff, C, is linearly dependent on the number of transactions carried out in the market. The total number of transactions can be divided as follows. Each of the M members of the minority will have $XM/(M+N)$ dealings with other minority members, so that a total of $XM^2/(2(M+N))$ intragroup transactions will be carried out within the minority.[10] Similarly for majority members, $XN^2/(2(M+N))$ intragroup transactions will occur. Dividing this by the total number of transactions, a portion π_i^2 of all transactions are carried out within group i, $i=N,M$. The payoff from a market transaction will be $C = 1 - d_N \pi_N{}^2 - d_M \pi_M{}^2 - 2 d_{NM} \pi_N \pi_M$, where d_i, $i=N,M$, is a dummy variable that equals 1 if members of the group in question cooperate when dealing with members of their own group, and 0 if they do not, and d_{NM} is a dummy variable equal to 1 if there is intergroup cooperation, and 0 if not. Thus, for any size groups, $0 \leq C \leq 1$, with the reward for a market

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[8] Continuing the example in the last footnote, the bigger the market, the greater the number of lawyers that can provide the specific contract needed, so the more competitive the market for lawyers, and the lower the transaction costs. When transaction costs are minimal but still positive, the gain from a market transaction is maximal, but still lower than the cooperative payoff.

[9] The division by 2 appears so that when two individuals interact, it is counted only once.

[10] This is only approximately true, because one can never be drawn to play oneself, so the number of minority members in the draw for a minority member is only M-1.

transaction equaling unity only when *all* transactions take place through the market (i.e., there are no cooperative agreements), and equaling zero when there are no market transactions.[11]

Finally, we turn to the gain an individual receives by deviating from a cooperative agreement (the payoff *A*).[12] This is an increasing function of the relative size of the *relevant* group (the size of the group as viewed by the individual for *that specific transaction*, as detailed below). This is due to the alleviation of social sanctions when agents get more anonymous, or, in other words, to the increasing incentives to free ride in larger groups. While this is a widely used assumption, it is usually based on absolute sizes.[13] As discussed at length in the introduction, we stray from that standard assumption, and posit, instead, that it is relative size, and not absolute size, that is of interest. The consequence of our assumption is that a change in the size of one group automatically changes the size of the other group (which would not occur if absolute sizes were considered). Such a change not only influences the payoff structure for transactions within that group, it also influences the payoff structure for transactions *within* the other group, as demonstrated below.

We now make the following assumption:

Assumption 1: *When an individual in group i, i=M,N, transacts with an individual in the same group, she views the size of the relevant group as π_i , but when she deals with someone from the other group, she views the size of the relevant group as the entire population.*

This is a reasonable assumption, that highlights the fact that only when dealing with someone from the same group is free riding relatively costly (i.e., the payoff from defecting is

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[11] *C* can never be negative since one always has the option of not interacting through the market.

[12] Continuing the lawyer example, this is the case where the players decided to transact without a contract, and one player reneged on the agreement.

[13] For experimental evidence, see for example Isaac and Walker (1988).

relatively low), while the cost of free riding is brought to a minimum when dealing with someone from another group.

With these understandings, we conclude that the payoff A is expressed as a function of the relative size of the relevant group. Assuming a linear form, $A_{ij} = B(1 + \pi_{ij}), i, j=M,N$, where $\pi_{ij} \equiv \pi_i$ for intragroup transactions, and $\pi_{ij} = 1$ for intergroup transactions. Table 1 can now be rewritten as follows:

Table 2: The payoff matrix

	Cooperation	No Cooperation
Cooperation	(B,B)	$(0, B(1 + \pi_{ij}))$
No Cooperation	$(B(1 + \pi_{ij}),0)$	$(1 - d_N \pi_N{}^2 - d_M \pi_M{}^2 - 2d_{NM} \pi_N \pi_M,$ $1 - d_N \pi_N{}^2 - d_M \pi_M{}^2 - 2d_{NM} \pi_N \pi_M)$

We now turn to individuals' preferences. Agents are homogeneous in their preferences independent of the group to which they belong; and they are assumed to have identical altruistic utility functions, so that the individual is concerned with the utility attained by his trading partner. More precisely, the individual's utility is a weighted average of the monetary payoffs of both trading partners, with a weight of $(1 - \alpha)$ placed on his/her own payment, and a weight of α placed on the payment to the other party. As a result of this specification, the payoff table needs to be modified only in those cells in which players play different actions, i.e., in the off-diagonal cells.

We rewrite the payoff matrix as follows:

Table 3: The payoff matrix with altruism

	Cooperation	No Cooperation
Cooperation	(B,B)	$(\alpha B(1+\pi_{ij}),(1-\alpha)B(1+\pi_{ij}))$
No Cooperation	$((1-\alpha)B(1+\pi_{ij}),\alpha B(1+\pi_{ij}))$	$(1-d_N\pi_N{}^2-d_M\pi_M{}^2-2d_{NM}\pi_N\pi_M,$ $1-d_N\pi_N{}^2-d_M\pi_M{}^2-2d_{NM}\pi_N\pi_M)$

Note that although preferences are homogeneous throughout the population, payoffs differ in different transactions solely as a result of the different relative sizes of the relevant groups. These differences could be strengthened by introducing an asymmetry in the quality of social ties (increased altruism) in favor of the minority. In this case, the bias between groups in their relative performance would be further enhanced (Van Dijk and Van Winden, 1996). Note also that the same degree of altruism applies for intragroup and intergroup transactions, i.e. it is independent of the identity of the trading partner.

We assume that when the Pareto superior cooperative outcome is also a Nash equilibrium, cooperation is chosen.[14] Thus, cooperation will be observed if the payoff when cooperating is higher than the payoff when defecting, i.e. if $B>(1-\alpha)B(1+\pi_{ij})$. A sufficient condition for cooperation to be a possible (but not unique) equilibrium in intragroup transactions is therefore:

$$\alpha > \frac{\pi_i}{1+\pi_i} \equiv \alpha_i^{\min}. \qquad (1)$$

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[14] The possibility of multiple equilibria is ignored; we simply assume the existence of coordination procedures if necessary.

Thus, we arrive at the following propositions:

Proposition 1: *The altruistic threshold required for cooperation to prevail in intragroup transactions is an (less than proportionally) increasing function of the relative size of that group.*

Proof: This is immediate because

$$\partial \alpha_i^{\min} / \partial \pi_i = \frac{1}{(1+\pi_i)^2} > 0 \text{ and } \partial^2 \alpha_i^{\min} / \partial \pi_i^2 = -\frac{2}{(1+\pi_i)^3} < 0.$$

Corollary 1: *It can never be the case that the majority cooperates, but the minority does not. The converse, however, can occur.*

We now make the following assumption:

Assumption 2: $\alpha \leq 1/2$.

Assumption 2 indicates that the value attached by an individual to the welfare of his partner in the exchange can never exceed the value he attaches to his own felicity. An extreme case is when $\alpha = 1/2$, i.e. when the individual values his partner's gains as much as he values his own.

Proposition 2: *Cooperation is never achieved in intergroup transactions; cooperation requires social segmentation.*

Proof: As discussed above, in intergroup transactions, the entire population is viewed as a single group ($\pi_{ij} = 1$). To get intergroup cooperation, we thus need $B>2(1-\alpha)B$, i.e. $\alpha>\frac{1}{2}$ which is ruled out by Assumption 2.

As stated in Corollary 1, there are instances in which transactions among members of the minority will be cooperative while those among members of the majority will be non-cooperative, and this despite the fact that both groups share the same degree of altruism. Indeed, since by definition $\pi_M < \pi_N$, it must be that $\alpha_M^{\min} < \alpha_N^{\min}$ for any minority size. Hence, there are three possible cases: 1) if $\alpha < \alpha_M^{\min}$ there are no cooperative transactions (Area 1 in Figure 1 below), 2) if $\alpha_M^{\min} < \alpha < \alpha_N^{\min}$ intragroup transactions are cooperative within the minority but non-cooperative within the majority (Area 2 in Figure 1), and 3) if $\alpha > \alpha_N^{\min}$ all intragroup transactions will be cooperative (Area 3 in Figure 1).[15]

Figure 1 about here

3. The optimal size

Until this point, the relative size of the minority (and, consequently, of the majority) has been exogenous. As discussed in the introduction, there are many instances in which steps can be taken to purposefully alter the size of a group. With this understanding, we proceed as follows. In this Section we show what the *optimal* size of the minority is when viewed from the minority's perspective. This done, we then turn in the next Section to consider whether it is likely that this optimum will be attained.

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[15] To give a numerical illustration, if the minority is one third and the majority is two thirds, the minority will experience intragroup cooperation while the incumbent majority will not when $0.25 < \alpha < 0.40$.

The main result of this section is that bigger is not necessarily better – an increase in the relative size of the minority may have ambiguous effects on the welfare of minority members. To show why, assume that intragroup cooperation prevails for the minority alone. In this case, a higher relative size means a higher share of intragroup transactions, which increases the number of transactions that yield the high payoff *B*. There are, however, two opposing effects. First, the number of transactions carried out through the market decreases, lowering the payoff from each of the intergroup transactions (which are always carried out through the market). Hence, the gain from an additional cooperative transaction may well be offset by numerous small losses on each non-cooperative transaction. Second, an increase in the group's size decreases the relative size of the majority. At some point this will act as a trigger that will spark cooperation within the majority. This would be detrimental for the minority, again because of the ensuing (substantial) decrease in the number of market transactions, and, concurrently, in the payoff from these transactions.

To find the optimal size, we first calculate the earnings per minority member in each situation. Assume *X*, the number of transactions per person, is of measure 1. Thus, π_i measures the percentage of transactions concluded with members of group *i*. From Table 3, the income if there is no cooperation (I_{nc}) in either group equals one.[16] If the minority alone cooperates, the payoff for a member of the minority is

$$I_{c,m} = \pi_M B + \pi_N \left(1 - \pi_M^2\right), \tag{2}$$

and if both groups cooperate, the payoff is:

$$I_{c,mn} = \pi_M B + \pi_N \left(1 - \pi_M^2 - \pi_N^2\right). \tag{3}$$

In the calculations that follow we substitute $\pi_N = 1 - \pi_M$, and, for notational simplicity, we write π to symbolize the size of the minority. This yields:

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[16] From Proposition 2 we know that there is *never* intergroup cooperation.

$$I_{c,m} = \pi^3 - \pi^2 + (B-1)\pi + 1,$$ (2')

and

$$I_{c,mn} = 2\pi^3 - 4\pi^2 + (B+2)\pi.$$ (3')

Equation (2') is depicted in Figure 2. Analysis of the function in Equation (2') shows

that if $B<4/3$ there is a local maximum at $\pi_1^* = \dfrac{2 - \sqrt{16 - 12B}}{6}$, and a local minimum at

$\pi_2^* = \dfrac{2 + \sqrt{16 - 12B}}{6}$. After this latter point the income will again increase, and there is a

value, denoted π_3, at which $I_{c,m}(\pi_1^*) = I_{c,m}(\pi_3)$. Note that π_1^* is increasing in B, attaining

a maximum at $\pi_1^* = 1/3$, while π_2^* is decreasing in B. Since, by definition, the minority can

never comprise more than half the population, it is of interest to note that $\pi_2^* = 1/2$ when

$B=1.25$, and $\pi_3 = 1/2$ when $B\approx1.32$. Finally, if $B>4/3$ income is monotonically increasing in

the size of the minority, so that π_1^*, π_2^* and π_3 do not exist.

Figure 2 about here

We use this information to find the optimal size for the minority *under the initial

assumption that the minority alone is cooperating* (Area 2 in Figure 1). If $\alpha<1/3$, the majority

(which must comprise more than half the population) will never cooperate. Hence, the largest

minority that will yield cooperation within the minority can be found from Equation (1):

$\pi_{c,m}^{\max} \equiv \alpha/(1-\alpha)$. If, however, $\alpha>1/3$, this minority size could well spark cooperation within

the majority also. As a result, the largest minority that will yield cooperation for the minority

only is $\pi_{c,m}^{\max} \equiv 1 - [\alpha/(1-\alpha)] = (1-2\alpha)/(1-\alpha)$.

The optimal size *assuming cooperation within the ranks of the minority only* is now

found as follows. If *B>4/3*, since $\dfrac{\partial I_{c,m}}{\partial \pi_M} > 0 \quad \forall \pi_M$, the optimal size, $\pi^*_{c,m}$, is $\pi^*_{c,m} = \pi^{\max}_{c,m}$.

This simply means that for sufficiently high returns to cooperation, it is always welfare

improving for the minority to increase its size as long as this does not induce cooperation

within the majority.[17] If *B<4/3*, however, then if $\pi^{\max}_{c,m} < \pi_3$, $\pi^*_{c,m} = \min\!\left(\pi_1^*, \pi^{\max}_{c,m}\right)$, and if

$\pi^{\max}_{c,m} > \pi_3$, then $\pi^*_{c,m} = \pi^{\max}_{c,m}$.[18]

Having set the optimal size for the minority when the minority alone cooperates, we

must now address two questions. First, does the minority always prefer a situation where the

minority alone cooperates to a situation where no one cooperates? Second, does the minority

always prefer a situation where the minority alone cooperates to a situation where both groups

cooperate? As we now show, the first question is answered in the affirmative, while the

second question is not.

To answer the first question, recall that the payoff from non-cooperation in either

group, I_{nc}, equals 1. As long as the payoff at the optimum with minority cooperation only is

greater than one, such cooperation will be preferred by the minority. As we show in the proof

to the following Proposition, this always holds at the optimal size.

Proposition 3: T*he optimal size for the minority is always strictly positive. That is,*

$I_{c,m} > 1$ if $\pi = \pi^*_{c,m}$.

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[17] A comparison of this outcome with the outcome when the majority also cooperates is carried out below.

[18] See Figures 3.1 to 3.3 for the different cases.

Proof: Note from Equation (2') that when $\pi = 0$, $I_{c,m} = 1$. Furthermore, when $\pi = 0$,

$\partial I_{c,m} / \partial \pi = B - 1 > 0$.[19] Therefore, the optimal minority size must yield at least as high a

payoff as attained at $\pi = \varepsilon$, so $I_{c,m} > 1$. Note that this is independent of the value of α, as

long as it is bounded away from 0 and 1/2 (see Figures 3.1-3.5)

To answer the second question posed above, we now compare the outcome without

majority cooperation with the outcome if there is also cooperation within the majority. When

$\alpha < 1/3$, the majority will never cooperate so that optimality is achieved from the minority's

perspective when its size is set as detailed above. However, when $\alpha > 1/3$ there are instances

(when π is sufficiently large) in which there is intragroup cooperation in both groups (Area

3). As seen from Equation (3'), since $B > 1$, $\dfrac{\partial I_{c,mn}}{\partial \pi} > 0 \quad \forall \pi$, so if the economy is already in

Area 3, it is optimal for the minority to be as large as possible ($\pi \to 1/2$). At that point,

$I_{c,mn} = 0.25 + 0.5B$. Thus, we must compare the highest payoff when there is cooperation within

the minority alone, to this value. To this end, we have the following proposition:

Proposition 4: a) If $B \le 1.5$ the minority always prefers that the majority not cooperate. b) If

$B > 1.5$, there exists a value of α, denoted α^*, such that if $\alpha \le \alpha^*$ the minority prefers no

cooperation within the majority, and if $\alpha > \alpha^*$ the minority prefers that the majority also

cooperate. c) In addition, this altruistic threshold is decreasing in B, i.e., $\partial \alpha^* / \partial B < 0$.

Proof: a) If $B \le 1.5$, $I_{c,mn}(\pi \to 1/2) \le 1$, and, as just shown, $\dfrac{\partial I_{c,mn}}{\partial \pi} > 0 \, \forall \pi$. Hence, for all

values of π, $I_{c,mn} \le 1$. As proven in Proposition 3, the payoff at the optimal minority size with

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[19] As discussed above, $I_{c,m}$ attains a local maximum at π_1^* if $B < 4/3$, and continually increases if $B > 4/3$.

minority cooperation only is strictly greater than 1 $\left(I_{c,m}\left(\pi_{c,m}^{*}\right)>1\right)$. Consequently, the first part of the proposition holds.

b) If $B>1.5$, since we are dealing with cases in which $\alpha>1/3$, the optimal size of the minority with minority cooperation only is $\pi_{c,m}^{\max}(\alpha)=(1-2\alpha)/(1-\alpha)$. Note that for values of α between 1/3 and 1/2 there is a one-to-one and onto relationship between $\pi_{c,m}^{\max}$ and α. In particular, when $\alpha=1/3$, $\pi_{c,m}^{\max}(\alpha)=1/2$, when $\alpha=1/2$, $\pi_{c,m}^{\max}(\alpha)=0$, and $\pi_{c,m}^{\max}(\alpha)$ is strictly decreasing in α. Hence (from Equation (2')), the greatest payoff when the minority alone cooperates is $I_{c,m}=\left(\pi_{c,m}^{\max}(\alpha)\right)^{3}-\left(\pi_{c,m}^{\max}(\alpha)\right)^{2}+(B-1)\pi_{c,m}^{\max}(\alpha)+1$. Recall that the maximal payoff when both groups cooperate is $I_{c,mn}=0.25+0.5B$. α^{*}, as defined in the proposition, is found by finding the value of $\pi_{c,m}^{\max}(\alpha)$ for which $I_{c,m}=I_{c,mn}$.

As shown above, for values of $B>1.5$, $\partial I_{c,m}/\partial\pi>0$, or, in the cases under consideration, $\partial I_{c,m}/\partial\alpha<0$. In addition $I_{c,mn}$ is not dependent on π. Thus, as α increases, $I_{c,m}-I_{c,mn}$ decreases. Now, when $\alpha=1/3$, $I_{c,m}-I_{c,mn}=1/8>0$, and when $\alpha=1/2$, $I_{c,m}-I_{c,mn}=0.75-0.5B<0$ (since $B>1/5$). Hence, there exists a value of α, α^{*}, for which $I_{c,m}=I_{c,mn}$.

c) With respect to the last part of the proposition, replace α^{*} in the desired equality to get the identity $L\equiv\left(\pi_{c,m}^{\max}(\alpha^{*})\right)^{3}-\left(\pi_{c,m}^{\max}(\alpha^{*})\right)^{2}+(B-1)\pi_{c,m}^{\max}(\alpha^{*})+1-0.25-0.5B\equiv0$. Totally differentiating L with respect to $\pi_{c,m}^{\max}$ and B and rearranging, we find that

$$\frac{d\pi_{c,m}^{\max}}{dB}=\frac{\left(0.5-\pi_{c,m}^{\max}\right)}{\partial L/\partial\pi_{c,m}^{\max}}>0,$$ since $\partial L/\partial\pi_{c,m}^{\max}=\partial I_{c,m}/\partial\pi_{c,m}^{\max}>0$, and $\pi_{c,m}^{\max}<1/2$. Hence,

$\partial\alpha^{*}/\partial B<0$.

Figures 3.1-3.5 show all the relevant cases, with the bold lines representing the optimum. In 3.1 and 3.2 $\pi_3 > 1/2$, so π_1^* is optimal when it can be attained. Because of the relatively low value of B, the minority always prefers to keep the majority from cooperating, even for high values of α. In 3.3 $\pi_3 < 1/2$, so when $\pi_{c,m}^{\max} > \pi_3$, then $\pi_{c,m}^{\max}$ is optimal, but if $\pi_{c,m}^{\max} < \pi_3$, the minority is better off at π_1^* (if attainable without majority cooperation). In 3.4 π_1^* does not exist, but B is still low enough that the minority is better off by keeping the majority from cooperating through a reduction of its own size if necessary. In 3.5 B is large enough that, above some values of α, the cost of keeping the majority from cooperating is too great, and the minority is better off with a larger group (more cooperative transactions) despite the induced cooperation within the majority.

Figure 3 about here

4. Moving towards the optimal size

We now ask whether the optimal size we have just characterized can be expected to be attained. We look at this question from three perspectives – one that can be described as an "invisible hand" perspective, and two that fit into the category of a "visible hand". The first is the personal choices of individuals considering changing affiliation. While the choice to change affiliation is most probably affected by many determinants, we assume that pecuniary issues alone are considered. Hence, ceteris paribus, individuals will desire to join (leave) a minority if and only if the expected income in the minority is greater (lower) than in the majority.[20] The other two forces involve with the leadership of the minority, interested in

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[20] That is, we assume that there are no non-monetary costs and benefits related to such a change. One could, however, introduce a discount factor that would reflect the individuals' attachment or distaste for her group of origin, without changing the essence of the results. More interestingly, one could also

maximizing income per member. We look at two kinds of leaderships – a "myopic" (or "local") leader, and an omniscient (or "global") leader. The difference between the two is that the myopic leader sees how a small (local) change in the relative size affects income, but does not see the overall picture, i.e., he knows only the sign of the derivative. An omniscient leader, however, knows the entire function, and can thus strive for the global optimum, although this may require a discrete jump in size. Consider, for instance, the case in Figure 2 in which $B<4/3$. For values of π such that $\pi_1*<\pi<\pi_2*$, the local leader will desire a decrease in the size of the minority in order to return to the locally optimal size of π_1*, while the global leader will push towards increasing the relative size past π_3, assuming that $\pi_3<\frac{1}{2}$. We show the directions of these three forces (individual incentives, local leader and global leader) with three sets of arrows in Figures 3.1-3.5.

Individual incentives can be best discerned from Figure 1. If the economy begins inside Area 1 of Figure 1 no one cooperates, so that everyone earns the same payoff. Thus, there is no individual incentive to switch affiliation (and, as a result, no corresponding arrow in Figures 3.1-3.5 in this area). In Area 2 the minority alone cooperates, so the income per member is greater for the minority than for the majority. Hence if only pecuniary considerations are of concern, there will be a desire by majority members to join the minority. In Area 3, however, both groups cooperate, and because there are more cooperative intragroup interactions within the majority than within the minority, majority members earn more than minority members, so, *ceteris paribus*, there will be defection from the minority to the majority (assimilation).

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introduce externalities whereby the move of one individual member would affect remaining members not only through the effect on income, but also through non-monetary channels (if affiliation *per se* enters one's utility function in a manner dependent upon others' affiliation decisions). It is clear that an implicit assumption in this section is that changing affiliation is a relevant option. In some instances this is obviously not the case. For example physical (e.g. color) or cultural (e.g. accent) features may limit the set of affiliation choice. See Akerlof and Kranton (2000) for extensive discussions of these issues.

A myopic leader in Area 1 will similarly see that local changes in the relative size have no effect on income. Hence, in Area 1 there is no pressure to increase or decrease the size of the minority (and, again, no corresponding arrow in Figures 3.1-3.5). With respect to Area 2, if π_1*, π_2* and π_3 exist (i.e., if $B<4/3$, as in the lower curve in Figure 2), then for values of π_M between 0 and π_2* the move will be towards π_1*, and if $\pi_2* < \pi_M < \pi_{c,m}^{\max}$ the move will be towards $\pi_{c,m}^{\max}$. If π_1*, π_2* and π_3 do not exist, the move will always be towards $\pi_{c,m}^{\max}$. In Area 3, however, the local leader will always desire a larger minority because, as discussed above, the payoff is locally increasing in minority size.

The omniscient leader, by definition, will always want to move towards the optimal size. Hence, the corresponding arrows will always point toward the bold lines that denote the optimal size.

As can be seen in the Figures, there are numerous instances of opposing forces. When all three arrows point in the same direction, it is likely that the fate of the minority members will be improved over time. However, when there are opposing forces, there is no a priori way of determining what forces will prevail. While it is possible to make ad-hoc assumptions about the relative strengths of these forces, we do not do so. Rather, we simply show the directions of the forces in order to demonstrate the kinds of conflicts that can arise.

For instance, in Figure 3.2 in Area 2 when $\pi_2* < \pi_M < 1/2$, members of the minority earn more than do members of the majority, so there will be a desire by members of the majority to join the minority. From a local perspective an increase in the size of the minority will increase the minority members' incomes, and so will be also be popular politically. But a global leader will desire a decrease in the size of the minority, and will want to take measures to keep these outsiders out (and, most likely, even harsher measures to drive some of the insiders out). This global leadership, however, will have to fight market forces from both

inside and outside the group, and internal pressures from members who see their incomes initially falling as the group size is decreased.

A glance at Figures 3.1-3.5 shows that almost all possible combinations of forces exist. Determining which forces will prevail when the forces point in different directions, is, however, beyond the scope of this research.

5. Conclusion

In the model presented in this paper, members of a minority and a majority play repetitive rounds of a one-shot prisoner's dilemma game, and despite all individuals being identical from all respects except group affiliation, they may behave differently with different trading partners. We have abandoned the usual assumption that the absolute size of a group affects behavior within the group, and replaced it with the postulation that it is the relative size of a group that determines behavior. Given this setting, the optimal size for the minority was discerned, and expected endogenous changes in the minority size were examined from the perspectives of individual members of the society, and of a planner for the minority. We have shown that when considering a change in size, the minority's planner must take two effects into account – the direct effect on welfare, and the indirect effect on the behavior of the majority. Assuming that cooperation initially prevails within the minority alone, an increase in the minority size negatively affects the welfare of the majority through a decrease in the breadth of market exchanges. This, in turn, affects the majority's incentives to adopt a cooperative mode in its internal transactions. The minority may wish to limit its size in order to prevent cooperation within the majority, since such cooperation will, in turn, decrease the breadth of market transactions yet more, and, consequently, harm the minority.

We believe that our theory is of interest for the analysis of intergroup tensions. Such tensions, prevalent in both developed and developing countries, are generally ignored by

economists (with the exception of Carlton, 1995), and left to the sagacity of other social scientists. Our model provides economic foundations for the emergence of hostile attitudes and behaviors towards minorities on the part of members of a majority. Hostile attitudes emerge initially due to a decrease in the market payoff to majority members resulting from an increase in the minority size. Note that the negative impact on payoffs is initiated by the mere existence of a minority. Still, hostility will most probably not arise while the minority remains small, since the effect would be minute. However, when the minority increases, the negative effect increases exponentially, which can trigger such hostility.[21] In addition, hostile behavior could deepen if the majority switches from a non-cooperative to a cooperative mode its in internal transactions, since this would introduce discrimination into the economy. It is worth emphasizing that, in our model, hostile attitudes and behavior arise despite the presence of altruism in individual relations. That is, the source of social conflicts is not at the individual level but rather at the group level.

We have also shown that the issue of minority size may give rise to internal conflicts within the minority. At the individual level (the invisible hand), people compare the personal costs and benefits of changing group affiliation, and of integrating new members into their group. Their willingness to integrate new members (that is, to make the group more attractive to potential newcomers) or to leave the group might be backed or opposed by the group authorities. Moreover, the group authorities themselves (the visible hand) may disagree on the relevant strategy for the group. Indeed, there are many instances in which a "local" planner (who knows only the effect of including or excluding one additional member) and a "global" planner for the minority (who knows the optimal size for the minority) will pull in opposing

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[21] Note that such a hostile attitude may be economically irrational in the case of ethnic minorities that grow through immigration flows. These flows tend to increase the size of the market and to consequently benefit the native population through an increase in the immigration surplus (Borjas, 1995). However, at a cognitive level, people might retain the negative effect of the increase of the minority size, as explicitly modeled in the paper.

directions. Taken together, these potentially opposing forces may lead to strong internal conflicts and eventually to schisms, civil wars, excommunications, etc.

The lessons from our model would seem to be widely applicable. For instance, we have not differentiated between ethnic and religious minorities, but could do so. A central difference between ethnic minorities and religious minorities, is that the relative size of the latter is primarily determined through competition among existing groups, while the relative size of the former depends mainly on immigration and assimilation flows. Applying our framework to these two issues could yield interesting insights on religious proselytism or exclusion, as well as on the degree of hospitality or lack of hospitality of existing ethnic communities towards newcomers. Another straightforward prediction of our theory is that the choice of location may be critical for the success of a minority – indeed, location choice might be a cost-efficient means for the minority to fix its relative size.[22] Finally, a natural extension would be to incorporate other channels through which the wellbeing of one group affects that of another group (e.g., social status, frustration, relative deprivation, etc.), and to consider how these alternative channels affect the degree of cooperation within each group.

On a final note, we would like to emphasize that the analysis carried out in this paper looked for optimality from the perspective of the minority alone. There are, of course, at least two other views that can be taken – that of the majority, and that of a social planner (total welfare). From the majority's perspective, minority cooperation is harmful, while cooperation within the majority is beneficial. Recall that it is impossible to have cooperation *only* within the majority. When cooperation within the majority is not attainable, the majority is better off if no one cooperates. When, however, cooperation within the majority is a feasible alternative, the majority will prefer that both groups cooperate. In addition, in this situation, the majority will want to be as large as possible while maintaining cooperation within their ranks.

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[22] For instance, the minority could prefer to locate itself in big cities rather than in small cities.

However, from a social planner's perspective the issue is more complicated since the interests of the minority and the interests of the majority must be weighed against each other. It can be shown that there are instances when the social optimum coincides with that of the majority, with that of the minority, or with neither.[23]

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[23] A full analysis of these issues is available from the authors upon request.

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Figure 1.

α_M^{Min} α_N^{Min}

Area 3

1/2

1/3

Area 2

Area 1

$1 - \pi_M$ 1/2 π_M

Figure 2

$I_{c,m}$

$B > 4/3$

$B < 4/3$

$\pi_1 *$ $\pi_2 *$ π_3 π
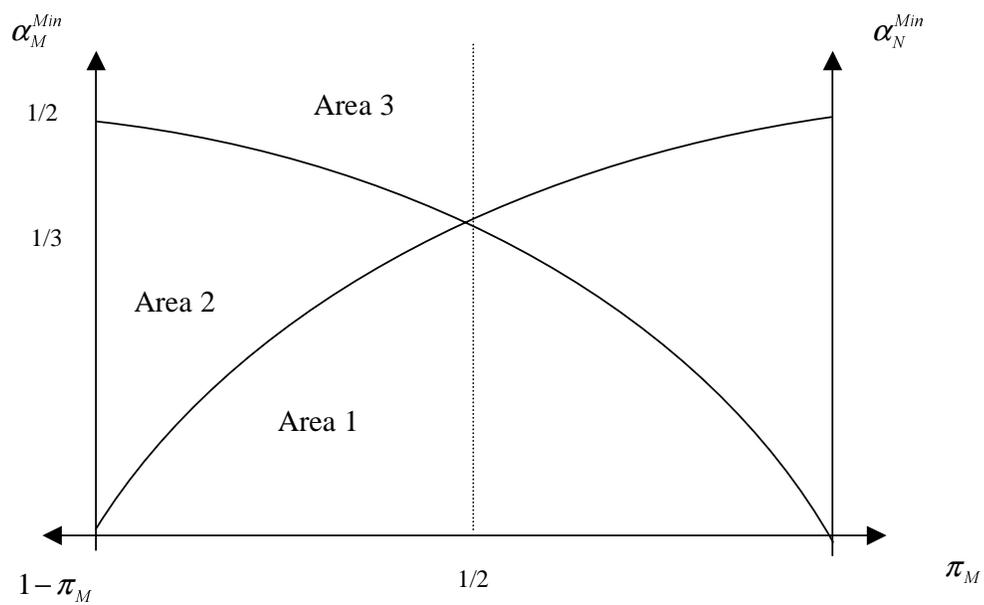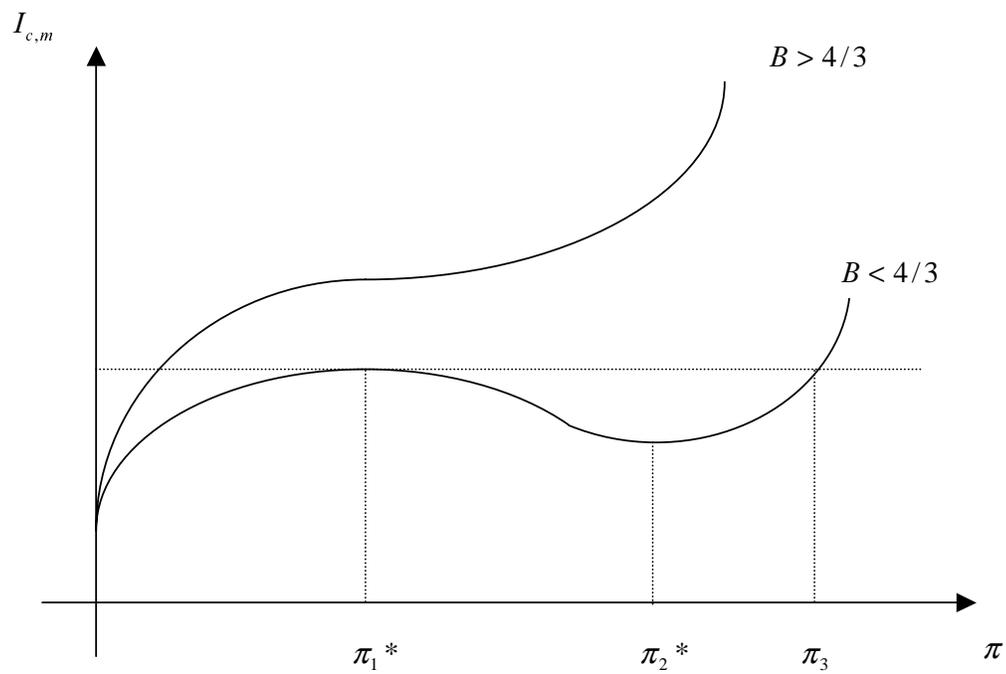
Figure 3.

Case 1: B<1.25, $\pi_1^* < 1/2 < \pi_2^* < \pi_3$.
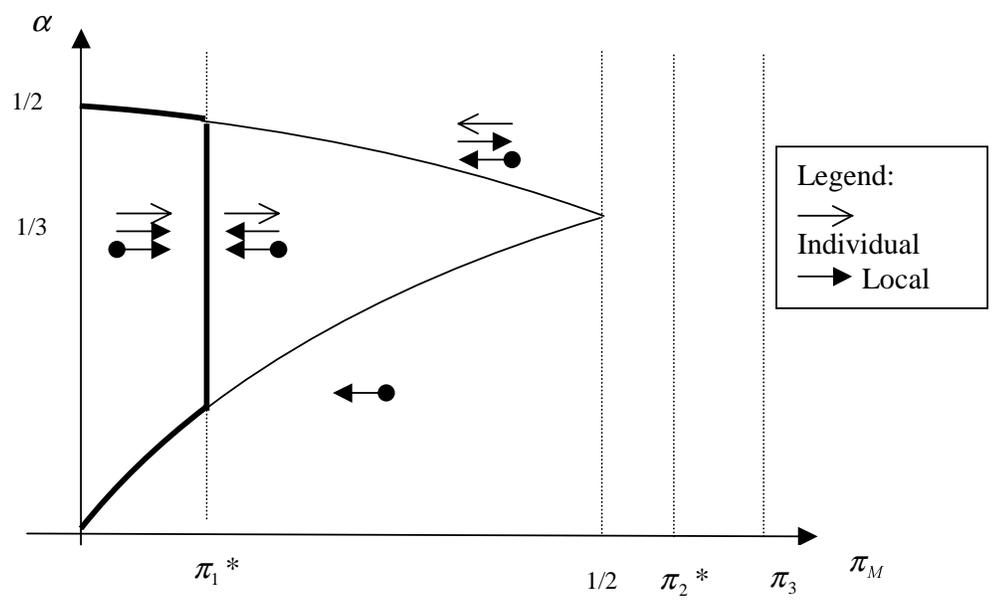
Case 2: 1.25<B<Bc, $\pi_1^* < \pi_2^* < 1/2 < \pi_3$.
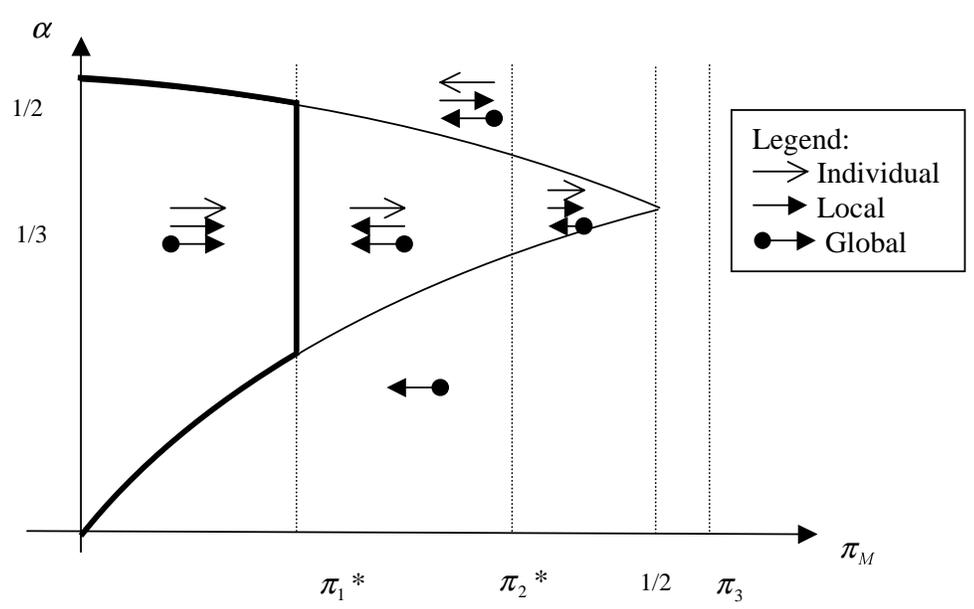
Case 3: Bc<B<4/3, $\pi_1^* < \pi_2^* < \pi_3 < 1/2$
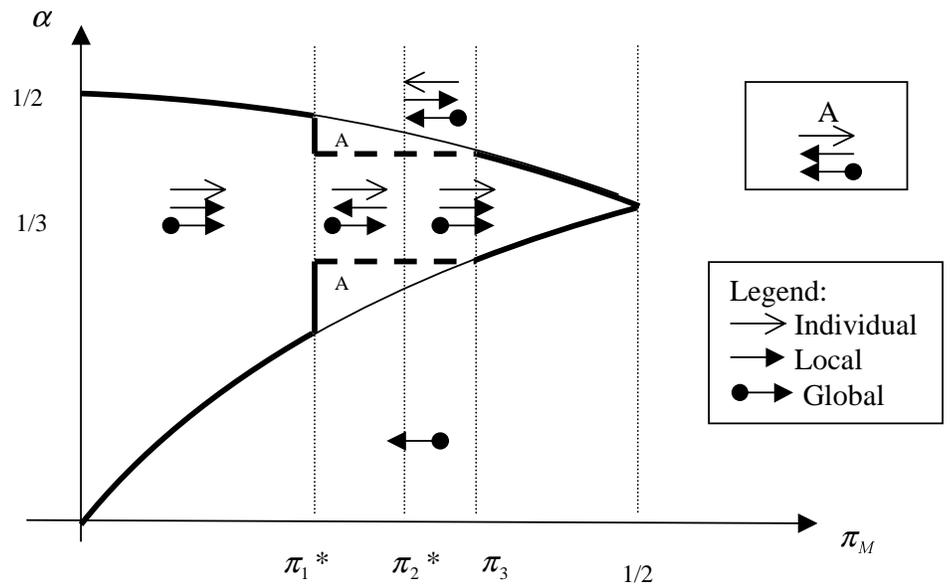
Case 4:4/3< B<1.5
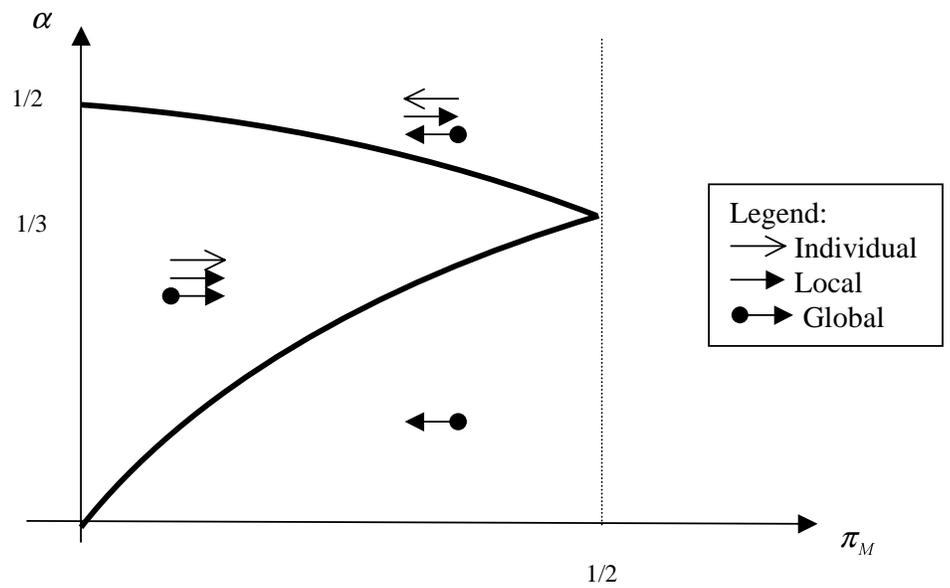
Case 5: B>1.5
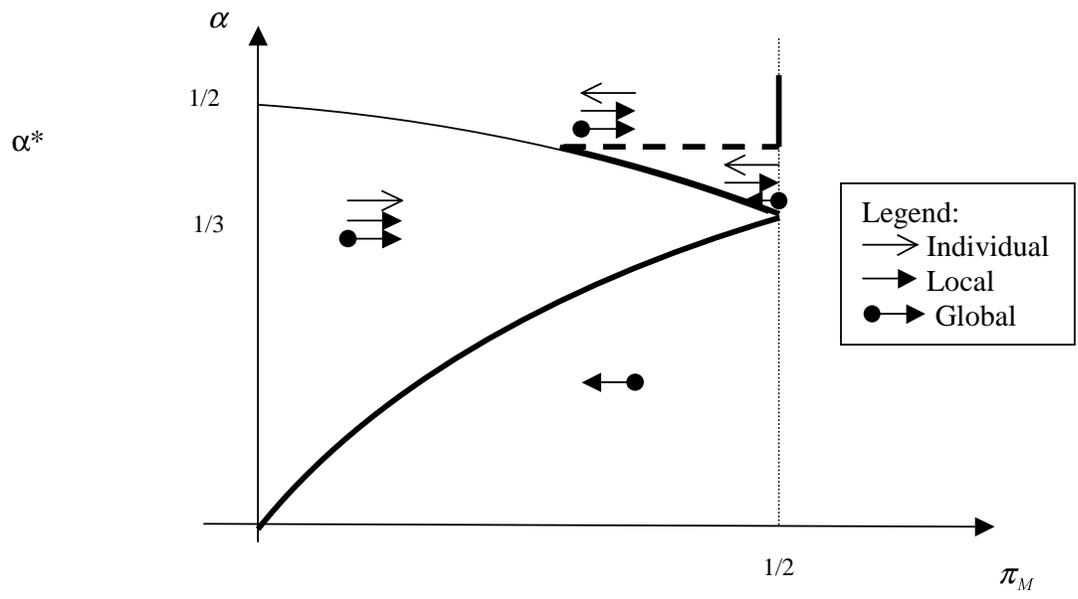
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