ANONYMOUS MARKET AND GROUP TIES IN INTERNATIONAL TRADE

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When trade involves differentiated products, preferential ties to a group settled abroad facilitate an exporter's entry into the foreign market by providing information and access to distribution channels. This contrasts with the difficulties experienced by an unattached producer unfamiliar with the foreign environment. We build a simple general equilibrium model of trade that formalizes this observation. Output is generated through bilateral matching of agents spanning a spectrum of types. In the domestic market every trader knows the type of all others and can approach whomever he chooses; when matching abroad, instead, traders lack the information necessary to choose their partner's type. A minority of individuals has access to group ties that extend complete information to international matches. The existence of informational barriers reduces the volume of trade, and thus by increasing total trade group ties are beneficial to the economy as a whole. However, the ties have significant distributional effects because they modify the composition of the market. Only the more desirable types choose to match through the group, worsening the prospects of successful international partnerships for everybody else. The volume of trade and expected per capita income rise for group members, but fall for non-members. Whether or not they have access to the ties, individuals with the weakest domestic alternatives are always hurt.

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I. Introduction

In this paper, we develop a model of trade that reflects the difficulty of introducing one's product in a foreign market. Access to local sources that can provide information about the market would facilitate entry, and in our set-up a minority of individuals has such preferential ties, reflecting for example the existence of coethnic bonds or membership in a business group. We analyze the aggregate volume of trade without ties, the use of ties versus the anonymous market by group members, the value of the ties to the overall economy and to the group, and the consequences of the ties for non-members.

A well-known contemporary example of the operation of coethnic ties in international trade and investment is provided by the Overseas Chinese (see, e.g., Redding 1995). They, as well as many other ethnic groups living outside their countries of origin, create formal or informal "societies" to which coethnic businesspeople from both the host countries and the mother country have access. Kotkin (1992) states that "Chinese entrepreneurs remain, in essence, arbitrageurs, their widespread dispersion a critical means of identifying prime business opportunities" (p. 169) and "most of Hong Kong's Indian businesses--from the tiny two-man operation to the giant conglomerate--fit the classical mold, with extended families providing the linkages between various national markets" (p. 219).[1]

The operation and economic importance of coethnic societies has been especially well documented for the special case of trade between countries hosting recent immigrants and these immigrants' countries of origin. Gould (1994) finds that immigration to the United States

[1] Rauch (1996) studies a formal society of English-speaking Caribbean-American businesspeople in New York City. The reasons why some ethnic groups form successful societies and others do not are still a mystery.

increases U. S. bilateral trade with the immigrants' countries of origin and that this "immigrant-link effect" is stronger for U. S. exports than for U.S. imports, indicating that the effect works primarily through the establishment of business contacts rather than through increased U. S. preferences for goods produced in the country of origin. Chin, Yoon , and Smith (1996, p. 498) give an example of how these business contacts worked to promote Korean wig exports to the United States:[2]

> Korean wig importers' contribution to the Korean wig import business was far greater than their numbers. From these immigrant wig importers, South Korea wig manufacturers could obtain information on new styles and market trends. Since they were not able to develop new styles of their own (prominent U.S. hair designers continuously developed innovative styles), South Korean wig manufacturers had to depend entirely on Korean immigrant wig importers for information on trends in U.S. wig fashion.

As a second example of the type of mechanisms we have in mind, consider the role played in international transactions by business groups. Business groups are "sets of firms that are integrated neither completely nor barely at all" (Granovetter 1994, p. 455), and where the lineages of the members can often be traced back to a founding family or small number of allied families. Typical mechanisms serving to integrate the firms include mutual stockholdings and frequent meetings of top executives.[3] Recent research (see, e.g., Dobson and Chia 1997) has found that business groups that have expanded outside their mother countries play a role similar to coethnic ties in facilitating international transactions. Member firms operating abroad have been found to preferentially trade intermediate goods (in particular) with domestic group members. The best

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[2]Wigs were one of the major items in Korea's initial drive to break into world markets for manufactures in the 1960s and early 1970s. They were her third largest export item in 1970, accounting for 11.2 percent of *total* exports.

[3]Business groups are common throughout Asia, continental Europe, and Latin America, but are rare to non-existent in Great Britain and the United States.

documented cases are of Japanese *keiretsu* operating in the United States and in Southeast Asia.[4]

The empirical success of coethnic societies and business groups highlights the shortcoming of the assumption of perfect information embedded in the standard approach to trade in differentiated products (e.g., Helpman and Krugman 1985). It is reasonable to imagine that within a country buyers are informed of all available varieties and their characteristics, and sellers are well aware of how to reach the buyers that form their particular market niches. We argue that these presumptions are much less plausible for the international market, where buying agents for consumer goods distributors and firms seeking inputs to production processes incur considerable costs in discovering the foreign varieties available and their characteristics, as well as the capabilities of the suppliers of these varieties, and sellers incur considerable costs in finding buyers that are good matches for the variety they have to offer. As Swedish Trade Council export consultant Kent Goldmann (quoted in Nothdurft 1992, p. 32) stated of his clients that are marginal or failed exporters, "Sometimes their product isn't right for the market, or the country they chose was not a good fit, or their approach or agents are not right." Preferential group ties operating across markets are effective exactly because they overcome these information problems.

The adverse consequences of ignoring informational barriers become clear in the standard model's prediction that in any differentiated product sector a country exports a share of its output equal to the rest of the world's share of world spending. The usual remedy for this empirically false prediction is to assume "home preference" on the part of domestic consumers (see, e.g., Harrigan 1994). This assumption would be easier to accept if home products were produced with

[4] Although in this paper we draw inspiration from these two examples, we think they should be seen as only the most empirically visible representatives of a much longer list of preferential networks.

domestic consumers in mind, yet in the standard model firms treat all of the world's consumers symmetrically: there is no reason for Austrian firms, say, to tailor their products to the small Austrian market rather than the large German market. In our opinion, the fact that a domestic bias nevertheless seems natural reflects the basic difference in information available to firms in the domestic market compared to the international market.

We see the emphasis on informational barriers to entry into foreign markets as the first contribution of our work. We conceive of trade as a process of matching among distributors and producers, with consumers strictly in the background. A successful match is interpreted as a joint venture between two distributors, two producers, or one distributor and one producer.[5] We then assume that an actor matching in the domestic market has complete information about others' types, and can approach whichever partner he chooses. When matching in the international market, on the other hand, a trader is unable to verify ex ante how suitable his partner is, and matching is effectively random.[6] As expected, we find that incomplete information abroad is a source of inefficiency and reduces the volume of trade. Because trade is limited by information, and not only dependent on relative country size, our model provides a plausible response to the overprediction of trade in the standard analysis: no matter how small a country is, relative to the rest of the world, the volume of trade is always bounded away from total production.

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[5]We believe this to be a more accurate description of the nature of trade in differentiated products. On the basis of their interviews with mid-level and senior managers responsible for international sourcing and investment decisions, Egan and Mody (1992, p. 325) state that, "Most U.S. buyers [of manufactures] interviewed for this study preferred long-term, stable and direct relationships with both developed and developing country suppliers."

[6]In this respect we have maintained continuity with more traditional models of international trade: Jones (1995) argues that international trade is the study of economies where some markets are integrated and others are not. This assumption may nevertheless seem extreme, and especially inappropriate for large, regionally diverse countries. We feel, however, that it is a justifiable stylization given results such as those of McCallum (1995, p. 616), who found that, controlling for distance and GDP, "trade between two [Canadian] provinces is more than 20 times larger than trade between a province and a [U.S.] state."

We then introduce, for a subset of individuals, the preferential information operating through the group. The group is able to extend to the international market the benefit of complete information that for non-members prevails only in domestic transactions. Acknowledging the empirical importance of group ties in trade and analyzing their role in a general equilibrium model is, in our view, the second contribution of this paper. We find that these ties are valuable for the economy as a whole, but have systematic distributional implications. Although total trade and GDP rise in each country, the volume of international transactions concluded by non-members actually falls, causing a decline in their welfare. Non-members suffer from a change in the composition of the anonymous market: even though group members mirror the distribution of types in the economy, it is the most desirable among them who find it advantageous to exploit the group ties. Their exit from the market diminishes the opportunities for successful international partnerships for all others. This type of "lemon" effect, worsening outcomes for agents excluded from preferential channels of information, has been noticed before in other contexts (e.g. Montgomery, 1991, on personal referrals in the labor market). We obtain it in a different set-up, and in response to a different question.

Not everyone is equally hurt by group members' self-selection in the use of the ties. The impact is larger the larger is a trader's reliance on the international market, i.e. the less profitable are his domestic opportunities. Thus these are the types who will resent particularly the existence of the group and who have most to gain from rejecting any interaction with group members.

For our purposes, our modeling strategy has two important advantages. First, because the existence and functioning of the ties we have described is very well documented empirically, we take complete information within the group as our point of departure. This leads us naturally to investigate economy-wide implications: we can study the general equilibrium interaction of the group and the market and we can see how it translates into measurable economic variables. Our approach is complementary to the study of the transmission of information within the group, a question whose focus has been primarily microeconomic even in analyses that more closely share our interest in information and trade (e.g. Greif, 1993).[7]

Second, by applying our analysis to groups whose membership is effectively inherited rather than actively pursued, we side-step the question of when and how the provision of information can be organized by market forces. This is an important issue: consultants that help firms to enter a foreign market are becoming increasingly common.[8] We hope to address this question in future research. For now, a simpler approach that takes the group as given is faithful to important empirical examples.

The paper proceeds as follows. Sections II to IV discuss the model in the absence of group ties; section V studies the equilibrium with group ties, and section VI the ties' welfare effects. Section VII examines possible extensions of the model to discrimination and to the trade effects of migration. Section VIII concludes.

II. The model

We begin by describing and solving our model in the absence of group ties. The world is composed of two countries, each formed by a continuum of types, uniformly distributed along a

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[7]Kranton (1996) studies a general equilibrium model where anonymous market transactions or personalized reciprocal exchange are alternative exchange arrangements, only one of which becomes established in the long term. Our own interest is in the stable coexistence and interaction of the two modes of organization.

[8]For example, see Miller (1997) for a story of how a former Chase Manhattan executive parlayed his experience in the bank's Hong Kong-based mergers and acquisitions department into such a consultant group.

line that extends from -1 to 1. Thus each type *i* is indexed by his position on the line, z_i . The distance between two types on the line is a measure of their diversity and an index of the gains from trade that matching of those two types would generate.

Output is indeed generated through bilateral matching. When an individual chooses to match domestically, he has complete information about all other domestic types, and can approach whomever he chooses. The total output from the match, to be divided between the two partners, is given by z_{ij}, the Euclidean distance between them. With complete information, before matches are concluded traders compete for the most desirable partners, and in equilibrium this determines the share of output that in each match goes to each partner.

Individuals have also the option of matching internationally, with a partner from the other country who is similarly interested in an international joint venture. For given types, international matches are more productive than domestic matches: total output is given by hz_{ij}, where h is a parameter larger than 1 capturing sources of gains from trade that are outside our model (comparative advantage, spreading out of fixed costs, or exchange of technical information). For simplicity, we assume $h \in (1,2]$. However, individuals are less adept at finding the best match for their product in the international market: they face higher uncertainty than they do at home. To capture this lack of information, we assume that a trader matching abroad cannot recognize ex ante the identity of his partner but has an equal probability of matching with any type: matching among international traders is random.

Once matching has occurred, however, individuals' types are revealed, and traders can return at no cost to the domestic market if their international match is unsatisfactory. Thus an international partnership is accepted only if it yields a higher total return than the sum of what the two partners can obtain in their domestic markets. With the lack of information preventing ex ante bidding for desirable partners, the net gains from trade are then assumed to be shared equally. In other words, the total return from international transactions is divided between the two partners according to the Nash bargaining solution where each trader uses his expected domestic return, if he were to go back, as threat point.

The timing of the model is the following: first, international partnerships are formed among all traders who have entered the international market; then types are revealed; finally, traders who accept their assigned foreign partner conclude their transaction, while those who reject their partner return home and match domestically. Since it is always possible to return to the domestic market at no cost, all traders initially attempt the international market.

Our model is an assignment problem in tradition of Becker (1973): different traders must match, and they are not all equally well-suited to one another. The equilibrium in the domestic market is equivalent to the complete information solution in assignment models. The equilibrium in the international market then corresponds to the incomplete information solution without resampling.[9] The important point is that individuals' reservation utilities in these latter matches are given by their expectations of domestic returns, i.e. the complete information solution acts as reference against which the international matches, potentially more productive but affected by incomplete information, are evaluated. Thus we need to begin by characterizing individuals' returns if they go back to the domestic market.

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[9]In this latter case, the canonical assumption in the literature is that all types face the same probability distribution of total match returns, because each individual is identical ex ante (see for example the discussion in Mortensen, 1988). In our model instead different types face different distributions of match returns - they have different positions on the line.

III. Domestic returns.

In evaluating domestic returns, we face two problems. First, individuals must form expectations about the distribution of types who will be available for domestic matching. Second, given a distribution of types, we need to characterize what matches will form in equilibrium, and how the match surplus will be divided between the two partners.

Suppose for now that the distribution of types is given, and consider the matching problem when everybody's type is common knowledge. Everything else equal, each type wants to match with someone as distant as possible from his own location. When types are distributed on a line, individuals are then more desirable the closer they are to the edges of the distribution. Thus bidding for these desirable partners will take place, and matching with them will require renouncing to a larger share of total profits than matching with individuals closer to the mean: a price will emerge for each type, equivalent to the individual return that he will command in equilibrium. Define a set of matches as *stable* if and only if there is no pair of individuals who can abandon their current partners, match among themselves and both be strictly better-off. A partition of the market into pairwise matches is an equilibrium if and only if all matches are stable. Then we can state:

Proposition 1. *Consider a continuum of types distributed on a line. Call* $\|z_i\|$ *type i's distance from the median and* z_{ij} *the Euclidean distance between types i and j. If the matching of i and j results in total return* z_{ij}*, and each type is free to choose and bid for his matching partner, then in equilibrium type i's return* r(i) *must equal* $\|z_i\|$.

The proposition, proved in the Appendix, establishes that individual returns in equilibrium are determined uniquely for any distribution of types, given the median of the distribution. Although the total return from a match depends on the distance between the two partners, competition for desirable types has the final effect of equalizing for each individual the payoff from all equilibrium matches: all extra-returns, beyond each type's net contribution to the match, are competed away. Notice that the proposition implies that any match between types on opposite sides of the median (generating total returns equal to ($\|z_i\| + \|z_j\|$) can take place in equilibrium. Because individual returns are determined uniquely, for our purposes the indeterminacy of the matches is irrelevant.[10]

The result is consistent with the general properties of the assignment problem. As is well known, with complete information competitive bidding for partners yields efficient pairing, and efficient pairing requires assortative matching (higher types with higher types) if each type's marginal contribution to total match output is increasing in the partner's type (and vice-versa in the opposite case).[11] In our case, each type's marginal contribution to total output is independent of the partner's type, as long as the two partners are on opposite sides of the median. Thus, not surprisingly, any match between two types on opposite sides of the median is efficient (and total output is invariant to the specific matches).

In the typical assignment problem, matching must occurs between two partners, each of which is drawn from a specific group (firms and workers, for example, or males and females). A general feature of the solution is that efficient pairing pins down relative returns for different types within each group, but usually an external "anchor" is required to determine relative returns

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[10]The result that competitive bidding brings every individual to indifference over all possible partners on the opposite side of the median is pleasing because it captures sharply our intuitive understanding of the effects of competition. In addition, in this model it greatly simplifies the analysis, as we shall see. However it is not robust: it depends on the functional form we have chosen to represent total match returns.

[11]See, for example, Becker (1973), Mortensen (1988), and Sattinger (1993). For a recent analysis that generalizes some of these results, see Legros and Newman (1997).

between the two groups. The external anchor is given by some measure of reservation utility. In our case, however, matching is not between two predetermined groups, and thus the median of the distribution provides the anchor. Because a priori any type can always match with the median, it is not possible for all types on one side of the median to earn extra returns over all types on the opposite side. Thus, as long as the support of the distribution of types is continuous around the median, the multiple equilibria problem that usually plagues the determination of individual returns disappears. When the support is not continuous around the median, the indeterminacy surfaces again. A simple way of thinking about this case is noticing that any point in the "gap" of the support can be identified as a median; thus $\|z_i\|$ in the proposition is not unique, but each equilibrium corresponds to a different median, and the measure of the "gap" in the support corresponds to the measure of the set of possible equilibria. However, for any point identified as the median, all equilibrium returns are determined uniquely, and we obtain a standard result in the literature on matching first proved by Gale and Shapley (1962): all individuals on a given side of the market agree on the welfare ranking of the different equilibria, and what is best for one side is worst for the other.

For our purposes, a strong but plausible requirement of symmetry is sufficient to rule out this source of indeterminacy. We show in the Appendix that Proposition 1 allows us to establish the following:

Corollary 1. *In any equilibrium in which the distribution of types in the markets is symmetrical around zero, if any domestic trade takes place type* i*'s return in the domestic market must equal* $|z_i|$, *his distance from zero.*

From now on, we concentrate on equilibria where the distribution of types in the markets is symmetrical around zero, and therefore we have $\|z_i\| = |z_i|$. The symmetry requirement guarantees that individual returns are determined uniquely for any distribution of types in the market.[12] The invariance of domestic returns to the distribution of returning types greatly simplifies the analysis: expected returns in the domestic markets are the threat points used in bargaining in international transactions, and thus expectations over these returns determine the distribution of types who choose to return home. If domestic returns depended on the distribution of returning types, we would have a difficult problem of multiple equilibria.

We conclude this section with two observations. First, notice that because in equilibrium $|z_i|$ represents type *i*'s profitability in domestic trade, the arbitrary types space over which an initial distribution is assumed has an immediate empirical counterpart in the different types' opportunities in the domestic market. Second, as our results make clear, matching with complete information does not guarantee high returns. Complete information leads to efficient matching, but the correct returns will not be high for producers of goods that are not very desirable.

IV. Trade

We can now characterize individuals' behavior in the international market. Call *p(i)* the probability that trader *i* concludes a successful match abroad, and define the expected volume of trade *E(T)* as the expected mass of successful international matches for each country:

$$E(T) = \int_{-1}^{1} p(i)di \qquad \textbf{(1)}$$

The match is successful if its total return is higher than the sum of the returns that the two

[12]More precisely, the result is due to the interplay of the distance specification for total match return, hence Proposition 1, and symmetry of the distribution. Notice that symmetry per se guarantees that 0 is *a* median, not that there is no gap in the distribution in its neighborhood, and hence that 0 is the unique median. To rule out asymmetries in returns to traders on opposite sides of 0, we need some additional arguments, as shown in the proof of Corollary 1.

partners can obtain domestically, or $h(|z_i - z_j|) > |z_i| + |z_j|$.[13] If z_i is positive (the opposite case is just the mirror image), a successful match between types *i* and *j* requires:

$$h(|z_i - z_j|) \geq z_i + |z_j| \qquad \textbf{(2)}$$

or, since *h* is larger than 1:

$$z_j \in [-1, [(h\text{-}1)/(h+1)]z_i] \qquad \text{if } z_i \geq (h\text{-}1)/(h+1) \qquad \textbf{(2)}$$

$$z_j \in [-1, [(h\text{-}1)/(h+1)]z_i] \quad [[(h+1)/(h\text{-}1)]z_i, 1] \qquad \text{if } z_i \in [0,(h\text{-}1)/(\text{h}+1)].$$

Recalling that the distribution of types is uniform, if we define *S(i)* (illustrated in Figure 1) as the set of successful partners of *i*, then:

$$p(i) = prob(j \in S(i)) = \begin{cases} \dfrac{1 + [(h-1)/(h+1)]z_i}{2} & \text{if } z_i \geq (h-1)/(h+1) \\ 1 - \dfrac{2h}{h^2-1} z_i & \text{if } z_i \in [0,(h-1)/(h+1)]. \end{cases} \qquad \textbf{(3)}$$

The probability of concluding a successful match in the international market is not the same for everyone: it is exactly 1 at $z_i = 0$, reaches a minimum at $z_i = (h\text{-}1)/(h+1)$ and then rises again to $2h/[2(h+1)]$ at $z_i = 1$. As expected, it is increasing in *h* for all types (but 0). It embodies two different factors: the desirability of any given type, according to his position on the line; and the bargaining power that each type has and that therefore reduces the net return for his partner. For example, $z_i = 0$ is not a very desirable partner, but he is always an acceptable one because he lays no claims on the partnership's return prior to the equal partition of net gains.[14]

[13]With a continuum of types, we can consider the probability of success for each trader as independent of other traders' matches.

[14]If we add to the model a fixed cost to going abroad, the non-monotonicity of *p(i)*, which is preserved in the new equilibrium, determines which types still choose to go: the low types, with nothing to lose at home and low bargaining power, and the high types, very desirable in both markets. We have verified that it is the intermediate types around (h-1)/(h+1) who prefer to stay home.

Substituting (3) in (1) and solving the integral, we obtain the expected volume of trade:

$$E(T) = \frac{2h}{1+h} \quad \textbf{(4)}$$

If we define the expected value of trade *E(VT)* in each country as the value accruing to its citizens as result of their international transactions, then:

$$\begin{aligned} E(VT) = 1/2\,[&\int_0^1 \int_{-1}^0 h(z_i - z_j) + z_i + z_j \, dz_j + \int_0^{(h-1)/(h+1)z_i} (h+1)(z_i - z_j)\, dz_j\, dz_i + \\ &+ \int_0^{(h-1)/(h+1)} \int_{(h+1)/(h-1)z_i}^1 (h-1)(z_j - z_i)\, dz_j\, dz_i] \end{aligned} \quad \textbf{(5)}$$

where the first line reflects the fact that international matches with $z_j \leq (h-1)/(h+1)\, z_i$ are successful for all positive z_i's, and the second line accounts for the additional international partnerships of z_i's located between 0 and *(h-1)/(h+1)*.[15] Solving the integral, we obtain:

$$E(VT) = \frac{2h^2(2+h)}{3(1+h)^2} \quad \textbf{(6)}$$

Finally, we can calculate expected GDP in each country as the total value of all transactions concluded by its citizens. This will differ from (6) because it will include the domestic exchanges concluded by traders whose international matches have proven less productive than their opportunities at home. For each individual *i*, total expected return equals:

[15]Notice that by symmetry we can focus exclusively on z_i's between 0 and 1, and double their aggregate exchanges. The term ½ outside the integral is equivalent to 2 multiplied by the density (½) multiplied by each trader's share of net returns in international partnerships (½).

$$Er(i) = 1/4\,[\int_{-1}^{0} h(z_i - z_j) + z_i + z_j\, dz_j + \int_{0}^{(h-1)/(h+1)z_i} (h+1)(z_i - z_j)\, dz_j] +$$

$$+ 1/2\,[\int_{(h-1)/(h+1)z_i}^{1} z_i\, dz_j] \qquad if\ z_i \geq (h-1)/(h+1)$$

$$Er(i) = 1/4\,[\int_{-1}^{0} h(z_i - z_j) + z_i + z_j\, dz_j + \int_{0}^{(h-1)/(h+1)z_i} (h+1)(z_i - z_j)\, dz_j] + \tag{7}$$

$$+ 1/2\,[\int_{(h-1)/(h+1)z_i}^{(h+1)/(h-1)z_i} z_i\, dz_j] + 1/4\,[\int_{(h+1)/(h-1)z_i}^{1} (h-1)(z_j - z_i)\, dz_j]$$

$$if\ z_i \in [0, (h-1)/(h+1)]$$

Because the probability of matching with any given partner abroad is the same for all types, expected returns must be increasing in $|z_i|$, the domestic fall-back option.

We define expected GDP (*E(GDP)*) as:

$$E(GDP) = \int_{-1}^{1} Er(i)di. \tag{8}$$

Solving the integrals in (7) and (8):

$$E(GDP) = \frac{2(h^3 - 1)}{3(h^2 - 1)} \tag{9}$$

Both the value of trade and GDP are increasing in h, the extra-profitability of international matches, and so is, as expected, the ratio of trade to GDP (*E(VT)/E(GDP))*. It is not difficult to verify, however, that this ratio is always smaller than one, capturing the existence of a positive mass of unsuccessful international matches. If agents were able to match with complete information in the foreign as well as in the home market, the return to each agent abroad would equal $h|z_i|$ (see Corollary 2 below) and all international matches would be successful. In our model, on the contrary, informational barriers in international markets create an inefficiency that reduces trade.

Since information problems are absent from standard models of trade in differentiated products (e.g. Helpman and Krugman, 1985), and our work is motivated in part by common overpredictions of the volume of trade, we believe this point deserves further elaboration in the following short digression.

A short digression

In the standard model of trade in differentiated products, the ratio of trade to GDP for a country approaches one as its trading partner grows large. This is unfortunate because it prevents the use of the "small country" assumption that has proved so useful in traditional trade theory, and because it is empirically inaccurate.[16] We can see the implications of informational barriers to trade by studying how our model behaves in the "small country" setting.

Let us suppose that for every domestic agent there are N corresponding foreign agents (we have fixed N at one until now). Since all agents attempt to match in the international market and incomplete information insures that rationing will be random with respect to location on the line, any foreign agent matches with a domestic agent with probability $1/N$. Denoting the large foreign country with an asterisk, it follows that $Er^*(j) = (1/N)Er(j) + [(N\text{-}1)/N]|z_j|$, where $Er(j)$ is given by equation (7). Integrating yields $E(GDP^*) = E(GDP) + N\text{-}1$, where $E(GDP)$ is given by equation (9). Note that $E(GDP^*)$ reduces to $E(GDP)$ for $N = 1$. Since $E(VT^*) = E(VT)$, where $E(VT)$ is given by equation (6), the ratio of trade to GDP for the large country

[16]The ratio of trade to GDP approaches one because the number of varieties of differentiated product made by the trading partner grows large relative to the number produced domestically, causing the ratio of imports to domestic consumption to approach one given the symmetric treatment of home and foreign consumers mentioned in the Introduction.

$E(VT^*)/E(GDP^*) = E(VT)/[E(GDP) + N\text{-}1]$, which declines monotonically with country size and approaches zero as N grows large. Thus as the foreign country comes to approximate the "rest of the world" it becomes a closed economy. In contrast, the openness of the smaller (home) country does not change.

V. Trade with group ties

We now complete our model by introducing the role of group ties. Suppose that in each country a minority of types of mass m belongs to a specific group. This minority is distributed uniformly along the whole support of the line. To capture the information advantage provided by group ties, we assume that when a minority agent chooses to match internationally within the group, he has complete information about the types of all other group members, and can approach and bid for whomever he chooses.[17] As in all international matches, the total output from this transaction is hz_{ij}, but now, in the presence of complete information within the group, the share that each partner receives is determined in equilibrium by competing offers for desirable partners. Alternatively, each member of the minority group can choose to forgo the use of his ties and enter the anonymous international market where matching is random. The choice, however, must be made ex ante: a minority trader knows the type of every group member settled in the foreign country, but must choose whether or not to use the ties before knowing the identity of his potential partner in the anonymous international market. As before, a trader always has the option of renouncing the international partnership, and returning home.

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[17]It has been stated of the overseas Chinese in Asia (Ziesemer 1996, p. 29), "Every key individual among them knows every other key figure."

We assume that the minority is distributed uniformly because we want to concentrate exclusively on the informational advantage provided by the group, and thus we want its members to be otherwise identical to non-members. A fortunate implication of this assumption is that we do not need to take a stance on the difficult question of whether or not group members can function as middlemen: can they introduce foreign members of the group to any domestic trader? Because the group replicates the distribution of types in the overall economy, access to group members alone, or through them to their conationals are equivalent.[18]

What is the equilibrium return to a group member matching within the group? Although members benefit from complete information, Proposition 1 does not apply automatically to the new problem because international trade must take place between citizens of the two countries, and thus the set of agents is now divided into two subsets whose members are limited to trading with each other. As we discussed in Section 3, this is the origin of a standard indeterminacy in the solution to the assignment problem. Nevertheless, we show in the Appendix that restricting our focus to symmetrical equilibria is sufficient to yield an intuitive generalization of Corollary 1. We can establish:

***Corollary 2**. An equilibrium is symmetrical if the distribution of types in all markets is symmetrical around zero, and identical types in the two countries make the same decision with respect to participation in the group. In the symmetrical equilibrium, the return to member i matching within the group must equal* $h|z_i|$.[19]

We can now investigate which members of the minority group will exploit their ties.

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[18]Provided that non-members cannot take the initiative and affectively nullify the informational barriers by exploiting their link to domestic group members, and that when indifferent a group member chooses to match with someone he knows rather than with someone who knows someone he knows.

[19]There is always an equilibrium where the group is inactive (no one matches through it because no one expects anyone else to match through it). We focus instead on equilibria where the existence of the group has some impact.

Suppose first that all members do so. In the anonymous international market, the density of traders in any given interval is reduced. However, because the distribution of group members is uniform and the mass of traders entering the market is reduced by an equal proportion in both countries, the probability of a successful match in the market is unchanged for all types. Thus, if all members use the group, expected returns for non-members continue to be defined by (7) and the probabilities of success by (3). These equations then also define the return in the market to a group member who were to deviate and abandon the group. Consider a group member at location $z_i = 0$. If he matches through the ties his return is zero (by Corollary 2) because the complete information existing within the group reveals his low productivity. If he enters the anonymous market, his expected return is $Er(0)=(h-1)/4$ (by equation 7) because his lack of bargaining power makes him an acceptable partner, and he enjoys his share of the gains associated with international trade. Thus he will always prefer the market. We can conclude that there can be no equilibrium where all members choose to match through the group: there will be self-selection in the use of the group ties. The following proposition, proved in the Appendix, makes this intuition precise:

Proposition 2. *The symmetrical equilibrium with group ties is unique: there exists a positive number* $\alpha(h,m)$ *such that all types* $|z_i| < \alpha(h,m)$ *prefer the market, and all types* $|z_i| > \alpha(h,m)$ *prefer the ties.*

The complete information existing within the group leads producers with less desirable products to attempt the anonymous market. Notice that the conclusion holds even though in all cases information is revealed before the match is concluded, and individuals always retain the option of returning to the domestic market.[20]

The formal derivation of the interval of minority traders foregoing the group is somewhat involved because, in the market, the density of potential partners is no longer uniform over the entire support, but is higher in the intervals that include minority traders. It is not difficult to verify that:

$$prob(z_j \in [s,v]) = \begin{cases} \dfrac{v-s}{2-m(1-\alpha)} & \text{in the high density intervals} \\[2ex] \dfrac{(v-s)(2-m)}{[2-m(1-\alpha)]2} & \text{in the low density intervals.} \end{cases} \quad \textbf{(10)}$$

The location of the marginal trader α must satisfy:

$$Er^M(\alpha) = h|\alpha| \quad \textbf{(11)}$$

where the superscript *M* indicates that expected market returns must now take into account the subset of minority traders that avoids the market. Expected returns in the anonymous market can be obtained from equations (7), but with probabilities and expected values reflecting the different densities, as described in (10).[21]

The comparative statics properties of α are summarized by the following proposition (proved in the Appendix):

Proposition 3. *The share of members relying on the ties is smaller the higher is the extra-profitability of trade, and the smaller is the share of the population that has access to the ties:* $d\alpha/dh > 0$, $d\alpha/dm < 0 \quad h \in (1,2]$.

The effect of higher *h* on returns within the group is linear in z_i, and thus becomes negligible

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[20]Types are ranked according to a measure of quality that is unobservable to foreigners who are not group members. Thus the empirical prediction is that group ties will be exploited disproportionately by high types, controlling for observable characteristics.

[21]The procedure is straightforward but cumbersome, and we report details and equations in the Appendix.

for low enough types. Its effect on market returns, on the other hand, is always bound away from zero. Proposition 3 states that α, the marginal type indifferent between market and group, is always low enough to shift to the market as *h* increases.

Changes in *m*, the proportion of the population that belongs to the minority, also affect the choice of market versus group. Because individuals in the proximity of zero choose to forgo the ties, an increase in *m* implies a higher probability of market matches with lower than average types. The adverse selection problem caused by the presence of the group becomes worse: the relative attractiveness of the market falls and the share of members relying on the ties increases.

VI. The welfare effects of group ties

In many countries substantial income differentials exist between ethnic minorities acknowledged to have access to international trading "societies" and the majority populations.[22] It is also true that most governments run trade promotion organizations with the professed intent to achieve the results we ascribe here to the group.[23] In this section we investigate the welfare effects of the preferential ties on the economy as a whole, and on those traders who have, or have not, access to them. The following Proposition, proved in the Appendix, provides the general answer:

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[22]Good examples are ethnic Chinese in Southeast Asia and ethnic Indians in East Africa. Of course these income differentials cannot be attributed entirely to superior international trade opportunities for the minorities, but it appears that these contribute significantly.

[23]The Hong Kong Trade Development Council is widely regarded as one of the most successful examples. According to Keesing (1988, p. 20), "HKTDC sees its central task as 'matchmaking' between foreign buyers and Hong Kong firms wishing to export." Since this policy allows *all* foreign agents *potential* access to the "group," while in practice not all domestic firms are represented due to limited administrative capacity, the HKTDC and similar trade promotion organizations are actually more closely analogous to the immigrant societies studied in section VII.B below.

Proposition 4. *The existence of ties among a minority group increases expected GDP in the economy*.

It also causes unambiguous distributional effects:
i) Expected per capita GDP rises for group members, but falls for non-members.

ii) All members who join the market are worse-off than in the absence of ties; all members who use the ties except those near α are better-off. The percentage gain in expected return (negative for low enough types) is monotonically increasing in $|z_i|$.

iii) There exists a value of $h\ \hat{h}(m)$ *such that for all* $h < \hat{h}(m)$ *all non-members are worse off than in the absence of ties; for* $h \geq \hat{h}(m)$ *the highest types are better off . In all cases, the percentage loss in expected return is monotonically declining in* $|z_i|$.

Figure 2 summarizes these findings. Although the existence of group ties is always beneficial to the economy as a whole, there are traders who gain and traders who lose, with the gains concentrated among those who have access to the ties, and the losses concentrated among non-members.

The change in expected per capita income is the result of the change in trade flows caused by the ties. Proposition 4 can be reinterpreted as stating that the existence of a group sharing preferential information abroad increases the ratio of trade over GDP for the group in particular, and for the economy as a whole, but decreases it for those traders who are not members. The injury to market traders is the result of the reliance on the group of the more desirable trading partners.

Not only are distributional effects present between the two sets of agents, but different types *within* each set also fare differently. The change in the composition of the market brought about by the existence of the group hurts low $|z_i|$ types, because the smaller is the agent's profitability in the domestic market, the larger is his reliance on the international market, and the international market has become more dense exactly in other low types.[24] This is true both among group members and non members, since low types are led to rely on the market whether or not they have access to the ties.

In summary, our analysis supports the view that coethnic societies, business groups operating across international borders, or institutions devoted to the creation of better information channels in foreign markets, are valuable. It stresses, however, that under most circumstances those excluded from these channels or less able to exploit them profitably will be hurt. Since those most hurt are the agents with the poorest domestic opportunities, measures to redress this grievance can be easily rationalized as instruments for redistribution. It is thus not surprising to find de jure or de facto requirements imposing partnerships with ethnic nationals in countries where coethnic societies are important.[25]

What is remarkable is that in our model these distributional effects stem uniquely from the ability of the minority group to match among themselves with complete information, even when the composition of the group mirrors the composition of the economy as a whole and when the option of using the ties per se would have no effect on the rest of the economy if it were exercised by all group members. Traders who do not belong to the group are hurt because differential information causes a "lemon" problem in the anonymous market.

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[24]Notice that if h is large enough, high types benefit from the changed composition of the market. Matches with low types are for them always successful because the latter have such low bargaining power: when h is high, the higher probability of concluding an international partnership overcomes the decreased quality (i.e. distance) of the average partnership.

[25]In the case of the Overseas Chinese, we find de jure requirements in Malaysia (Jesudason 1989) and de facto requirements in Indonesia (Robison 1986), for example.

VII. Extensions

A. Discrimination.

The observation at the end of the previous section raises a natural question. Since the lemon problem arises because the market is chosen disproportionately by group members of lower types, wouldn't the other traders refrain from matching with any minority member present in the market? In other words, could this model give rise to statistical discrimination? Answering this question requires allowing for non-random interaction between group members and non-members, and assumptions in this respect are less firmly grounded in empirical evidence than is the case for the rest of the model. To discuss the possibility of discrimination, we must suppose that agents can distinguish group members from non-members in advance of matching, so that the international market is no longer completely anonymous. Whether this requirement is met in reality is unclear. While coethnicity or business group membership may be transparent to home country nationals, it may often not be for foreigners. A Thai national may recognize that another Thai businessman is of ethnic Chinese origin, but an Indonesian national (not of ethnic Chinese origin) may not be able to.[26] Encaoua and Jacquemin (1982, p. 26) note that business groups in France "have no legal existence and are not identified in official censuses. Each subsidiary maintains its legal autonomy and keeps separate accounts."

If however this distinction is possible, then we can show that an equilibrium with complete segregation can arise: only non-members match in the market. Group members believe

[26]Weidenbaum and Hughes (1996, p.26) note that "the overseas Chinese have attempted to blend in with their local cultures. Many change their names to avoid persecution. Corazon Aquino's maiden name--Cojuangco-- appears to be Spanish but in reality is derived from her immigrant grandfather's name--Ko Hwan Ko. In Thailand, ethnic Chinese were required to take Thai names from a government list."

(rationally) that they would be shunned if they tried to enter the market, and non-members believe that any member present in the market would be a worse partner than the average non-member.[27] With segregation, non-members fare as in the no-ties equilibrium and the distributional implications can be easily deduced from the previous section (and seen clearly in Figure 2). Expected per capita income for non-members always rises - relative to no segregation - but the gains fall mostly on the least profitable types located around zero.[28] As for members, per capita income for the group must fall, with all losses concentrated on those types that would prefer to match in the market but are now prevented from doing so. Thus the possibility of discriminating between members and non-members affects almost exclusively the income of low types, whether as objects of discrimination (among group members) or as active subjects (non group members), a result that seems intuitively very plausible.

From an aggregate point of view, the absence of group members from the market is costly. Segregation reduces profitable market matches between very high and very low types, and leads to a decline in trade and in expected GDP for the economy.

It should be noted that these results on discrimination arise in a model where there is no difference between group members and non members in terms of their attractiveness as matching partners. The only, but crucial, difference, is that group members can overcome the informational barriers that hamper international trade. All other effects, culminating in active

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[27] It is not difficult to find beliefs for non-members that support segregation as a sequential equilibrium. For example, the belief that only members located at $-1/2 + e$ and $1/2 - e$ would enter the market ($e > 0$ but close to zero) supports segregation, since all non-members would then prefer to match only among themselves.

[28] Indeed, if h is high enough, the highest types may be hurt.

discrimination, stem from this single informational advantage.[29]

B. The trade effects of migration

Often immigrants come to constitute a coethnic society in their host country, facilitating international trade between that country and their country of origin. Indeed, as mentioned in the Introduction, this is one of the most important and well-documented instances of the use of coethnic ties in international trade.

Consider an ethnically homogeneous country and suppose that a uniformly distributed subset of its population has migrated to a second country. For simplicity let us also suppose that the two countries are of equal size (post-migration): thus the country of origin is of size 2 and consists of a single ethnic group; the host country has an ethnic minority of size m and a mass of natives of size $(2 - m)$. Assume now that when traders from the country of origin are rationed in their attempt to match within the coethnic group, they can match randomly in the anonymous international market. We can then make two preliminary observations. First, since equilibrium returns exploiting the ties are independent of the partner's identity, there is an equilibrium where all traders from the country of origin have the same probability of being rationed when trying to use the ties. It follows, and this is the second observation, that if in the absence of rationing expected returns within the coethnic group are higher than in the market, it is still an equilibrium to (attempt to) use the ties.

[29]It would be misleading to imply that segregation is the unique equilibrium. For example, the following scenario with "mixed" market partnerships is an equilibrium. A mass of members close to zero enters the market, gambling that they will be matched with high $|z_i|$'s who are not group members. At low h, most fail and return home (the mass of members in the market is much larger than the mass of non-members willing to match with them), but some succeed, justifying the initial gamble. As h increases, the probability of being rationed decreases rapidly. Thus in this equilibrium some mixed partnerships are observed, and the more so the higher is h.

It is not difficult to see that in this example the analysis is exactly identical to that presented so far. Consider any interval of the support such that coethnics from that interval prefer to use the ties. In the country of origin it is still the case that a fraction $m/2$ of traders in that interval will be able to exploit the coethnic group, and that this fraction will be distributed uniformly; the remaining fraction $(2 - m)/2$, again distributed uniformly, will enter the market. Given the assumption we have maintained throughout the paper that coethnics meeting in the market are unable to rely on the coethnic ties (i.e., do not have complete information) everything follows as in the preceding sections. We can reinterpret the effect of the ties in increasing trade as the trade effect of migration.[30]

VIII. Conclusions and suggestions for future research

In this paper, we have studied the effect of group ties in a world where entry into foreign markets is hampered by problems of information. We have found that while group ties increase the total volume of trade, they worsen the composition of the anonymous market, and thus reduce trade and per capita income of those individuals who are excluded from, or choose not to exploit, the preferential channel.

Although our results are derived within a very specific model, the intuition behind them

[30]The analysis remains unchanged for any example where the masses of coethnics m^1 and m^2 in country 1 and country 2, respectively, are different and $m^1 > m^2$. (Note that expected per capita income of coethnics in country 1 is lower than that of coethnics in country 2: the larger is the mass of country 1 coethnics relative to country 2 coethnics, the less they benefit from the coethnic society). Although our model can easily handle this simple case, this may not be the best way to represent migration. First, the decision to migrate should be endogenous. In this model, the incentive to migrate is the ability to exploit one's ties to the country of origin, once in the host country. This incentive varies across types, and thus the distribution of migrants should not be uniform. Second, in our example most coethnics in the country of origin are rationed in their attempts to match abroad within the coethnic group. This lends increased importance to a question that can be set aside when the minority masses are equal (see page18 above): to what extent are domestic group members able and willing to introduce foreign members to their non-member compatriots? Little is known about this in any systematic manner, and it seems prudent to await more information before proceeding further.

seems strong enough to survive relaxing some of our assumptions. For example, in this paper the strength of demand for an individual's good is unchanged at home and abroad: a variety is equally desirable in the domestic and in the international market. In a more extensive version of this work (Casella and Rauch, 1997), we have verified that our conclusions hold true when traders do not know how their good is placed in the international market (i.e. prior to matching abroad, they do not know their position on the line in the international market), an assumption that seems appropriate in the case of trade between countries with different tastes.

It is clear though that there is room for extending our framework In particular, in order to focus on what is new in our approach we have omitted any role for goods and factors prices. Yet some of the most interesting results of our approach should come from the interaction of the matching process we have described with market prices. This is the subject of a companion paper (Casella and Rauch, 1998).

We have already mentioned the possible application of our model to government trade promotion organizations, so widely observed yet so little studied. A more speculative application, which would require considerable modification of the model, is to the alleged benefit from government coordination of complementary domestic investments in less developed countries given the difficulty of finding the inputs that match domestic needs in the international market (Murphy, Shleifer, and Vishny 1989; Rodrik 1995).

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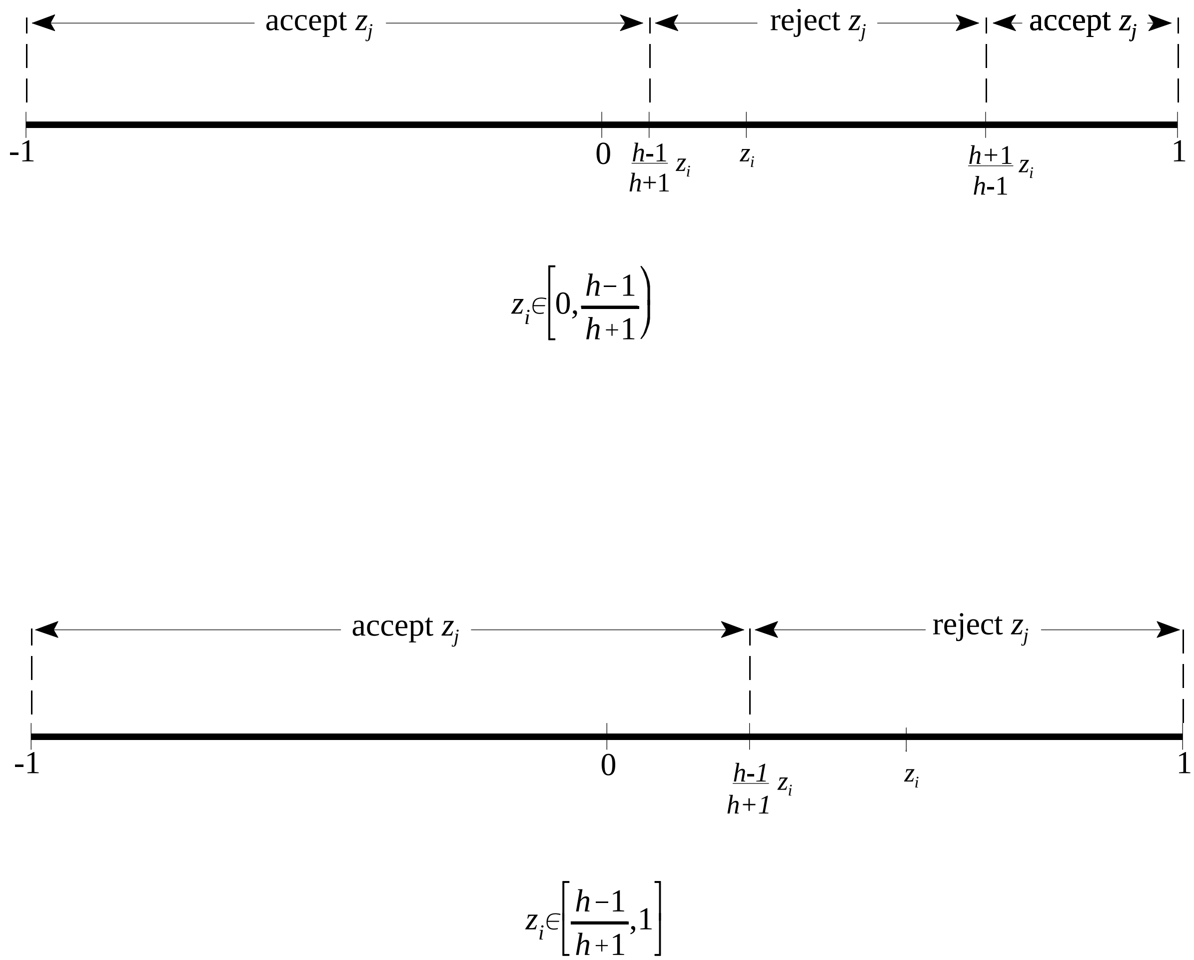

Figure 1: Determination of *S(i)*

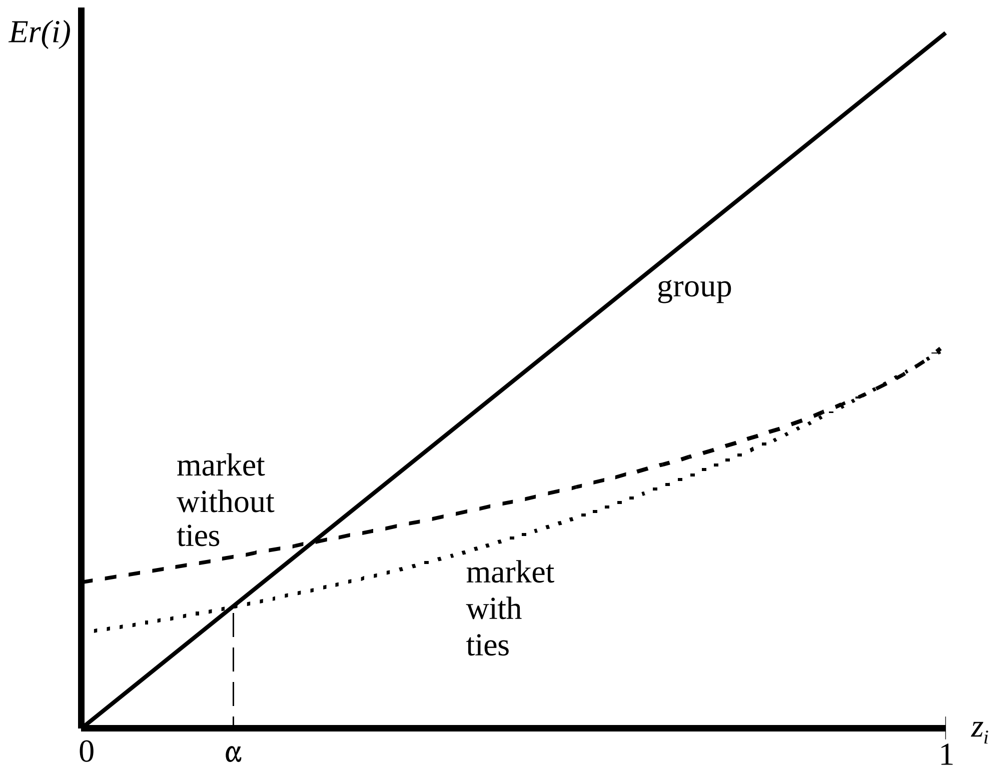

Figure 2: Expected returns in the presence of group ties

Appendix

Proof of Proposition 1. We begin by establishing the following Lemma:

Lemma 1. *In equilibrium there can be no set of types of positive measure who match with partners located on the same side of the median.*

Proof of Lemma 1. Suppose this were the case. Then there must be a set of types of equal measure on the opposite side of the median who match among themselves. But then it is always possible to create new partnerships with each member located on a different side of the median such that both partners are at least as well-off. Suppose that types j and s, on the same side of the median, were matched with each other. Then the maximum possible return to j is z_{js} when he appropriates the entire return from the partnership, with $z_{js} < \|z_j\|$. Similarly, if i and v, on the opposite side of the median from j and s, match among themselves, i can obtain at most $z_{iv} < \|z_i\|$. By matching among themselves j can earn $\|z_j\|$ and i can earn $\|z_i\|$; each type's return is strictly higher than in the original scenario unless his previous partner was located at the median, in which case the return is unchanged.■

Thus in what follows we will ignore the possibility of equilibrium matches occurring between partners on the same side of the median.

We proceed with the proof of Proposition 1.

Suppose first that the the support of the distribution is continuous around the median. Consider types i and j, on opposite sides of the median. They can always match, produce z_{ij} and share it as $\|z_i\|$ to i and $\|z_j\|$ to j. Thus in equilibrium they cannot both earn less. Can at least one of them earn more (for example, can j earn $\|z_j\| + k$, with $k > 0$)? Only if j matches with w (on the opposite side of the median) who accepts $\|z_w\| - k$ ($\|z_w\| \geq k$). But this can only occur if all types v on w's side of the median are receiving $\|z_v\| - k$. (Suppose that there exists a v who is matched with s and receives $\|z_v\| - d$, $d < k$. Then there exists an $\epsilon > 0$ such that w can undercut v, offer s $\|z_s\|+d+\epsilon$ and be better off.)

But all v receiving $\|z_v\| - k$ cannot occur in equilibrium because any v can then match with a type on the same side of the median, but arbitrarily close to the median and make both better off. Thus, if the support of the distribution is continuous around the median, the return to j must equal $\|z_j\|$ and the return to i $\|z_i\|$.

Suppose now that there exists a discrete interval of length $2A$ in the immediate neighborhood of the median over which the mass of types equals zero. Call $\langle z_i \rangle$ type i's distance from the mid point of the interval. Each type i on one side of the interval earns individual return $\langle z_i \rangle - k$ ($k \geq 0$), and each type j on the opposite side earns $\langle z_j \rangle + k$. Following the logic detailed above, the parameter k must be the same for every type and k must be smaller than A (since underbidding would otherwise be possible), but no profitable deviation exists for all $k \leq A$. Similarly the mirror image of this equilibrium ($k < 0$) is also an equilibrium as long as $k \in [-A,0]$. We can interpret this multiplicity as arising because any point in the interval can be identified as a median. The choice of a median then determines uniquely the entire distribution of returns.■

Proof of Corollary 1. Consider an equilibrium where the distribution of types returning to the domestic market is symmetrical and suppose that in the domestic market all $z_i < 0$ receive $|z_i| - k$ and all $z_i > 0$ $|z_i| + k$ ($k > 0$). By Proposition 1 this can occur only if all types in $[-a,a]$ ($a \geq k$) are absent from the domestic market, i.e., if they are successful with probability 1 in the international market. Consider traders $-a$ and a. Since they have the same probability of matching with any foreign type in the international market, and different expected returns in the domestic market, their probabilities of success cannot be equal. If the probability of success is 1 for $z_i = -a$ and less than 1 for all $z_i < -a$, then it must be less than 1 for $z_i = a$. This establishes the Corollary. ■

Proof of Corollary 2. Although the two sets of traders restricted to matching with each other are not on opposite sides of the median by assumption (contrary to most standard models), the first part of Proposition 1 remains unchanged: all equilibrium matches must be between individuals on opposite sides of the median. (The argument in Lemma 1 easily generalizes).

Suppose now that in matching through the group all traders from country 1 located to the left of the median receive $h|z_i| + k$ ($k \geq 0$) when matched with members from country 2 located to the right of the median (k must be the same for all types to prevent underbidding). In any equilibrium where the distribution of types in the markets (and hence in the group) is symmetrical around the median, it must then be the case that members from country 2 located to the left of the median receive $h|z_i| - k$ when matched with members from country 1. Any k can now be supported without underbidding, but participation in the group requires that all members be better off than in the domestic equilibrium (notice that there is no uncertainty). Thus we require $h|z_i| - k \geq |z_i|$ or $k \leq |z_i|(h-1)$ for any z_i in the group. If $z_i = 0$ is among those who use the ties, k must equal zero. Suppose now that individuals in $[-a,a]$ do not use their group ties. Then in a symmetrical equilibrium a must be the same in both countries, and, for a given type, the expected return from entering the international market is equal in both countries. But if k differs from zero, participation in the group is more advantageous for citizens of country 1 than for citizens of country 2 and the threshold a cannot be the same in both countries. It follows that in any symmetrical equilibrium k must equal zero. ■

Proof of Proposition 2. Observe first that there is always an equilibrium where no-one uses the group ties (since an individual cannot deviate alone). Let us focus instead on the equilibrium with an active group. We proceed by proving two preliminary results:

(i) *For any $h > 1$, all members using their ties is not an equilibrium*. Suppose that all members use the ties. Then expected returns in the market are unchanged and are given by equation (7). Consider $z_i = 0$. His return in the group equals 0 while his expected return in the market equals $(h-1)/4$. Thus $z_i = 0$ would deviate to the market. ■

(ii) *For any h > 1, in any rational expectations equilibrium with an active group,* $|z_i| = 1$ *prefers to use his ties*. Consider two types, z_i and z_s, such that $z_s > z_i$ and $z_i > 0$. It is not difficult to verify that for any z_j (and $h > 1$), $(r(i,j) - hz_i) > (r(s,j) - hz_s)$, where $r(i,j)$ is the realized return to z_i from matching with z_j in the market, and where we need to consider the four possible cases: $z_j \in S(i), S(s)$; $z_j \in S(i), \notin S(s)$; $z_j \notin S(i), \in S(s)$; $z_j \notin S(i), \notin S(s)$. Because the inequality holds for any z_j, it must hold in expected values for any distribution of types in the market. Thus if z_i prefers the ties to the market, so does z_s. By symmetry, the argument can be applied to $z_i<0$; thus more generally if $|z_i|$ prefers the ties to the market, so does $|z_s| > |z_i|$. It follows that if any $|z_i|$ matches within the group, so does $|z_i| = 1$. ■

We have established that in any equilibrium with an active group: a) not every member relies on the group; b) if $|z_i|$ prefers the ties to the market, so does $|z_s| > |z_i|$. Hence there must exist a positive number $\alpha(h,m)$ such that all members in $[0, |\alpha(h,m)|]$ prefer the market, and all members in $(|\alpha(h,m)|,1]$ prefer the ties. The equilibrium configuration is unique. We show below, when we derive the explicit solution for $\alpha(h,m)$, that $\alpha(h,m)$ itself is unique, concluding the proof of the proposition. ■

Trade with group ties.

Proposition 2 establishes that the distribution of traders in the anonymous international market is not uniform any longer: because members in the interval $[-\alpha,\alpha]$ enter the market, the density of types must be higher in that interval. Equation (10) reports the two densities, for $|z_i| < \alpha$ and $|z_i| > \alpha$. In writing expected returns, we must divide the support so that for all types in a given subinterval the marginal successful partner falls in an interval of equal density. Consider $z_i > 0$. All matches with $z_j \leq (h-1)/(h+1)\, z_i$ are successful, and so are all matches with $z_j \geq (h+1)/(h-1)\, z_i$; thus those are the two marginal successful partners on z_i's two sides. Call $(h-1)/(h+1)\, z_i \equiv \underline{z}_j(i)$, and $(h+1)/(h-1)\, z_i \equiv Z_j(i)$. Depending on z_i, both $\underline{z}_j(i)$ and $Z_j(i)$ can be larger or smaller than α; in addition $Z_j(i)$ could be larger than 1 (if $z_i > (h-1)/(h+1)$). Thus there are five possible combinations, identifying five relevant segments of traders. A segment will include all z_i's such that: (1) $\underline{z}_j(i) \leq \alpha$, $Z_j(i) \leq \alpha$; (2) $\underline{z}_j(i) \leq \alpha$, $Z_j(i) \in [\alpha, 1]$; (3) $\underline{z}_j(i) \leq \alpha$, $Z_j(i) > 1$; (4) $\underline{z}_j(i) \in (\alpha, 1]$, $Z_j(i) > 1$; (5) $\underline{z}_j(i) \in (\alpha, 1]$, $Z_j(i) \in [\alpha, 1]$. Which of these combinations are possible at the same time depends on the relationship between α and $(h-1)/(h+1)$ in equilibrium. Call $f \equiv (h-1)/(h+1)$. There are three different regimes, as shown in Figure A:

a) $\alpha > f$.

It is easy to see that if $z_i \in [0, \alpha f]$, we are in (1) above; if $z_i \in (\alpha f, f]$ then we are in segment (2), and if $z_i \in (f, 1]$ we are in segment (3). The combinations identified by (4) and (5) are not possible in this regime, because $\underline{z}_j(i) > \alpha$ implies $z_i f > \alpha$, which contradicts $\alpha > f$ and $z_i < 1$.

b) $\alpha \in [f^2, f]$.

The condition $Z_j(i) \in [\alpha, 1]$ requires $z_i/f < 1$ or $z_i < f$, while $\underline{z}_j(i) \in (\alpha, 1]$ requires $z_i > \alpha/f$. Together they imply $f > \alpha/f$, or $\alpha < f^2$, impossible in this regime. Thus condition

(5) above is impossible here, and four segments are relevant, defined by conditions (1) to (4). Respectively: (1) $z_i \in [0,\ \alpha f]$; (2) $z_i \in (\alpha f,\ f]$; (3) $z_i \in (f,\ \alpha/f]$; (4) $z_i \in (\alpha/f,\ 1]$.

c) $\alpha < f^2$.
The condition $\underline{z}_j(i) \leq \alpha$ requires $z_i \leq \alpha/f$, while $Z_j(i) > 1$ requires $z_i > f$. Together they imply $\alpha > f^2$, impossible in this regime. Thus condition (3) above is impossible here and four segments are relevant, defined by conditions (1), (2), (5) and (4). Respectively:
(1) $z_i \in [0,\ \alpha f]$; (2) $z_i \in (\alpha f,\ \alpha/f]$; (5) $z_i \in (\alpha/f,\ f]$; (4) $z_i \in (f,\ 1]$.

Call $Er1^M(i)$ the expected return of a trader belonging to segment (1), i.e. $z_i \in [0,\alpha f]$, (and similarly below for segments (2), (3), (4), and (5)). Consider z_i's potential partner $z_j \in [-1, 1]$, and divide the support into different intervals, according to two criteria: whether there will be a successful match, and whether the density of the types' distribution is low or high: $[-1, -\alpha]$: low density, successful match; $[-\alpha, 0]$: high density, successful match; $[0, z_i f]$: high density, successful match; $[z_i f, z_i/f]$: high density, unsuccessful match; $[z_i/f, \alpha]$: high density, successful match; $[\alpha, 1]$: low density, successful match. Taking into account equation (10) and using the notation $d \equiv 2 - m(1-\alpha)$, we obtain:

$$Er1^{\,M}(i) = \frac{(2-m)}{2d}\,\frac{1}{2}\int_{-1}^{-\alpha}[(h+1)z_i-(h-1)z_j]\,dz_j + \frac{1}{d}\,\frac{1}{2}\int_{-\alpha}^{0}[(h+1)z_i-(h-1)z_j]\,dz_j +$$
$$\frac{1}{d}\,\frac{1}{2}\int_{0}^{fz_i}(h+1)(z_i-z_j)\,dz_j + \frac{1}{d}\int_{fz_i}^{z_i/f} z_i\,dz_j + \frac{1}{d}\,\frac{1}{2}\int_{z_i/f}^{\alpha}(-h+1)(z_i-z_j)\,dz_j + \frac{(2-m)}{2d}\,\frac{1}{2}\int_{\alpha}^{1}(h-1)(z_j-z_i)\,dz_j. \tag{A1}$$

Similarly, when z_i belongs to segment (2), i.e. $z_i \in [\alpha f, \min(f, \alpha/f))$, we divide the support of his potential partner z_j into the following intervals: $[-1, -\alpha]$: low density, successful match; $[-\alpha, 0]$: high density, successful match; $[0, z_i f]$: high density, successful match; $[z_i f, \alpha]$: high density, unsuccessful match; $[\alpha, z_i/f]$: low density, unsuccessful match; $[z_i/f, 1]$ low density, successful match. We obtain:

$$Er2^{\,M}(i) = \frac{(2-m)}{2d}\,\frac{1}{2}\int_{-1}^{-\alpha}[(h+1)z_i-(h-1)z_j]\,dz_j + \frac{1}{d}\,\frac{1}{2}\int_{-\alpha}^{0}[(h+1)z_i-(h-1)z_j]\,dz_j +$$
$$\frac{1}{d}\,\frac{1}{2}\int_{0}^{z_i f}(h+1)(z_i-z_j)\,dz_j + \frac{1}{d}\int_{z_i f}^{\alpha} z_i\,dz_j + \frac{(2-m)}{2d}\int_{\alpha}^{z_i/f} z_i\,dz_j + \frac{(2-m)}{2d}\,\frac{1}{2}\int_{z_i/f}^{1}(h-1)(z_j-z_i)\,dz_j. \tag{A2}$$

Following the same logic:

$$Er3^M(i) = \frac{(2-m)}{2d}\frac{1}{2}\int_{-1}^{-\alpha}[(h+1)z_i-(h-1)z_j]\,dz_j + \frac{1}{d}\frac{1}{2}\int_{-\alpha}^{0}[(h+1)z_i-(h-1)z_j]\,dz_j + \frac{1}{d}\frac{1}{2}\int_{0}^{z_if}(h+1)(z_i-z_j)\,dz_j + \frac{1}{d}\int_{z_if}^{\alpha}z_i\,dz_j + \frac{(2-m)}{2d}\int_{\alpha}^{1}z_i\,dz_j \quad \textbf{(A3)}$$

for $z_i \in [f, \min(\alpha/f, 1)]$.

$$Er4^M(i) = \frac{(2-m)}{2d}\frac{1}{2}\int_{-1}^{-\alpha}[(h+1)z_i-(h-1)z_j]\,dz_j + \frac{1}{d}\frac{1}{2}\int_{-\alpha}^{0}[(h+1)z_i-(h-1)z_j]\,dz_j + \frac{1}{d}\frac{1}{2}\int_{0}^{\alpha}(h+1)(z_i-z_j)\,dz_j + \frac{(2-m)}{2d}\frac{1}{2}\int_{\alpha}^{z_if}(h+1)(z_i-z_j)\,dz_j + \frac{(2-m)}{2d}\int_{z_if}^{1}z_i\,dz_j \quad \textbf{(A4)}$$

for $z_i \in (\max(\alpha/f, f), 1]$.

$$Er5^M(i) = \frac{(2-m)}{2d}\frac{1}{2}\int_{-1}^{-\alpha}[(h+1)z_i-(h-1)z_j]\,dz_j + \frac{1}{d}\frac{1}{2}\int_{-\alpha}^{0}[(h+1)z_i-(h-1)z_j]\,dz_j + \frac{1}{d}\frac{1}{2}\int_{0}^{\alpha}(h+1)(z_i-z_j)\,dz_j + \frac{(2-m)}{2d}\frac{1}{2}\int_{\alpha}^{fz_i}(h+1)(z_i-z_j)\,dz_j + \frac{(2-m)}{2d}\int_{fz_i}^{z_i/f}z_i\,dz_j + \frac{(2-m)}{2d}\frac{1}{2}\int_{z_i/f}^{1}(h-1)(z_j-z_i)\,dz_j \quad \textbf{(A5)}$$

for $z_i \in (\alpha/f, f]$, when $\alpha < f^2$, in regime (c).

The equilibrium condition defining α differs in the different regimes. As shown in Figure A, if α is larger than f, (regime (a)), then α solves $Er3^M(\alpha) = h\alpha$. If α instead is smaller than f (regimes (b) and (c)), then α solves $Er2^M(\alpha) = h\alpha$. Manipulating the relevant equations, we find:

$$\alpha_3 = \begin{cases} 1/6 & \text{if } m = \dfrac{2(h-1)}{5(h+1)} \\ -3(1+h)(2-m) + 2\dfrac{\sqrt{(h+1)(2-m)(5+4h-m(h+1))}}{5m(h+1)-2(h-1)} & \text{otherwise} \end{cases} \quad \textbf{(A6)}$$

$$\alpha_2 = \begin{cases} \dfrac{h-1}{2(2h-1)} & \text{if } 2h(3+h^2) = m(3+3h^3-h-h^2) \\ (h-1)\dfrac{(2-m)(h+1)(2h-1)-\sqrt{(h+1)(2-m)[2+(h^2-2)(6h-m(h+1))]}}{2h(3+h^2)-m(3+3h^2-h-h^2)} & \text{otherwise} \end{cases} \quad \textbf{(A7)}$$

where the subscript indicates the segment in which α falls.

Both expressions are roots of quadratic equations, but in both cases the root to be chosen is determined uniquely given the requirements: $\alpha \in (0,1)$, $\alpha_3 > f$, $\alpha_2 < f$, and $h \in (1,2]$. Notice that α_2 is defined only for values of h and m such that the argument of the square root is positive -- however, as shown below, this constraint is never binding.

When is α given by α_2, and when by α_3? The following Proposition answers the question.

Proposition A1. *For each* m $\in$ (0, 1], *there exists a value* $\hat{\text{h}}(\text{m})$ *strictly decreasing in* m, *such that* $\alpha = \alpha_3$ *for all* h $< \hat{\text{h}}(\text{m})$, *and* $\alpha = \alpha_2$ *for all* h $\geq \hat{\text{h}}(\text{m})$.

Proof of Proposition A1. We begin by establishing the following lemma:

Lemma 2. *For all values of* h $\in$ (1, 2] *and* m $\in$ (0, 2] *such that they are well defined,* α_2 *and* α_3 *are declining in* m..

Proof of Lemma 2. We need to find the appropriate sufficient conditions that allow us to sign the derivatives of (A6) and (A7) with respect to m. The details are available upon request, but the logical steps are the following: 1. In the case of α_3, it is possible to show $d^2\alpha_3/dmdh > 0$ over the relevant range of parameters (unless $\alpha_3 = 1/6$). Hence $d\alpha_3/dm$ reaches a maximum at $h = 2$. The sign of $d\alpha_3/dm$ evaluated at $h = 2$ depends on the sign of an expression that has a unique maximum, in the relevant range, at $m = 2/15$, where it equals zero. Thus $d\alpha_3/dm < 0$ for all values of α_3. 2. In the case of α_2, it is convenient to rewrite α_2 as a function of (2-m). It is then possible to show that the sign of $d\alpha_2/d(2-m)$ depends on the sign of an expression that reaches a maximum when the denominator of (A7) reaches 1. Evaluated at the appropriate value of m, the expression is negative, guaranteeing that $d\alpha_2/d(2-m)$ is negative and hence $d\alpha_2/dm$ is positive over the entire admissible range of parameters.■

Consider now the condition $\alpha = f$, where α_2 and α_3 are equal. By solving $Er3^M(i) = hz_i$ at $z_i = f$ we find that indifference requires:

$$(3+h-2h^2)m = 3+6h-3h^2-2h^3 \quad \textbf{(A8)}$$

where (A8) is meaningful only for $m \in (0,2]$. When the LHS is larger than the RHS, $z_i = f$

prefers the ties. Call $\hat{m}$ the value of m that solves (A8). It is easy to verify that for all $h \in (1, 1.351)$, $\hat{m}$ falls monotonically from 2 to 1. With $m \leq 1$, Lemma 2 implies that both α_3 and α_2 (if defined) must be larger than f; it follows that in this range of h values, for any m, α is given by α_3. At h = 1.4023, the RHS of (A8) equals zero, and is negative for larger values of h; at h = 1.5 the LHS of (A8) equals zero, and is negative for larger values of h. Finally, for h larger than 1.5, there is no solution with $\hat{m} < 2$. Thus for $h \in (1.4023, 2]$, $z_i = f$ always prefers the ties to the market. By the proof of Proposition 2 above, this implies $\alpha < f$, or α given by α_2. For $h \in [1.351, 1.4023]$, $\hat{m}$ is a declining function of h: the higher is h, the smaller is $\hat{m}$, and the larger the set of m values for which m is greater than $\hat{m}$ and α is given by α_2. Equivalently, for given m, there exists an $\hat{h}(m)$ such that $\alpha = \alpha_3$ for all $h \in [1.351, \hat{h}(m)]$, and $\alpha = \alpha_2$ for all $h \in (\hat{h}(m), 1.4023]$, where $\hat{h}(m)$ is declining in m. Finally, note that at $h \geq 1.351$, the smallest value of h for which α_2 could be relevant, α_2 is always well-defined. ■

It is easy to verify from (A6) and (A7) that $\hat{h}(m)$ equals 1.351 when m = 1, and approaches 1.4023 when m approaches 0.

Proof of Proposition 3. i) To establish $d\alpha/dh > 0$, we need to verify both $d\alpha_3/dh > 0$ and $d\alpha_2/dh > 0$ over the relevant range of parameters. The details are available upon request, but the logical steps are the following: in the case of α_3 it is easier to write α_3 as a function of f. Hence $d\alpha_3/dh = (d\alpha_3/df)(df/dh)$, or $\text{sign}(d\alpha_3/dh) = \text{sign}(d\alpha_3/df)$. It is then easy to show that a sufficient condition for $\text{sign}(d\alpha_3/df) > 0$ is: (18-2f-13m) > 0, which is always satisfied if $h \in (1,2]$, $m \in (0,1]$. In the case of α_2, it is convenient to recall that α_2 solves $Er2^M(\alpha_2) = h\alpha_2$. Thus $d\alpha_2/dh = (\alpha_2 - dEr2^M(\alpha_2)/dh)/(dEr2^M(\alpha_2)/d\alpha_2 - h)$. The denominator is increasing in α_2; because it is easily shown to be negative when evaluated at the upper bound $\alpha_2 = f$, it must be negative for all possible values of α_2. The numerator is also increasing in α_2. Call α^* the value of α that solves $\alpha^* = dEr2^M(\alpha^*)/dh$; because $\alpha^* > \alpha_2$ in the admissible range of parameters, the numerator must also be negative for all α_2. Hence $d\alpha_2/dh > 0$. ii) $d\alpha/dm < 0$ is established in Lemma 2 above.■

Proof of Proposition 4. To calculate expected GDP, we need to integrate individual expected returns for both members and non-members, but to do so we need first to establish for which parameter values each of the three possible regimes (a, b or c, described above) is relevant. Since $d\alpha_2/dm < 0$ by Proposition 3, for any h, α_2 is at a minimum at m = 1. But $\alpha_2(m{=}1) > f^2$ for all $h \in (1,2]$; it follows that regime (c) is never realized in the relevant range of parameters. Proposition A1 then establishes that for any m, the equilibrium regime is (a) for $h < \hat{h}(m)$ (where $\alpha > f$), and (b) for $h \geq \hat{h}(m)$ (where $\alpha \leq f$). Thus:

$$EGDP_N = (2-m)\left(\int_0^{\alpha f} Er1^M(i)\ dz_i + \int_{\alpha f}^{f} Er2^M(i)\ dz_i + \int_f^1 Er3^M(i)\ dz_i\right) \qquad \text{if } h < \hat{h}(m)$$

(A9)

$$EGDP_N = (2-m)\left(\int_0^{\alpha f} Er1^M(i)\ dz_i + \int_{\alpha f}^{f} Er2^M(i)\ dz_i + \int_f^{\alpha/f} Er3^M(i)\ dz_i + \int_{\alpha/f}^{1} Er4^M(i)\ dz_i\right) \quad \text{if } h \geq \hat{h}(m)$$

and

$$EGDP_G = m\left(\int_0^{\alpha f} Er1^M(i)\ dz_i + \int_{\alpha f}^{f} Er2^M(i)\ dz_i + \int_f^{\alpha} Er3^M(i)\ dz_i + \int_{\alpha}^{1} hz_i\ dz_i\right) \qquad \text{if } h < \hat{h}(m)$$

(A10)

$$EGDP_G = m\left(\int_0^{\alpha f} Er1^M(i)\ dz_i + \int_{\alpha f}^{\alpha} Er2^M(i)\ dz_i + \int_{\alpha}^{1} hz_i\ dz_i\right) \qquad \text{if } h \geq \hat{h}(m)$$

where the subscript N (G) stands for non-members (group members), and expected returns $Er1^M(i)$, $Er2^M(i)$, $Er3^M(i)$ and $Er4^M(i)$ are given by equations (A1), (A2), (A3) and (A4). Expected GDP for the economy as a whole is the sum of expected GDP for the two groups.

We can then establish: 1. *Expected GDP for group members must increase*. Since each member has the option of using the ties:

$$EGDP_G > m\left(\int_0^1 hz_i dz_i\right) = m(h/2) > m\,\frac{h^3-1}{3(h^2-1)} \qquad \textbf{(A11)}$$

where the last term is expected GDP for the group in the absence of ties (equation (9) in the text, corrected for mass).

2. *Expected GDP for non-members must fall.* We have calculated the integrals and studied the properties of the resulting function with the help of Mathematica. As expected, $EGDP_N$ simplifies to equation (9) in the text if $m = 0$ (for any h), or if $\alpha = 1$ (for $h < \hat{h}(m)$). We can establish sufficient conditions guaranteeing that (A10) is everywhere below (9) (corrected for mass) for all $m > 0,\ \alpha \in (0,\ 1)$. The details are available upon request, but the logical steps are the following: a) When $h < \hat{h}(m)$, (A10) is everywhere convex in α ; at $\alpha = f$ (the lower bound of the relevant interval for α), it is strictly declining in m, and thus smaller than (9) for all $m>0$. Hence for all $m > 0$, $\alpha < 1$, it must be smaller than (9). b) When $h \geq \hat{h}(m)$, (A10) is strictly decreasing in α, for all $\alpha \in [f^2,\ f],\ m \in (0,\ 1]$, and is smaller than (9) at $\alpha = f^2$.

3. *Expected GDP for the economy as a whole must rise*. a) When $h < \hat{h}(m)$, it is possible to find sufficient conditions guaranteeing that $EGDP$ is strictly decreasing in α, for all $\alpha \in [f,\ 1],\ m \in (0,\ 1]$. Hence it has a minimum at $\alpha = 1$, where it equals (9). b) When $h \geq \hat{h}(m)$, $EGDP$ is strictly concave in α over the relevant range of parameter values. For all $m \in (0,\ 1]$, it is larger than (9) when evaluated at either extreme ($\alpha = f^2,\ \alpha = f$), hence it must be larger than (9) everywhere.

To evaluate the welfare effect of the ties on individual types, we must study expected returns for each type in each segment. Manipulating the relevant equations, we can establish:
i) $(Er1^M(i) - Er(i))$ is increasing in z_i, but always negative at $z_i = \alpha f$, the upper bound of the interval. Hence every market trader in $[0, \alpha f]$ is hurt by the ties; because $Er(i)$ is increasing in z_i, the percentage loss is smaller the higher the type. ii) $(Er2^M(i) - Er(i))$ is concave in z_i for all $z_i \in (\alpha f,\ f]$, given $\alpha > f^2$. Because the expression is increasing at the upper bound of the

interval ($z_i = f$), it must be increasing everywhere. And because the expression is negative at $z_i = f$, it must be negative everywhere. Hence every market trader in $(\alpha f, f]$ is hurt by the ties, and the percentage loss is smaller the higher the type. iii) ($Er3^M(i)$ - $Er(i)$) is increasing in z_i. If $h < \hat{h}(m)$ (and thus $\alpha > f$), the expression is negative at $z_i = 1$, and hence negative everywhere. If $h = \hat{h}(m)$, the expression is zero at $z_i = 1$, and negative everywhere else. If $h > \hat{h}(m)$, the upper bound of the interval is $z_i = \alpha/f$, where the expression is always negative. Thus, every trader in $(f, \min[1, \alpha/f]]$ is hurt by the ties unless $\alpha/f = 1$, in which case $z_i = 1$ is just indifferent. The percentage loss is smaller the higher is the type. iv) ($Er4^M(i)$ - $Er(i)$) is of interest only if $h > \hat{h}(m)$. The expression is always increasing in z_i, and for all $h > \hat{h}(m)$, equals zero at $\hat{z}_i(h) \in (\alpha/f, 1)$. Once again the percentage loss is smaller the higher the type. All together these observations establish the pattern of individual losses for non-members described in the Proposition.

In the group, all $z_i \leq \alpha$ enter the market. The results above show that all of them, including α, must be worse-off (recall that α belongs to segment 3 if $h < \hat{h}(m)$, and segment 2 if $h \geq \hat{h}(m)$), and that their percentage loss must be declining in z_i. Among members choosing the group, by continuity types close to α must lose, although a majority must gain given the aggregate gain for the group. It is not difficult to verify that $(hz_i - Er(i))/(Er(i))$ is increasing in z_i (for both z_i larger and smaller than f). This establishes the remaining part of the Proposition. ■