Identifying Business Networks in Emerging Economies

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Abstract

This paper provides a detailed description of the shape and financial importance networks amongst the universe of firms in an emerging economy where a network link is defined as board interlocks i.e. two firms share a common director. We do so by making use of a novel dataset from Pakistan that includes information on all the 140,000 firms borrowing from formal financial markets over a four year period. We find that a significant fraction of firms, upto one-third, have board interlocks with other firms. More interestingly, while firm networks typically range from networks of 2 to 100 firms, there exists a single very large network – the "super-network" – that comprises of almost 10,000 firms and is more than a hundred times the size of the second largest network. This super-network plays a disproportionately important role in financial markets: Although comprising 7% of firms, over 55% of all formal lending goes to firms in this super-network. Moreover, super-network firms have access to a greater number of lenders, default less and appear to be insured against adverse shocks in the economy. The super-network is robust to different definitions of firm linkages and over time. Moreover, a closer examination reveals that there are no important nodes (directors or firms) in the super-network and that is a very robust and diffuse network – eliminating important nodes (either singly or in clusters) does little to disrupt the network. This suggests that in addition to what one normally thinks of as business groups – a closely coordinated group of firms – more loosely yet very stably knit firm networks may also play an important role in emerging economies.

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I. Introduction

While there has been a lot of interest in examining the role of business groups particularly in emerging markets (Berglof and Perotti 1994, Chang and Choi 1998, Hoshi et al. 1991, Khanna et. al. 1998, 1999, 2000, 2001,), this work has generally focused on ties between a small number of firms in the economy, usually the larger publicly listed ones and those affiliated with them. A related theoretical literature examines the importance and form of networks more broadly (Bala and Goyal 1998, 2000, Granovetter 1973, 1994, 1995, Jackson et. al. 1996, 2002, 2003). To the extent that such network ties are also present in the broader population of firms, this paper provides a detailed description of the nature and form of business networks in the overall economy and the roles such networks play in financial markets. We do so by making use of a novel data set that comprises around 140,000 firms in Pakistan that ever borrow from any financial institution over a period of four years. This set of firms is likely to be representative of the universe of all but the very small of enterprises and since we have directorship information for each, permits us to examine firm network relations in the forms of board inter-locks.

Defining two firms as being linked if they have at least one director in common, we provide a picture of the extent to which firms are networked. While the majority of firms do not share any links with others, a third of the firms in our data are in networked relations with one or more firms. This is substantial given that our sample includes a large number of firms in the economy including fairly small ones. However, perhaps the most surprising and interesting feature that emerges from this exercise is that while firm networks typically range from networks of 2 firms to 100 firms, there also exists a single very large network which outweighs the second largest network by an order of magnitude. This network – hence-forth the "super-network" – comprises of almost 10,000 firms – more than hundred times the size of the second largest network! What makes this even more interesting is that although this network includes only 7% of firms in the sample it seems to play a much more dominant role in the economy with over 55% of all lending going to firms in this super-network. The remainder of this paper examines the form of this super-network and briefly examines its role in the financial market.

We first examine the robustness of the overall network patterns we see in the economy to various definitions of board interlock links. Our results show that the general patterns identified i.e. a sizeable fraction of firms belonging in some network and the existence of a super-network that is orders of magnitude larger than any other – hold true for all these definitions. In particular, the alternate link criteria we consider are (i) excluding all government directors since they may be only be nominally appointed on firm boards and as such may not constitute a real link; (ii) excluding all directors in a firm

who do not also hold equity in the firm; (iii) only consider links between two firms if they have at least two directors in common; and (iv) only considering firms with multiple directors. While the second last (two directors in common) is extremely demanding and does in general increase the fraction of firms that have no links of this nature, what is surprising is that the super-network, while smaller, is still in the thousands of firms. Finally, we also find that this network structure is relatively stable over time.

Networks matter because they play a dominant role in the financial market. The super- network, while around 7% of firms in the sample, collectively borrows more than half of all formal lending. Exploring this further we find that networks are dominant in financial markets along a variety of measures: Not only is their average borrowing 7.3 times as large as that of single firms but they tend to have 7.7 times as many lenders and have higher loan limits, and a greater fraction of unfunded loans. Moreover, the results suggest they are better quality borrowers as they have 59% lower default rates than single-firms and higher recovery rates even when they do go into default. Finally, there is evidence that such firms are better protected from shocks hitting similar firms in the economy.

Having shown the robustness of the general network patterns and in particular of the super-network and its relative dominance in financial markets, we next examine the shape of this network. In particular, does it present a dense star structure with all firms connected to a lot/most of the others, a "royal family" where a few important firms act as links between all others, or a more diffuse structure? Since a graphical analysis is not revealing in such a large network, we instead rely on various other metrics that all suggest that in fact the network appears to be a fairly diffuse structure.

We first look for highly networked firms and find that while firms do vary in the degree to which they are directly connected to other firms – from as low as just one such direct link to as high as 200 links – none of these really constitute what one would consider to be a "royal firm" since even the most networked firm has direct links with barely 2% of the firms in the network. A similar exercise can be conducted to see if there are any "super directors" i.e. directors who hold positions on a large number of firms. Not surprisingly the results are the same – while there are directors who serve on the boards of several different firms – this by itself can hardly explain the size of the super network. We then turn to examine the robustness of the super network in terms of the "loss" of firms in the network and very interestingly, find that the super-network is incredibly robust and remains unaffected not only if we individually exclude firms with a large number of direct links, but even if we remove such firms *together*. In fact the network only significantly reduces in size once we eliminate the almost 2,000 firms in the super network with 10 or more direct links to other firms.

Our results suggest that networks may play an important role even amongst the broader set of firms in the economy. Moreover, the existence, robustness and form of the super-network suggests that not only do firms try to become part of some network but that these links are not formed with a few important firms or with as many firms as possible but more sparsely. Yet the links are formed in a manner that ensures the firm remains in the super-network and in turn the super-network itself continues to exist even if a large number of firms in the network are lost. To borrow from the computer science literature, this suggests a network architecture that is not too costly i.e. each node does not have to link itself to other nodes, yet manages to remain connected to the network through a multitude of routes so that it is not sensitive to an "attack" on a few nodes. The fact that such a structure emerges amongst firms not through the conscious design of a central planner but through decentralized link formation is all the more remarkable.

II. Data & Methodology

We use two new data sets in this paper. The first has directorship information for all borrowing firms in Pakistan from 1999-2003 and the second has detailed loan level information for all corporate loans given out by banks in Pakistan from 1996 to 2002. Both datasets were provided by the Credit Information Bureau (CIB) at the State Bank of Pakistan (SBP). We describe each of these below:

A. Board of Directors Information

The Credit Information Bureau maintains a list of the board of directors of all firms borrowing at any given period from any formal lending institution. Our data consists of all such firms borrowing from 1999 to 2003 at a frequency of every six months and represents the universe of all firms borrowing from the formal financial sector during this 4 year period. This database uniquely identifies each firm by a specific code allowing us to match firms over time and to the loan level database. However, we should note that unlike firms, board of director members are not given a unique code and therefore an important part of our analysis was to first identify unique directors in the database. With a total of 1,517,799 individuals this is not a trivial task.

The database provides the full name, national identification card (NIC) number and full father's name for every board of director of the firm and this allows us to also uniquely identify directors over time and across firms. In order to do so we utilize an algorithm that identifies directors by first exactly matching on

the NIC number of the director since this number does not suffer from the usual spelling variation common when Urdu names are recorded in English. In case the NIC numbers do not match, we ensure that the two individuals are not classified as the same (even if their names match). However, in case the NIC number information is missing or obviously incorrect (i.e. is not of the required length and format etc.), we then match individuals if both their full name and father's (or husband as the case may be) full name matches exactly. Finally, if two individuals are reported as directors for the *same* firm (over time), we also allow for a looser match by matching on the director's full name alone. Given this strict match algorithm it is more likely that we will under-match rather than over-match and therefore we may overestimate the total number of distinct directors in the sample or more pertinent to our analysis, may *underestimate* the extent of board interlocks amongst firms in the economy. However, we have conduced robustness exercises using different matching algorithms to identify unique directors and our analysis remains robust to doing so.

In addition the database provides information on the percentage of firm equity the directors' own. This data provides us with a total of 139,526 unique borrowers and after we have carried out our director matching algorithm, 261,069 unique directors.

B. Loan Level Information

The loan-level data is unique both in terms of its coverage, and detail. We have quarterly information on the entire universe of corporate bank loans outstanding in Pakistan during a 7 year period from 1996-2002. The data was provided by the State Bank of Pakistan which supervises and regulates all banking activity in the country and as such, accurately captures this universe. The data is at the level of the bank, borrowing firm and quarter and traces the history of lending with information on the amount of the loan (principal and interest) outstanding by different loan types (fixed, working capital, etc.), default amounts and duration, and any litigation, write-offs or recoveries on these loans. In addition, we have information on the name, location and directorship of the borrowing firms and banks allowing us to construct various borrower and bank level attributes.

This leaves us with a panel data set of 153 banks lending to 108,068 unique firms during the 25 quarters (April 1996 to April 2002). As most of analysis examines cross-sectional variation in the data, we collapse the time component of our panel by "cross-sectionalizing" the data at the firm-bank-level. This averaging is likely to reduce measurement error concerns in the data. Cross-sectionalizing the data involves converting all values into real 1995 rupees (Rs.), and then taking the time average of each loan,

making the loan the unit of observation with each loan identified by the borrowing firm and its corresponding bank. The cross-sectionalized version of our data has 147,094 observations or loans. This number is greater than the number of unique firms because a single firm may be borrowing from more than one bank.

Table I summarizes these basic characteristics of the data set. We should note that since this data shows the stock of outstanding loans and defaulted amounts etc. it is liable to also reflect lending activity prior to our data period and as such our results should not be construed as driven solely by behavior in the mid to late 90s but also earlier periods.

In terms of data quality, our personal examination of the collection and compilation procedures, as well as consistency checks on the data suggest that it is of very good quality. CIB was part of a large effort by the central bank to setup a reliable information sharing resource that all banks could access. Perhaps the most credible signal of data quality is the fact that all banks refer to information in CIB on a daily basis to verify the credit history of prospective borrowers. For example, we checked with one of the largest and most profitable private banks in Pakistan and found that they use CIB information about prospective borrowers explicitly in their internal credit scoring models. We also ran several internal consistency tests on the data such as aggregation checks, and found the data to be of high quality. As a random check, we also showed the data from a particular branch of a bank to that branch's loan officer who confirmed the authenticity of the data related to his portfolio.

C. Defining Firm Networks

A crucial part of the analysis is the construction of firm networks. Given the nature of the data we define firm links based on whether they share a common director or not (i.e. a board interlock). A firm network is the set of firms that are connected to each other through such inter-locked boards. Figure I illustrates the hypothetical construction of a network where each link represents a common director between two firms (the number on the link indicates the number of shared directors if there are more than one). This example considers an economy with 8 firms, firm A to H, and a total of 15 directors, director 1 to 15. Linking firms if they share a director produces two distinct networks in the economy and two firms, G and H, that are not connected to any one else (i.e. form a singleton network). Note that even though the four firms A through D are in one network, they are not all directly connected to each other. While firms A, B and C are all linked to one another (although through different directors), firm D is only linked indirectly to firms A and B through its direct link to firm C. Larger networks may be linked though even

longer chains of such indirect links. Also firms within a network may vary by how "important" they are in the network. Thus firm C is important in the network because it not only has the most number of firm's directly connected to it but also because it connects firm D to firms A and B. Similarly, firm links may vary in their "strength" such as in terms of the number of common directors. Thus while the network of firms A through D is larger, the two firm network of firms E to F may be "stronger" in the sense that these two firms share three directors. Moreover, networks may differ in their shapes from "totally connected" networks where all firms are connected to each other (a two firm network like that of firms E and F is by definition totally connected) to a "star" shaped network where all firms in the network are connected (only) through one crucial firm (had firm A and B not been connected directly, our four firm network would have been a "star" network). We will make use of such attributes and structures in analyzing networks in our data.

III. Economy-wide Networks

In this section, we examine the overall network pattern and its robustness using various alternative definitions to establish the link between different firms. In all cases we find that a large fraction of firms belong to some network and the existence of a super-network that is orders of magnitude larger than any other. We describe the basic network pattern and each subsequent robustness test below.

A. Network Patterns

In order to create the basic network structure we define the link between two firms as having at least one director in common. Figure 2 illustrates the distribution of firms across the different network sizes. Almost two-thirds of the firms in the data are not linked to any other firm and the other third are a member of some network. One interesting fact is the distribution of the networks. While, most of the networks have between 2 and 100 firms, there is one "super-network" composed of 9480 firms. In comparison, the second largest network is only formed by 85 firms,[2] less that one-hundredth the size of the super-network.

Another interesting fact is how total lending is distributed across the single – i.e. non-networked - firms and the networked firms. While single firms represent 64% of total firms in our sample, they account for only 20% of total lending. On the other hand, the super network, formed by 7% of total firms, borrows

[2] See Appendix Table 1 for the complete network distribution.

60% of total lending! The economic significance of the super network is clearly substantial. We will examine this further in the next section.

B. Network Pattern Robustness

In the previous section we defined the link between two firms as having at least one director in common. In order to check the robustness of the network pattern above, we employ four alternative ways of identifying links between firms. The different panels in Figure 3 show the distribution of firm network sizes for each of these definitions, and Figure 4 shows the percentage of total borrowing for these networks.

(i) Excluding government directors:[3] The rationale for excluding government directors is that in some cases they might just be political appointees sitting in boards of different firms. If this is the case, this could be a reason for having one big network. Nevertheless, using this new definition does not affect our previous group distribution. From Figure 3 we see that the proportion of single firms remains at 64%, the super network includes 8936 firms and it is still a 100 times higher than the second largest group. In terms of the economic power of the super-network, it still accounts for over 50% of total lending (Figure 4).

(ii) Excluding all directors in a firm who do not hold equity in the firm: Again, being part of a firm's board of directors but not holding shares of the firm might imply that such a director is not a "real director" at least in terms of having the power to influence firm decisions. So it would be important to see how the network structure changes once such directors are excluded. While the super network reduces in size, it still includes 4.5% of the firms in the database, over 40% of total lending and it is 25 times bigger than the second largest firm.

(iii) Consider links between two firms if they have at least two directors in common. This definition is extremely demanding since it only allows a link between two firms if they share two distinct directors. Not surprisingly this definition significantly increases the fraction of firms that have no links. In fact, over 90% of the firms are not linked to any other firm when using this new definition. Nevertheless, the structure of the network remains fairly stable. The super-network, while smaller, still includes over two thousand firms, borrows almost 50% of total lending and is 70 times bigger than the second largest network.

[3] See Appendix Table 1 for a detailed description of each group definition.

(iv) Excluding individual borrowers: Finally, we test our network distribution by excluding individual/small borrowers. To do so we excluded all the firms that have only one director on their board. This restrictive condition left us with only 35% of the total number observations since a lot of the single firms are now excluded. As expected, only 53% of total firms are now not part of any network. However, from Figures 3 and 4 we can see that both the distribution of firms and total lending across the different networks remains fairly stable when using this new group definition. The super network now includes 13% of total firms and accounts for over 65% of total lending.

By using these different group definitions we are able to test the robustness of the network structure. The general patterns identified i.e. a sizeable fraction of firms belonging in some network and the existence of a super-network that is orders of magnitude larger than any other – hold true for all these definitions.

C. Network Stability over Time

Our directors' CIB database contains 6 monthly information on all borrowing firms board of directors from 1999 to 2003. We can therefore exploit the time variation in our data to further test the robustness of our network structure by analyzing its stability over time. In order to do so, two firms are defined as being connecting to each other only if they have a director in common in the *same* quarter. In other words, we are using a much more restrictive group definition by not allowing firms to be linked to each other if they have directors in common but only in different quarters.

Figure 5 shows the distribution of networks in four different quarters.[4] We find that the distribution of the networks is very similar at different points in time. In all cases, over 25% of the firms belong to some network, the super network includes between 4% and 5% of total firms and it is outweighs the second largest network by 40 to a 100 times.

Not only is the network structure is stable over time but so is the super networks dominance in the financial markets. For all periods considered in our analysis, the super-group borrows 50% to 60% of total lending - smaller networks account for 20% to 25% and the single firms for the rest. Overall, both the

[4] For display convenience we only graphed the histograms for the quarters ending in June of every year. The complete distribution for the remaining quarters can be found in Appendix Table 2.

structure of the networks –their distribution and magnitude- and their participation in the financial market is very stable and robust.

IV. Networks and Access to Financial Markets

In this section we analyze the role of networks – particularly that of the super-network - in financial market. Tables 2 and 3 examine a variety of measure of financial market access and performance using the loan level data. In both tables we typically first run specifications without any controls. However, a potential concern is that the preferential treatment for networked firms may be biased if banks differ in their loan terms and conditions, or loans differ across different cities and/or industries where networked firms are located. Therefore we also present the results where we non-parametrically control for these factors by introducing lender, city and industry type fixed effects.

Financial Access:

Table 2 first takes a look at whether networked firms have differential access to financial markets in terms of amount and form of borrowing. Columns (1)-(4) bear out the results we had highlighted before – that super-network firms borrow a disproportionately large part of all formal lending. Columns (1)-(2) look at their average borrowing size for a given lender (intensive margin) and then Columns (3)-(4) examine the other (extensive) margin and examine whether networked firms differ in the number of lenders they borrow from. The results show that networked firms – particularly those in the super-network do better on both margins. Column (1) shows that firms in the super network borrow 7.3 times more than single (non-networked) firms and firms in smaller networks almost twice as much as single firms. The numbers are robust to controlling for bank, city and industry factors. Column (3) shows that firms in the super network have, on average, 7.7 times as many lenders than stand alone firms, while the medium-sized network firms have, on average, less than twice as many lenders than small firms (80% more). This numbers are drop a bit but still remain fairly large for the super-network firms once we controlling for other lenders, and firm business and city. (Column 4) - super network firms now have 6 times more lenders than small firms and medium network firms have on average 40% more than small firms. These results confirm what we have already seen in the Figures 2, 4 and 6 regarding distribution of total lending across different groups.

Columns (5)-(8) then examine other aspects of such loans that may also reflect preferential access in form rather than size. Columns (5)-(6) first look at the share of unfunded loans made to a firm. While the majority of loans are funded a significant fraction is also unfunded. Unfunded loans consist of essentially

guarantees such as letters of credit that the bank issues to firms (particularly importers). Since unfunded loans reflect higher risk for the lender, a greater fraction of such loans is likely to reflect a greater confidence or preference towards the borrower. Column (4) shows that super network firms receive 7.26 percentage points (55%) more unfunded loans than small firms and firms in smaller networks receive 5.84 percentage points more than not networked firms. The magnitude drops but remains statistically significant once we include controls for each lender and firm location and business type. However, we should note that by including separate dummies for each lender we may be "over-controlling" here. In particular if banks differ in their share of unfunded loans (which is very likely) that part of the network firms differential access may precisely be in accessing such lender types. By introducing lender fixed effects we are taking away this effect.

Finally, Columns (7)-(8) examine whether networked firms have higher credit limits, Column (7) shows that super network firms have 49% greater credit limits on their fund based loan facilities than single firms, while the medium-size network firms have 18.5% greater limits than single firms. Note that we include a firm's borrowing as a control therefore this result is all the more surprising given that we already know that networked firms borrow larger amounts. So even once we account for their greater borrowing we still find that in facts banks extend an even larger credit window to such firms. Column (8) shows that the results are still significant when controlling for the lender and firm's location and business.

Financial Performance:

Table 3 shows that in addition to better access to financial markets, networked firms also have better borrowing performance. Columns (1) and (2) show that super network and medium network firms default less than small firms. Specifically, we can see that on average, firms in the super network default 59 % less than small firms (31% if using controls) and default rates for firms in smaller networks are 46% less than for not networked firms (18% if using controls).

Columns (3)-(4) then examine what happens when a firm does default – specifically in terms of recovery on the defaulted amount. Interestingly not only do networked firms default less but, as Columns (3)-(4) show, even when they do default they are more likely to repay the default. Column (4) shows that the recovery rate on default of firms in the super-network is 37% higher than recovery rates for single firms (Column (4)). The results drops to 24% higher recovery once we add in more controls (Column (5)). Interestingly, in this case the difference between the super-network and medium sized networked firms is not that large.

Columns (5) and (6) show that, conditional on loan size, networked firms are also less likely to face litigation than single firms: 55% less litigation for super network firms and 17% less for medium sized network firms. The results fall somewhat but still remain relatively larger with controls.

Finally, in Columns (7) and (8) we test whether part of the reason networked firms perform better is due to insurance provided through their networks. The literature on business groups often stresses that an important component of such groups is that they have access to the groups internal financial markets and this protects them against adverse liquidity shocks in the economy. Columns (7)-(8) perform, such insurance tests by using our data to generate shocks in terms of default rates at different levels of connectedness to a firm and then seeing if networks firms are less sensitive to such shocks. In particular we consider two firms that are linked to each other (are "sisters") either because they are located in the same city, the same industry type, have the same ownership type (foreign vs. local etc.) or fall in a similar borrowing size category. We then conduct the following hypothetical comparison. Consider two firms that are in the same sister category (for example, share the same city etc,) but one is a networked firm and the other a single one. Is the networked firm less sensitive to the shock that hits all firms in its (city) neighborhood compared to the non-networked firm? So in other words is it the case that for the non-networked firm when default rate on all firms in its city rises, its default rate also increases while for the networked firm there is a smaller increase (or no increase at all). If so, this would suggest that networked firms are less sensitive to i.e. insured against – shocks that affect their local environment (whether that be defined geographically in terms of city or along business, ownership type and borrowing size lines).

Note that in order to conduct these tests we will be exploiting variation over time as well. As such we collapse our original panel data over lenders (by aggregating a firm's default over all its lenders at any given time) so that we are left with only borrower-time variation. We can now test whether firms in the super network are differently affected by a shock in their "sister-group" (using the different definitions of sisters above) than single firms. Column (7) presents the results of the unweighted regression, while in Column (8) we weight by total lending. While we have separate interactions for medium sized-firms in the regressions we exclude them for presentational purposes – their results are smaller but similar to that of the super-network firms.

We will describe the result of the weighted version since they are more economically meaningful results. As we can see from Column (8) if a single firm's own city firms experience a 10 percentage points increase in their default rate, the default for the single firm will go up by 7.5 percentage points. However, for a firm in the super network in that city, their default rate is almost not affected at all by their city's

firm's default (the interaction term of city-sister with super-network is negative and of the almost exact magnitude as the term on city-sister). Thus suggests that that the networked firms may be being bailed out by other firms in its network (and possibly in a different city), generating a insurance to the city shock.

The same pattern can be found when considering shocks to an industry. While single firms' default rate would go up by 4 percentage points if the firms in the same industry get a 10 percentage point increase in default rate, a firm in the same industry but in the super-network would only suffer from a 1 percent point increase in its default rate. The insurance effect however is lower in the case of shocks to the same firm type (government, domestic, foreign, etc). This may not be surprising since the majority of firms are domestic and so shocks at this level are likely to affect a large fraction of firms in the economy and therefore a large fraction of firms even in the super-network. If so, mutual bailing out may not be as feasible. Finally, we also consider shocks to firms that belong to a similar borrowing class. We categorize firms into 5 borrowing classes based on their overall borrowing size. In this case we again find an insurance effect or more specifically, we find that firms in the super-network in fact move in the opposite direction from non-networked firms in their borrowing size class: A 10 percentage point increase in default rate of firms that borrow in a given borrowing size class affects single firm's in that borrowing class by increasing their average default rate by 0.8 percentage points. However, for a firm in the super-network, instead of experiencing a similar increase, it sees a reduction in the average default rate of 3 percentage points.

From Table 2 and 3 we see that not only do networked firms get preferential treatment in the financial markets but also that their borrowing performance is much better than that of single firms. Also, we see that among networked firms, firms in the super network have more access and better borrowing performance than firms in smaller networks. We should caution though that these results do not imply causality. It could just as well be that networked firms are treated and perform better simply because they were better firms to begin with or because the network itself adds value to such firms. The insurance results do hint at the latter interpretation.

V. The Structure of the "Super-Network"

Having established the importance role of the super-network in financial markets, we now examine how the super network looks like. In particular, does it present a dense structure with all firms connected to a lot/most of the others, a "royal family" where a few important firms act as links between all others, or a more diffuse structure? Could the network be explained by the presence of some popular directors that are

linked to most of the firms? By analyzing different nodes, clusters of firms and directors we find that the network appears to be a fairly diffuse structure.

A. Large Nodes?

We first look at the super network and see if there are any "super directors" i.e. directors who hold positions on a large number of firms. Figure shows, for each unique director in the super-network, the distribution of the number of firm boards this director sits on. As Figure 7 shows, there are not that many very popular directors. Less than 1% of the directors sit in the boards of more than 10 firms[5] and in fact 78% of the directors are appointed to the board of just one firm. While there are directors who serve on the boards of several different firms – some of them sit in over 60 different boards – this by itself can hardly explain the size of the super network.

We do the same exercise but now see whether there are firms that are connected to lots of other firms and that can explain the network: a "royal firm". Figure 8 shows the distribution of all firms in the super-network of the number of firms a given firm is linked to (including itself). We look first at highly networked firms and find that while firms do vary in the degree to which they are directly connected to other firms, the most connected firm has direct links with 215 firms in the network (less than 2% of the firms). On the other hand, most of the firms have links with only a few others. Out of the 9480 firms in the network, 75% of them have links with less than 10 firms. The analysis suggests that no firm constitutes a "royal node" but the network structure responds to a dense web of links across the entire network.

B. "Important" Nodes?

We then turn to examine the robustness of the super network in terms of the "loss" of directors or firms in the network. We want to see if there is a crucial director or firm that can explain the web of links among firms in the super networks. In order to test this hypothesis, we take out -one by one- each director/firm that is important in terms of the number of firms the director or firm is linked to.

Figures 9-10 shows the results of doing so for directors. They show the summary results of doing this exercise of single-director removal by removing a given director and each time computing what happens to the network structure. Figure 9 examines how many different sub-networks are formed once a given

[5] See Appendix Table 3 in the Appendix for more detailed information.

director is removed while Figure 10 examines what the sixe of the largets and second largest group is once this director is removed. The directors removed are those who sit on the boards on over 20 firms – there are 328 such directors. Both Figures 9 and 10 show that the super-network is very robust to the loss of important directors.

As we can see from Figure 9, in 60% of the cases; the group structure remained exactly the same in terms of number of sub-networks. In other words, the director's removal does not create any new sub-networks but a single original super-network remains. While in 40% of the cases, the super network breaks into more subgroups, there always is a dominant network left (see Figure 10) order of magnitudes larger than the second largest network. For example, when we take out one director that is linked to 43 firms, the super-network breaks into 17 different subgroups. Out of these 17 subgroups, the biggest network is still composed of 9438 firms (99.6% of total firms) and borrows over 60% of total lending. In comparison, the second largest group has only 7 firms and accounts for less than 0.06% of total lending.[6]

Figure 10 illustrates the strength of the super network by showing the histogram and kernel density for the distribution of the proportion of firms in the biggest and second biggest networks after the above exercise of excluding each director one by one. In all cases, the biggest group is composed of 98.9% to 100% of the firms in the super-network. In no case does the second maximum network size has more than 0.7% of total firms. The exercise suggests that the super-network is incredibly robust and remains unaffected even if we exclude highly linked directors.

A similar exercise can be conducted to see if what happens to the super-network if we exclude firms one by one. We exclude firms that are linked to 75 firms or more. Figures 11 and 12 are analogous to Figures 9 and 10 respectively. As we can see from Figure 11, in over 50% of the cases, excluding one firm does not change the structure of the super network at all. In these cases, 9,479 firms still belong to the network and borrow around 60% of total lending. Even in the cases were other sub-groups are formed, the biggest group still includes 99.5% of the firms in the original super-network and accounts for a similar share of total lending.[7] As before, Figure 12 illustrates that the effect of excluding one firm on the size of the two biggest networks: regardless of which highly-linked firms is excluded over 99,5% remain in the super network while the second largest group has less than 0.4% of the firms.

[6] Appendix Table 4 shows the statistics calculated after excluding one by one each director linked to more than 20 firms.

[7] For detailed information, see Appendix Table 5.

C. "Important" Clusters?

All the exercises conducted in the previous section point to the same general conclusion: there are no important nodes in the structure of the super-network. But what if there are important clusters of firms or directors? As in the previous section we are going to analyze how the structure of the super-network is affected when removing firm and director but instead of one by one, we remove all firms of directors (i.e. clusters) that are above a given threshold.

We start by removing clusters of directors. In order to do so, we eliminate all directors that sit on the board of more than a given number of firms. We start with a threshold value of 51 (i.e. remove all directors who sit on the board of equal to or more than 51 firms and recomputed the network structure) and then lower this threshold in steps of 2. Table 4 shows the result of this exercise.[8] We are interested not only in the number of distinct sub-networks that are formed once directors above a certain threshold are eliminated but what is the relative size and financial importance of the largest and second largest remaining groups. As we can see from Table 4, the super network does not break until we drop all directors directly related to more than or equal to 3 firms. By then, only 24% of the firms are still in the largest network although they still borrow slightly disproportionately more (33%). The remarkable thing to note is that even if we drop all directors who sit on the boards of five or more firms, while there are several hundred smaller networks, we still find that there one large sub-network that has 63% of the original super-network firms and that borrows 52% of total lending. Moreover what is interesting is that in all these cases (even when we drop directors who sit on 3 or more firms' boards) the second largest group remains extremely small - never greater than 1% of the firms and 0.5% in terms of lending share.

Table 5 shows the results of conducting a similar exercise but now dropping all firms above a certain threshold in terms of how many other firms they are linked to. We start with a threshold of 202 firms and lower the threshold in steps of 10. The same robustness is observed as when we drop clusters of directors. Table 5 shows the super-network remains important even when we drop the top 500 or so firms (with links to 32 or more firms). In fact the network only significantly reduces in size once we eliminate the firms in the super network with 22 or more direct links to other firms. Even after dropping these more than 800 firms, the largest remaining network still has 35% of the remaining firms and 11% of total original lending. Moreover, this sub-network is more than ten times bigger than the second largest sub-network. It is only once we drop the top 2000 or so firms in terms of firm linkages (threshold of 12 or more links) that we find that the largest sub-network becomes small and comparable to the second largest

[8] In Table 4 the difference between each row is no always 2 steps because at higher directors count values, there may not be directors for every count value.

sub-network. These results show that the super-network is indeed extremely robust to the loss of not only individual nodes but also clusters on important nodes.

VI. Conclusion

Our current understanding of the role of firm networks, particularly in emerging markets, is that that they are in the form "business groups" – a set of firms that are closely held, typically by members of the same family, and are highly collusive with well coordinated actions and strategies. While such closely knit groups are indeed likely to play an important role, this paper documents the presence and importance of a much larger and far more diffuse network of firms in the wider set of firms in the economy.

These networks are more reminiscent of the weaker networks often discussed in labor markets (networks of distant relatives and friends-of-friends) and in other social networks, "small-world" networks (Watts and Strogatz 1998) etc. What is interesting from the perspective of this paper is that such looser networks are not only very robust but show the presence of a super-network that dominates all other networks in the economy. This network is able to withstand the loss of a large part of its (important) nodes through a set of diffuse and "additional" links that imply that firms are typically linked through multiple pathways. A promising direction of further enquiry is to examine the structure of this super-network in more detail and in light of models of network formation to understand the environments in which is likely to arise and the role that such weak links may be playing. Our results also suggest that even such loosely linked networks may generate substantial benefits for its member firms, although inferring causality is difficult and offers another area for future research.

References

Bala, V. and S. Goyal (2000), A Non-Cooperative Model of Network Formation, Econometrica.

Bala, V. and S. Goyal (1998), Learning from Neighbours, Review of Economic Studies.

Berglof, E. and E. Perotti. 1994. "The Governance Structure of the Japanese Financial *Keiretsu*." *Journal of Financial Economics* (36), 259-284.

Chang, S. J., and U. Choi. 1988. "Strategy, Structure, and Performance of Korean Business Groups: A Transactions Cost Approach." *Journal of Industrial Economics*. Vol. 37, No. 2: 141-158. December.

Collin, S-O. 1998. "Why are These Islands of Conscious Power Found in the Ocean of Ownership?: Institutional and Governance Hypotheses Explaining the Existence of Business Groups in Sweden." Journal of Management Studies 35(6): 719-746.

Dutta, B and M. Jackson (2003).``On the Formation of Networks and Groups," in Networks and Groups: Models of Strategic Formation, edited by B. Dutta and M. Jackson, Springer--Verlag, Heidelberg 2003.

Encaoua, D. and A. Jacquemin. 1982. "Organizational Efficiency and Monopoly Power: The Case of French Industrial Groups." *European Economic Review* (19), 25-51.

Feenstra, R., T.-H. Yang, and G.G. Hamilton. Nov 1993. "Market Structure and International Trade: Business Groups in East Asia". (ITI). NBER Working Pap 4536.

Fisman, R. and T. Khanna. 1998. "Facilitating Development: the Role of Business Groups". Working Paper.

Goto, A. 1982. "Business Groups in a Market Economy." *European Economic Review* (19), 53-70.

Granovetter, M.S. 1973. "The Strength of Weak Ties." *American Journal of Sociology* (78), 1360-1380. May.

Granovetter, M.S.. 1983. "The Strength of Weak Ties: A Network Theory Revisited." *Sociological Theory*, Vol. 1: 201-233.

Granovetter, M.S. 1994. "Business Groups." In N.J. Smelser and R. Swedberg, eds. *Handbook of Economic Sociology*. Princeton: Princeton University Press and New York: Russell Sage Foundation.

Granovetter, M.S. 1995. "Coase Revisited: Business Groups in the Modern Economy". *Industrial and Corporate Change* 4(1): 93-130.

Hoshi, T., A. Kashyap, and D. Scharfstein. 1991. "Corporate Structure, Liquidity, and Investment: Evidence from Japanese Industrial Groups." *Quarterly Journal of Economics* (106), 33-60.

Jackson, M and A. Wolinsky (1996). "A Strategic Model of Social and Economic Networks," Journal of Economic Theory, Vol. 71, No. 1, pp 44—74.

Jackson, M and A. Watts (2002). "The Evolution of Social And Economic Networks,'" Journal of Economic Theory, vol. 106, no. 2, pp 265-295.

Jackson, M and B. Rogers. `"The Economics of Small Worlds,'" forthcoming: Journal of the European Economic Association (papers and proceedings).

Jackson, M. "A Survey of Models of Network Formation: Stability and Efficiency," Forthcoming in Group Formation in Economics; Networks, Clubs and Coalitions, edited by G. Demange and M. Wooders, Cambridge University Press.

Keister, L. 1998. "The Emergence of Interorganizational Exchange: The Effects of Uncertainty, Firm Reputation and Cost on Resource Exchange in Chinese Business Groups." University of North Carolina and Ohio State University mimeo.

Keister, L. 2001. "Exchange Structures in Transition: Lending and Trade Relations in Chinese Business Groups. *American Sociological Review*, Vol. 66, No. 3: 336-360. June.

Khanna, T. and K. Palepu. 1999. "Policy Shocks, Market Intermediaries, and Corporate Strategy: the Evolution of Business Groups in Chile and India". *Journal of Economics and Management Strategy*. Vol 8, No. 2: 271-310. Summer.

Khanna, T. 2000. "Business Groups and Social Welfare in Emerging Markets: Existing Evidence and Unanswered Questions." *European Economic Review* (44) 748-761.

Khanna, T. and K. Palepu. 2000a. "The Future of Business Groups in Emerging Markets: Long Run Evidence from Chile." *Academy of Management Journal.* Vol. 43, No. 3: 268-85. June.

Khanna, T. and K. Palepu. 2000b. "Is Group Affiliation Profitable in Emerging Markets? An Analysis of Diversified Indian Business Groups." *Journal of Finance.* Vol 55, No. 2: 867-891. April.

Khanna, T. and J. Rivkin. 2000. "Ties that Bind Business Groups: Evidence from an Emerging Economy". Working Paper, Harvard Business School.

Khanna, T. and J. Rivkin. 2001. "Estimating the Performance Effects of Business Groups in Emerging Markets." *Strategic Management Journal.* 22: 45-74.

Khanna, T. and Y. Yafeh. "Business Groups and Risk Sharing around the World. Working Paper, Harvard Business School.

Leff, N. 1976. "Capital Markets in the Less Developed Countries: The Group Principle." Pp. 97-122 In R. McKinnon, editor. *Money and Finance in Economic Growth and Development.* New York: Marcel Dekker, Inc.

Lincoln, J. and M. Gerlach. 2002. Structure and Change in the Japanese Network Economy: The Form and Consequences of Business Networks. Forthcoming, Cambridge University Press.

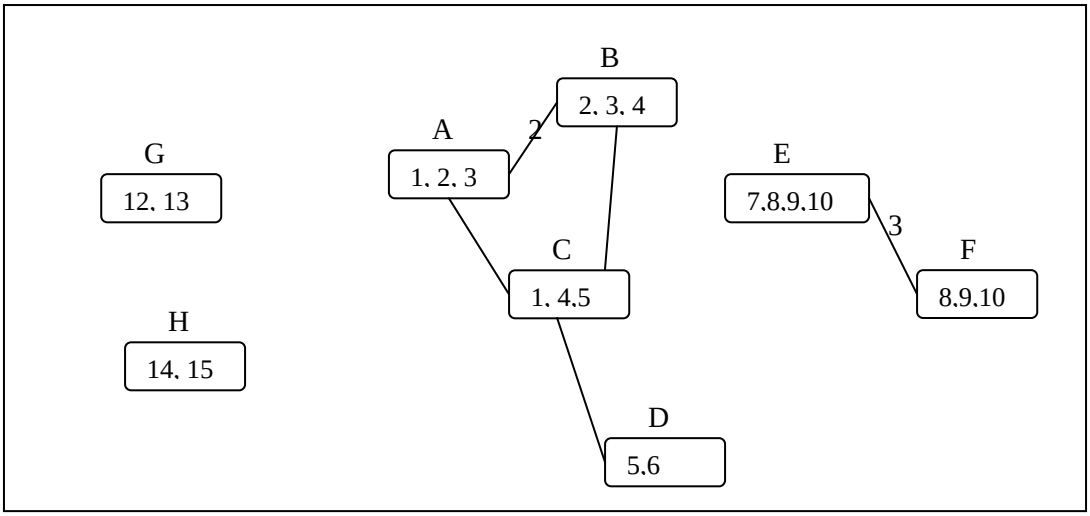
Majluf, N., N. Abarca, D. Rodríguez, and L.A. Fuentes. 1995. "The Ownership of Economic Groups in Chile." Pontifica Catholic University of Chile, Santiago, Chile mimeo.

Watts, D. J., and S. H. Strogatz (1998). "Collective Dynamics of 'Small-World' Networks," Nature, CCCLXXXXIII, 440.

White, L.J. 1974. *Industrial Concentration and Economic Power in Pakistan.* Princeton: Princeton University Press.

FIGURES

Figure I – Constructing Networks



Firms are represented as boxes and labeled using alphabets. Directors are identified as numbers inside the firm boxes. Common directorship is denoted by a connected line between two firms. If firms share more than one director this is represented by a number (number of shared directors >1) above the line.

Figure 2: One Director in Common

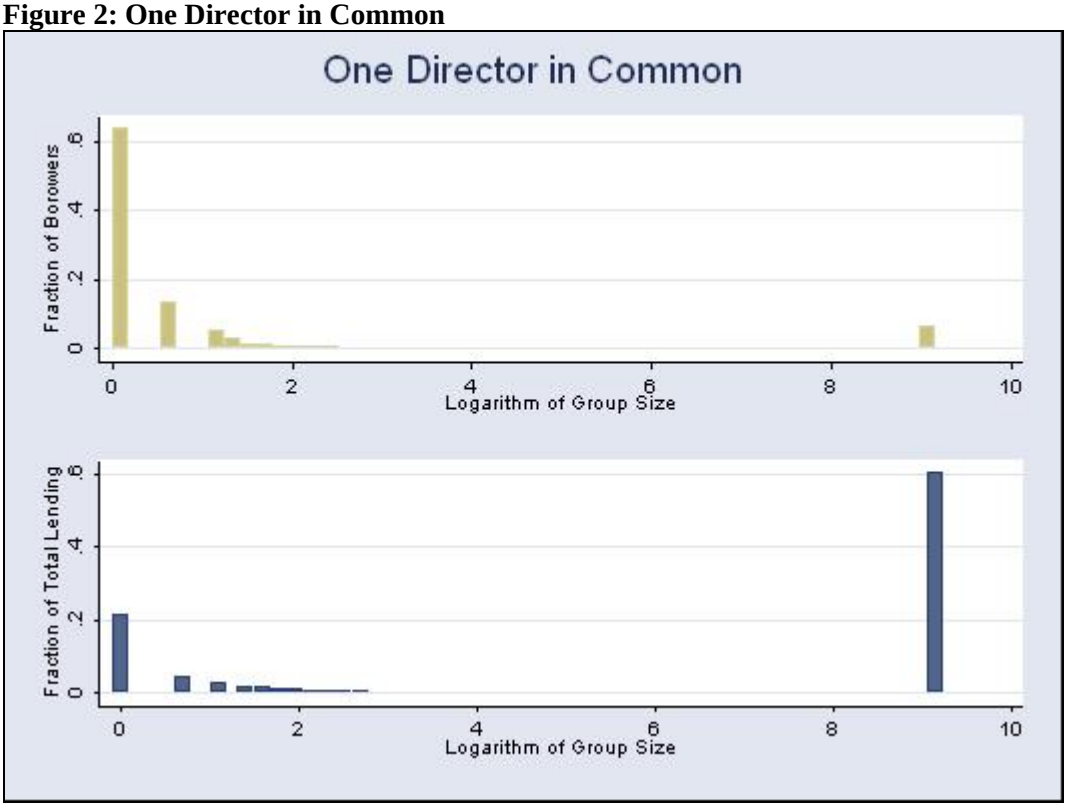


Figure 3: Robustness of Group Distribution to Different Definitions of Groups

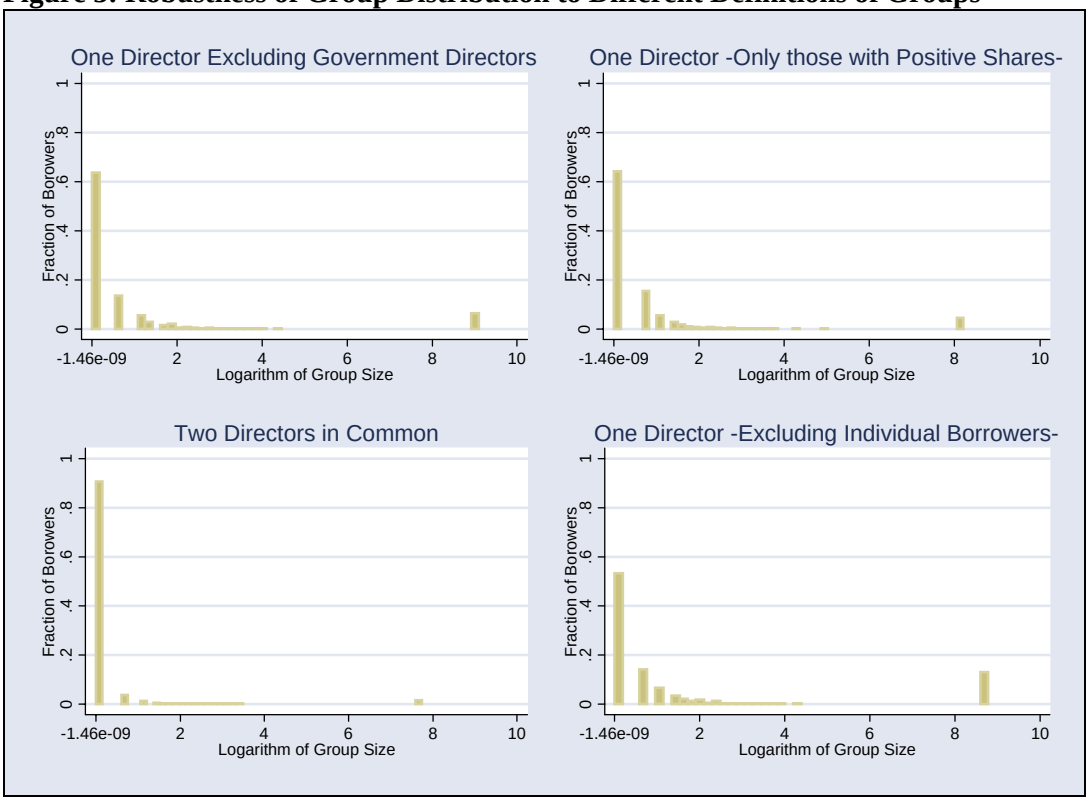


Figure 4: Robustness of Group Borrowing Shares to Different Definitions of Groups

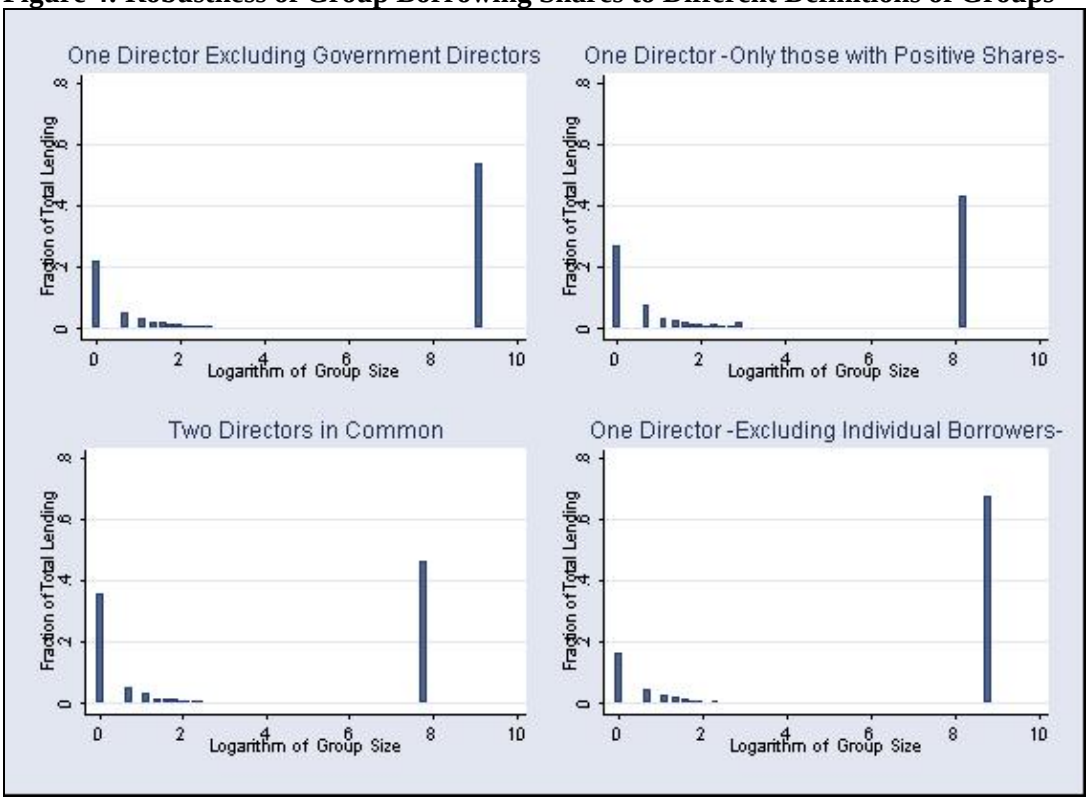


Figure 5: One Director-in-Common. Year by Year

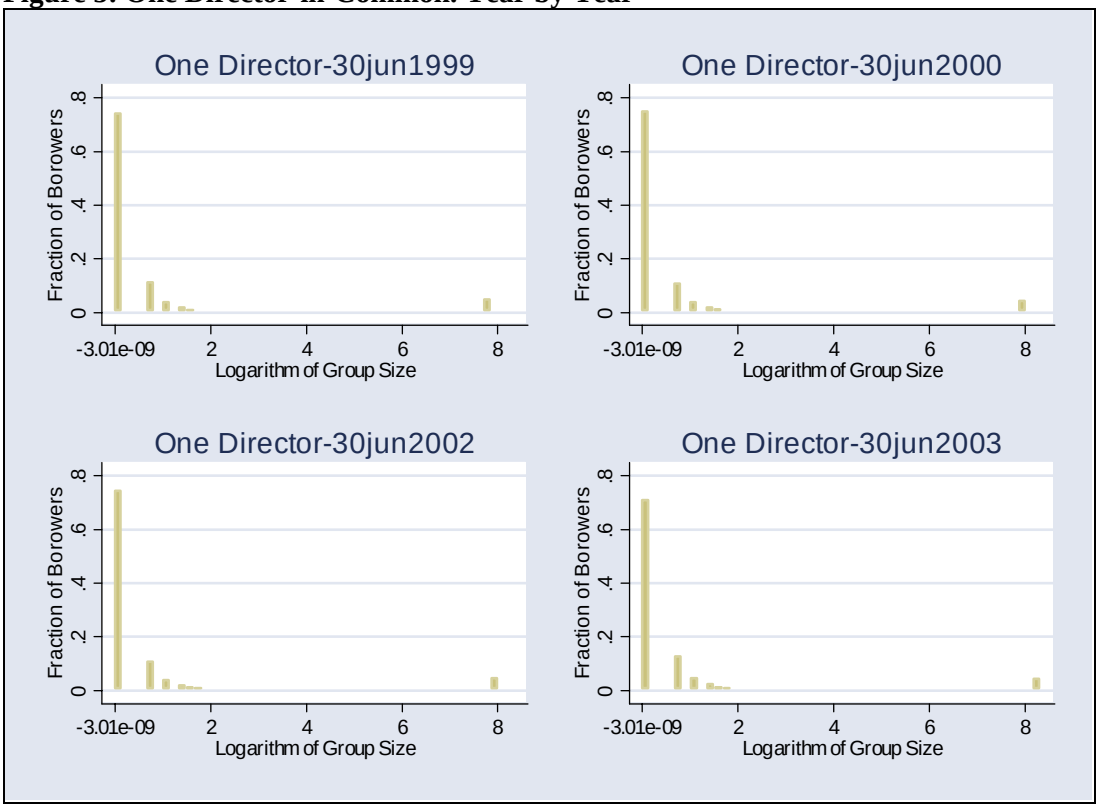


Figure 6: One Director-in-Common. Borrowing Shares Year by Year

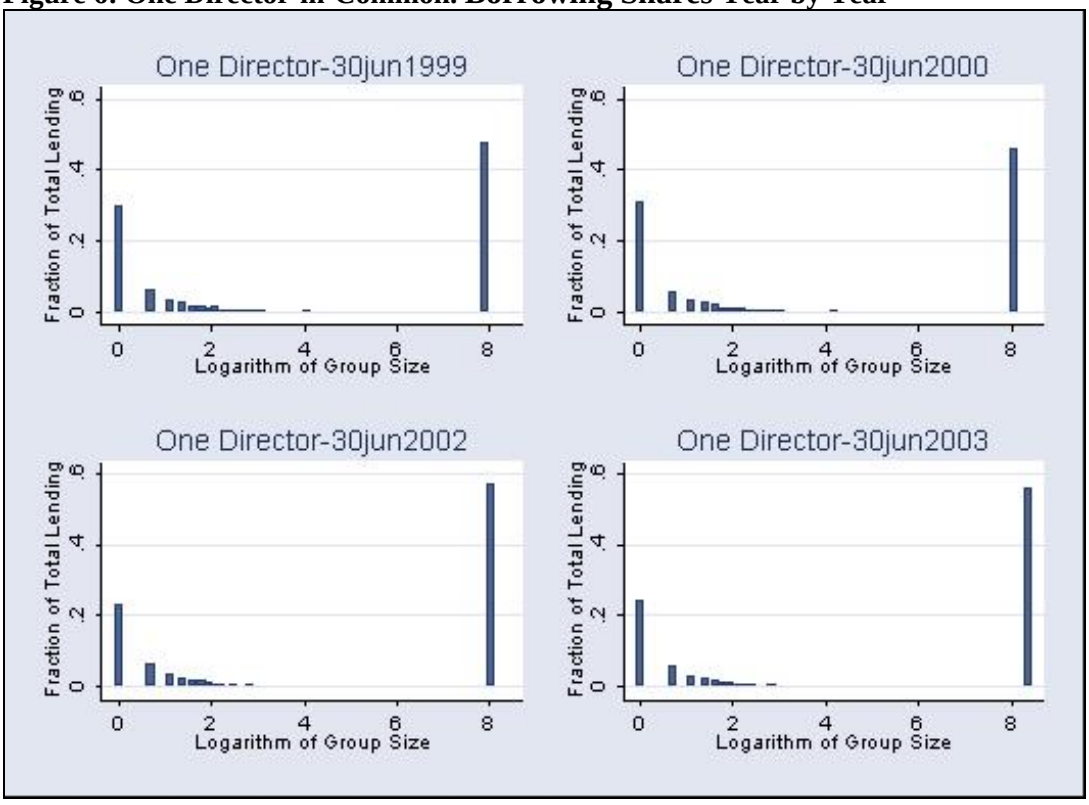


Figure 7: Number of Firms Linked to Each Director

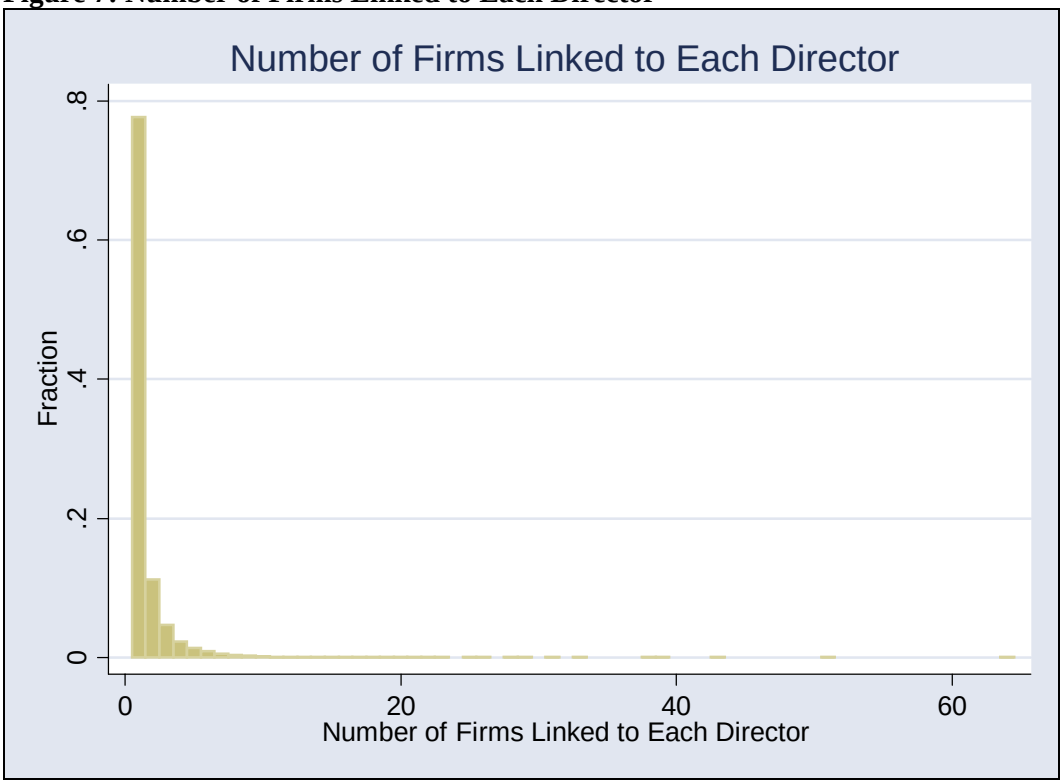


Figure 8: Number of Firms a Given Firm is Linked to Including Itself

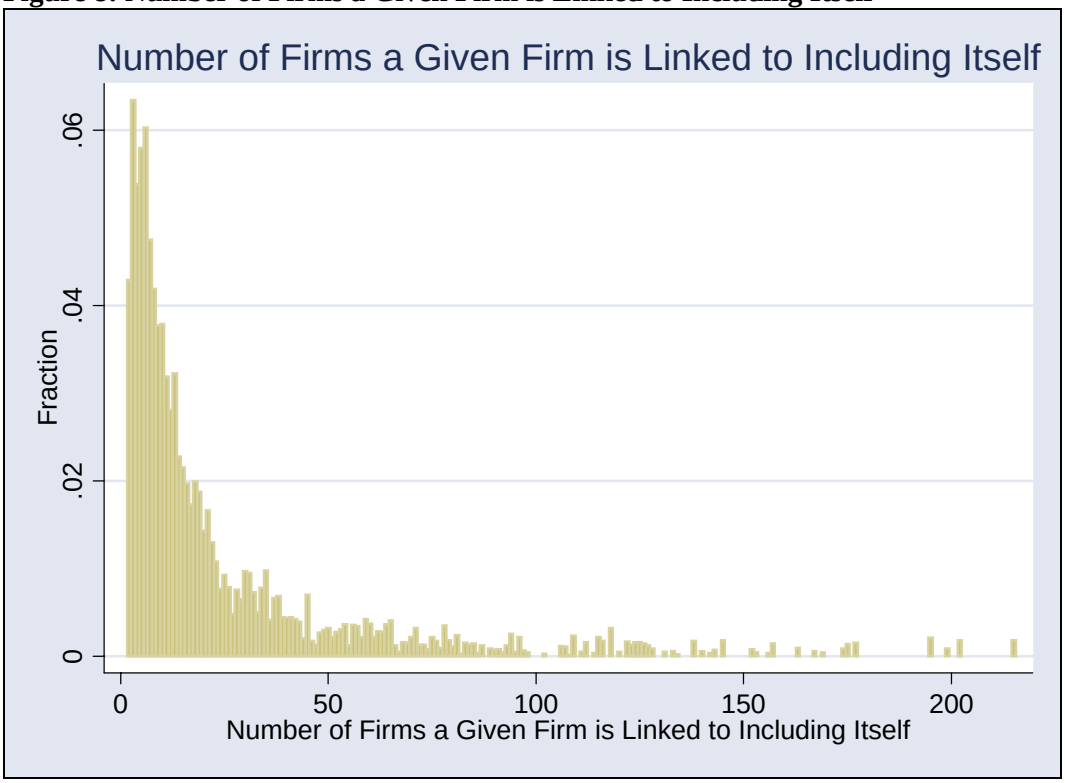


Figure 9: Number of Sub-Groups Formed After Excluding One Director at a Time

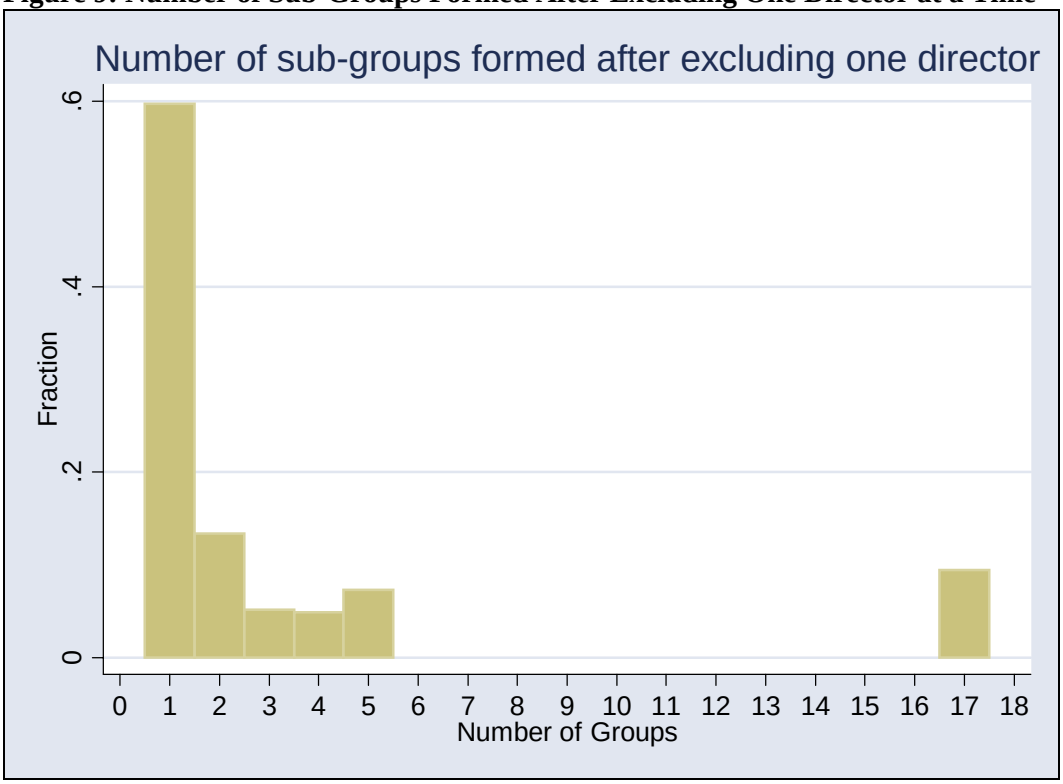


Figure 10: Maximum and Second Maximum Group Relative to Total Number of Firms (Minus One) After Excluding One Director at a Time

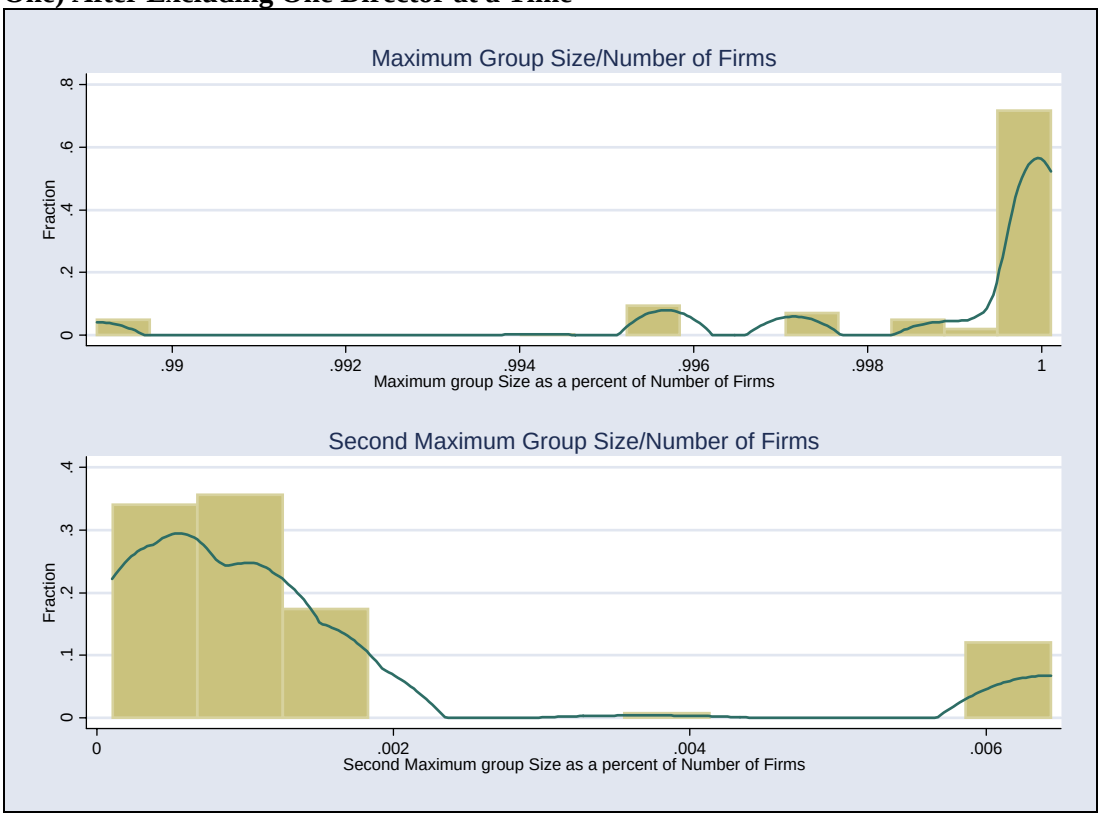


Figure 11: Number of sub-Groups formed after excluding one firm at a time

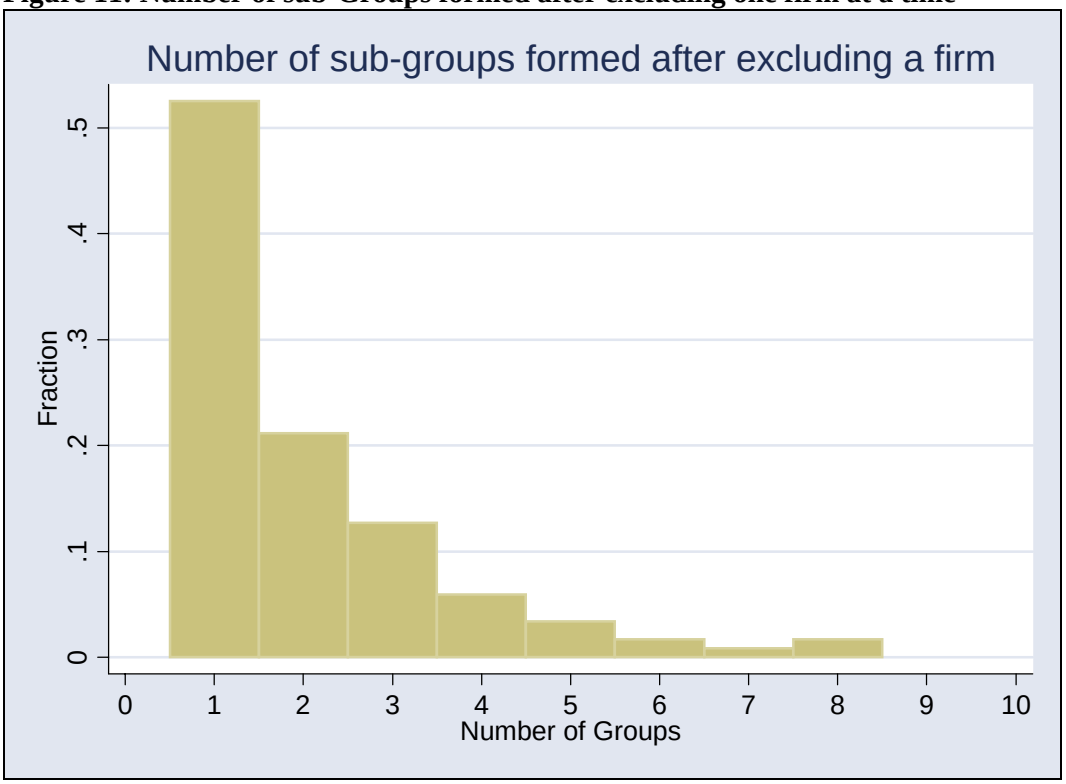
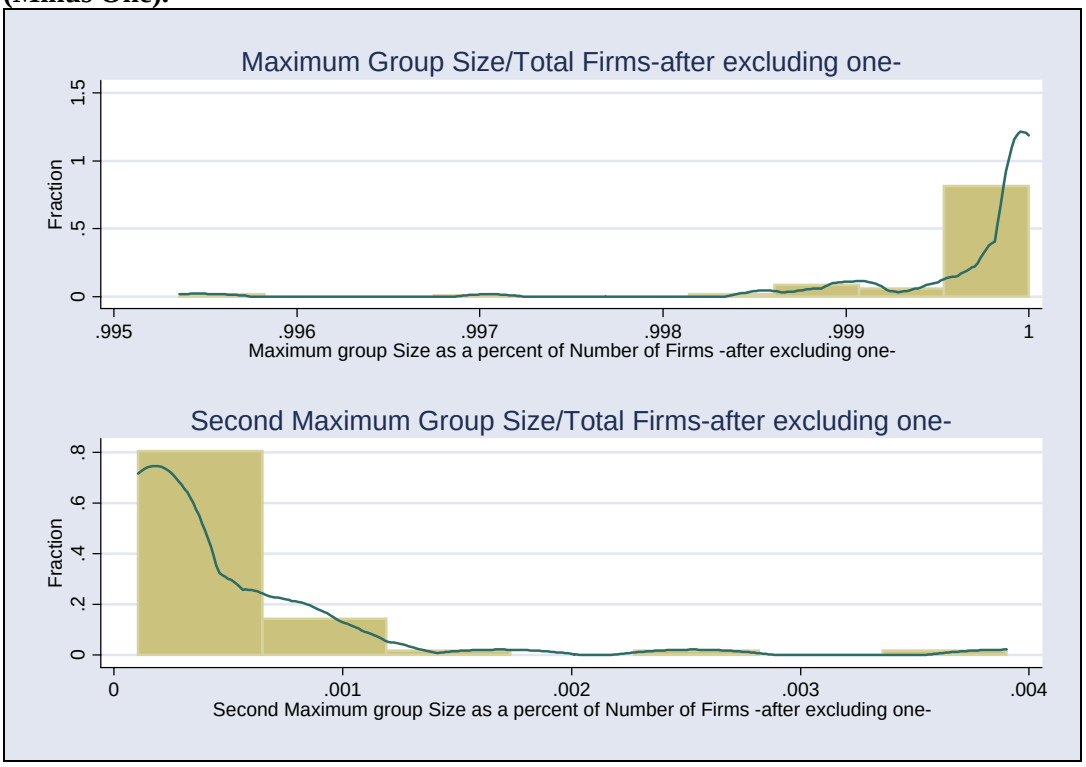


Figure 12: Maximum and Second Maximum Group Size Relative to Total Number of Firms Size (Minus One).



TABLES

Table 1 – Summary Statistics

Variable	Mean	SD	SE (Mean)	N
Log of Total Lending	7.1	1.5	0.0039482	147,094
Ratio of Unfunded Loans over Total Lending	16.3	40.6	0.1058001	147,094
Actual Number of Creditors	3.1	5.9	0.0154375	147,094
Log of Limit for Fund Based Facilities	7.1	1.6	0.0052591	93,864
Default Rate (%)	13.7	29.9	0.0779395	147,094
Recovery Rate(% of Total Lending)	1.8	8.5	0.0278463	93,258
Recovery Rate(% of Default)	13.9	32.0	0.1788565	32,044
Litigation Rate(% of Total Lending)	7.3	25.7	0.0842653	93,258
Litigation Rate(% of Default)	21.5	40.9	0.2283954	32,044

Table 2: Networks and Access to the Financial Markets

DO BIG AND MEDIUM FIRMS HAVE BETTER ACCESS TO THE FINANCIAL MARKETS?

Dependent Variable	Log Total Lending		Number of Different Lenders		% of Unfunded in Total Lending		Log Limit for Fund Based Facilities	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Super-Network Firms	1.99	1.35	8.64	6.36	7.26	1.57	0.4	0.33
	(0.01)	(0.01)	(0.04)	(0.04)	(0.29)	(0.32)	(0.01)	(0.01)
Medium Network Firms	0.65	0.39	1.01	0.53	5.84	1.01	0.17	0.11
	(0.01)	(0.01)	(0.03)	(0.03)	(0.24)	(0.24)	(0.01)	(0.01)
Constant	6.56	7.9	1.29	4.04	13.12	21.29	1.01	1.88
	(0.01)	(0.23)	(0.02)	(0.87)	(0.15)	(7.16)	(0.01)	(0.18)
Controls	NO	YES	NO	YES	NO	YES	NO	YES
R-squared	0.23	0.38	0.29	0.4	0.01	0.13	0.77	0.79
Observations	147,094	147,094	147,094	147,094	147,094	147,094	93,864	93,864

Results based on cross-sectionalized data. A unit of observation is a loan (bank-firm pair). There are 93,864 observations instead of 147,094 in columns (7) and (8) as limit for fund based facilities data is not available for all banks. Standard errors are reported in parentheses. . The omitted category of firms is single or not networked firms. Controls in Columns (2), (4), (6) and (8) include 172 dummies for each lender, 146 dummies for each of the cities/towns where firms borrow from and 20 dummies for the industry of the firm. Controls in columns (7) an d(8) also include firm's total lending.

Table 3: Networks Borrowing Performance

DO BIG AND MEDIUM FIRMS HAVE BETTER BORROWING PERFORMACE?

Dependent Variable	Default Rate (%)		Recovery Rate (% of Default)		Litigation Rate (% of Total Lending)		Insurance (Default Rate -%-)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Super-Network Firms	-10.86	-5.71	4.48	2.93	-9.66	-4.62		
	(0.21)	(0.22)	(0.55)	(0.58)	(0.27)	(0.26)		
Medium Network Firms	-8.49	-3.28	5.2	2.44	-2.94	-1.8		
	(0.17)	(0.17)	(0.42)	(0.40)	(0.19)	(0.19)		
Constant	18.35	2.8	12.04	15.26	-17.51	15.92	5.467	5.135
	(0.11)	(5.04)	(0.23)	(9.65)	(0.43)	(5.58)	(0.76)	(0.76)
City Sister							0.094	0.75
							(0.01)	(0.01)
Borrower Size (by lending) Sister							0.426	0.084
							(0.01)	(0.01)
Industry Sister							0.20	0.40
							(0.01)	(0.01)
Type of Firm Sister							1.05	0.287
							(0.06)	(0.01)
City Sister * Super-Network Firm							-0.059	-0.796
							(0.02)	(0.01)
Borrower Size (by lending) Sister * Super-Network Firm							-0.356	-0.407
							(0.02)	(0.02)
Industry Sister * Super-Network Firm							-0.131	-0.299
							(0.02)	(0.01)
Type of Firm Sister * Super-Network Firm							-0.727	-0.028
							(0.03)	(0.02)
Controls	NO	YES	NO	YES	NO	YES	YES	YES
R-squared	0.03	0.21	0.01	0.27	0.04	0.14	0.75	0.76
Observations	147,094	147,094	32,044	32,044	93,258	93,258	1,023,500	968,764

Results based on cross-sectionalized data. A unit of observation is a loan (bank-firm pair). There are 32,044 observations in columns (3) and (4) because data in conditional on a firm having defaulted. Also, there are 93,864 observations instead of 147,094 in columns (7) and (8) as litigation data is not available for all banks. Standard errors are reported in parentheses. The omitted category of firms is single or not networked firms. Controls in Columns (2), (4) and (6) include 172 dummies for each lender, 146 dummies for each of the cities/towns where firms borrow from and 20 dummies for the industry of the firm. Controls in column (5) and also include firm's total lending. In Columns (7) and (8) we are using a different dataset. We have constructed sister variables for each of the following characteristics: City/town were the firms borrows from, industry of the firm, Size of the firm (by the amount it bowwows) and type of firm (whether is a government, foreign or domestic firm). Therefore, the coefficient for the variable city represents how a small firm reacts to a shock of total lending in its city. Similarly, the variable Super Network * city represents how a firm in the super network react

For control, we also included in the regressions interaction terms of all sister variables with firms in medium networks as well as the constant term. We do not include them here for presentation purposes. However, it is worth mentioning the firms in medium networks also show some insurance, though much smaller than super network firms. Column (7) is the un-weighted version and in Column (8) we weight by total lending

Table 4: Super-Network after excluding all directors above a threshold

Director Count	Remaining Firms	Number of Groups	Maximum Group Size	Second Maximum Group Size	Maximum Group Size/Total number of Firms	Second Maximum Group Size / Total number of Firms	Maximum Group (% of Total Lending)	Second Maximum Group (% of Total Lending)
51	9479	1	9,479	0	100%	0.000%	60.508%	0.000%
43	9479	1	9,479	0	100%	0.000%	60.508%	0.000%
39	9472	17	9,437	7	99.641%	0.074%	60.502%	0.000%
33	9470	17	9,435	7	99.641%	0.074%	60.502%	0.000%
31	9470	17	9,435	7	99.641%	0.074%	60.502%	0.000%
29	9470	20	9,331	61	98.543%	0.644%	60.376%	0.063%
26	9464	20	9,325	61	98.542%	0.645%	60.359%	0.063%
25	9463	23	9,311	61	98.404%	0.645%	60.348%	0.063%
23	9459	32	9,255	61	97.854%	0.645%	60.237%	0.063%
21	9456	37	9,241	61	97.737%	0.645%	60.215%	0.063%
19	9449	41	9,228	61	97.671%	0.646%	60.161%	0.063%
17	9440	51	9,155	61	96.991%	0.646%	60.034%	0.063%
15	9431	58	9,121	61	96.723%	0.647%	59.774%	0.063%
13	9392	84	8,974	61	95.560%	0.650%	59.577%	0.063%
11	9347	107	8,848	61	94.672%	0.653%	59.421%	0.063%
9	9250	204	8,459	61	91.459%	0.660%	58.858%	0.063%
7	9086	384	7,538	54	82.972%	0.594%	57.392%	0.049%
5	8646	834	5,461	77	63.169%	0.891%	52.437%	0.221%
3	7682	1,981	1,819	76	23.682%	0.989%	33.434%	0.532%
1	5133	5,133	1	0	0.019%	0.000%	57.812%	0.000%

Table 5: Super-Network after Excluding all firms above a threshold

Firm Count	Remaining Firms	Number of Groups	Maximum Group Size	Second Maximum Group Size	Maximum Group Size/Total number of Firms	Second Maximum Group Size / Total number of Firms	Maximum Group (% of Total Lending)	Second Maximum Group (% of Total Lending)
202	9,479	8	9,465	6	99.863%	0.063%	60.146%	0.001%
177	9,476	9	9,461	6	99.852%	0.063%	59.061%	0.001%
169	9,473	12	9,455	6	99.821%	0.063%	57.829%	0.001%
157	9,470	13	9,449	6	99.789%	0.063%	57.595%	0.001%
152	9,467	22	9,391	24	99.208%	0.254%	57.297%	0.011%
142	9,463	26	9,382	24	99.155%	0.254%	57.094%	0.011%
131	9,458	31	9,365	24	99.027%	0.254%	56.797%	0.011%
122	9,446	44	9,331	24	98.793%	0.254%	55.956%	0.011%
112	9,433	59	9,280	24	98.388%	0.254%	54.442%	0.011%
102	9,423	70	9,229	24	97.952%	0.255%	53.355%	0.011%
92	9,408	86	9,156	24	97.332%	0.255%	52.691%	0.011%
82	9,390	111	9,055	37	96.443%	0.394%	51.958%	0.031%
72	9,357	144	8,954	37	95.703%	0.395%	49.129%	0.031%
62	9,310	176	8,780	37	94.317%	0.397%	45.113%	0.031%
52	9,214	249	8,274	98	89.808%	1.064%	42.614%	0.230%
42	9,118	323	7,723	133	84.710%	1.459%	38.245%	0.074%
32	8,961	490	6,727	133	75.078%	1.484%	31.296%	0.074%
22	8,641	842	2,977	197	34.456%	2.280%	10.844%	0.630%
12	7,580	1,812	67	54	0.884%	0.713%	0.150%	0.084%
2	1,227	1,227	1	0	0.082%	0.000%	1.846%	0.000%

APPENDIX

Appendix Table 1: Robustness of Group Distribution to Different Definitions of Groups

Group Size/ Frequency	One director in common	Excluding governemnt directors	Positive shares	Two directors in common	Excluding individual borrowers
1	88,907	88,961	52,281	126,614	26,638
2	18,916	18,942	12,558	5,420	7,096
3	7,791	7,815	4,656	1,869	3,285
4	4,036	4,044	2,340	896	1,684
5	2,295	2,320	1,440	525	1,090
6	1716	1752	840	426	672
7	1162	1183	749	336	539
8	904	928	344	192	368
9	666	684	423	144	288
10	600	600	280	180	280
11	363	374	209	110	198
12	312	336	264	144	144
13	208	195	104	39	91
14	252	252	84	84	56
15	345	360	165	30	75
16	160	160	128	0	80
17	153	170	85	17	0
18	72	72	108	18	36
19	114	114	38	0	57
20	0	0	80	20	60
21	21	42	0	0	42
22	66	66	0	22	22
23	69	69	23	0	23
24	72	72	72	0	24
25	100	100	25	0	0
26	52	52	0	52	0
27	108	108	54	54	0
28	28	28	56	0	56
30	0	0	0	0	30
31	0	0	31	31	0
32	32	32	0	0	32
33	0	0	33	0	66
35	0	35	0	0	0
36	0	0	36	0	0
38	38	38	0	0	0
40	40	40	0	0	0
41	0	0	0	0	41
42	42	42	0	0	0
43	43	43	0	0	0
46	46	46	46	0	0
47	47	47	47	0	0
50	50	50	0	0	50
55	55	55	0	0	55
69	0	0	0	0	69
74	0	0	74	0	0
80	80	80	0	0	0
85	85	85	0	0	0
135	0	0	0	0	0
149	0	0	149	0	0
2303	0	0	0	2303	0
3700	0	0	3700	0	0
6603	0	0	0	0	6603
8936	0	8936	0	0	0
9480	9480	0	0	0	0
TOTAL	139,526	139,328	81,522	139,526	49850

Appendix Table 2 : One Director In Common for Each Period

Group Size/ Frequency	Jun-99	Jun-00	Jan-01	Jun-01	Jan-02	Jun-02	Jan-03	Jun-03
1	40,874	55,111	62,345	39,381	49,019	50,516	58,793	70,646
2	6,154	7,980	9,368	5,206	7,588	7,350	9,572	12,668
3	2091	2790	3198	1923	2670	2676	3507	4677
4	984	1432	1592	864	1344	1384	1604	2288
5	535	820	940	565	865	805	1040	1300
6	378	438	618	348	450	558	660	924
7	322	371	420	280	357	357	434	616
8	216	312	240	160	208	224	320	360
9	135	198	306	126	225	171	225	297
10	140	150	210	70	170	110	190	270
11	110	121	154	55	99	121	110	187
12	36	60	84	60	96	84	72	168
13	52	52	65	52	104	52	117	130
14	98	56	56	56	14	112	112	98
15	90	105	45	15	45	45	15	75
16	16	112	160	34	64	48	64	96
17	17	68	85	0	0	34	34	102
18	36	36	36	0	54	0	54	18
19	0	19	38	0	19	0	0	57
20	20	40	0	0	20	40	0	0
21	21	84	21	0	21	0	63	42
22	22	22	66	0	22	0	22	0
23	0	0	23	23	23	23	23	69
24	0	24	48	0	0	0	0	0
25	25	0	0	0	0	0	25	75
26	0	0	26	0	0	0	0	52
27	0	0	0	0	0	0	27	0
28	0	0	28	0	0	0	0	0
29	0	0	0	58	0	0	0	0
30	0	0	0	0	0	0	30	30
31	0	0	0	0	0	0	0	31
32	0	0	0	0	32	32	0	32
35	35	35	0	0	0	35	0	0
38	0	0	0	0	0	0	0	0
40	0	0	0	0	40	0	38	0
44	0	0	44	0	0	0	0	44
58	58	0	0	0	0	0	0	0
66	0	66	0	0	0	0	0	0
67	67	0	0	0	0	0	0	0
71	0	0	0	0	0	0	0	0
73	0	73	0	0	0	0	0	0
111	0	0	0	0	0	0	0	0
2596	0	0	0	2596	0	0	0	0
2641	2641	0	0	0	0	0	0	0
3083	0	0	0	0	0	3083	0	0
3144	0	3144	0	0	0	0	0	0
3238	0	0	0	0	3238	0	0	0
3483	0	0	0	0	0	0	3483	0
3715	0	0	3715	0	0	0	0	0
4223	0	0	0	0	0	0	0	4254
Total	55,173	73,719	83,931	51,872	66,787	67,860	80,634	99,606

Appendix Table 3: Super-Network – Directors and Firm Links

Director Count	Frequency
1	34,945
2	5,042
3	2104
4	1044
5	615
6	405
7	227
8	154
9	104
10	92
11	53
12	38
13	28
14	24
15	25
16	15
17	4
18	6
19	6
20	7
21	4
22	5
23	4
25	5
26	2
28	1
29	1
31	2
33	1
38	1
39	1
43	1
51	1
64	1
Total	44,968

Firm Count	Frequency	Firm Count	Frequency	Firm Count	Frequency
2	1,227	48	9	95	2
3	1,367	49	9	96	3
4	1074	50	4	97	1
5	917	51	6	98	1
6	797	52	6	102	1
7	576	53	7	106	2
8	449	54	7	107	1
9	361	55	5	108	1
10	332	56	13	109	2
11	276	57	15	111	1
12	204	58	13	112	3
13	190	59	14	114	1
14	165	60	7	114	1
15	140	61	4	115	4
16	129	62	11	116	1
17	84	63	4	118	4
18	93	64	8	120	1
19	86	65	7	122	2
20	61	66	3	123	3
21	52	67	2	124	2
22	61	68	4	125	2
23	37	69	2	126	2
24	29	70	3	127	1
25	32	71	9	128	1
26	31	72	5	131	1
27	23	73	3	133	1
28	37	74	2	134	1
29	34	75	6	138	1
30	29	76	4	140	1
31	39	77	2	142	1
32	29	78	3	143	1
33	19	79	3	145	2
34	27	80	3	152	1
35	26	81	5	153	1
36	15	82	2	156	1
37	14	83	3	157	1
38	14	84	3	163	1
39	13	85	2	167	1
40	10	86	1	169	1
41	7	87	4	174	1
42	12	89	1	175	1
43	25	90	2	177	1
44	8	91	1	195	1
45	17	92	1	199	1
46	5	93	2	202	1
47	7	94	5	215	1
				Total	9,480

Firm count represents number of firms a borrower is connected to through at least one director within the Super-Network (includes firm itself)

Director Count represents number of firms connected to each director i.e. are there "super directors"

Appendix Table 4: Big Group after excluding one director[9]

Director Count	Number of Groups	Maximum Group Size	Second Maximum Group Size	Maximum Group Size/Total number of Firms	Second Maximum Group Size / Total number of Firms	Maximum Group (% of Total Lending)	Second Maximum Group (% of Total Lending)
64	1	9,479	0	100%	0.000%	60.508%	0.000%
51	1	9,480	0	100%	0.000%	60.509%	0.000%
43	17	9,438	7	100%	0.074%	60.503%	0.000%
39	1	9,480	0	100%	0.000%	60.509%	0.000%
38	1	9,478	0	100%	0.000%	60.509%	0.000%
33	1	9,480	0	100%	0.000%	60.509%	0.000%
31	1	9,480	0	100%	0.000%	60.509%	0.000%
31	4	9,376	61	99%	0.644%	60.384%	0.063%
29	1	9,476	0	100%	0.000%	60.492%	0.000%
28	1	9,478	0	100%	0.000%	60.509%	0.000%
26	2	9,468	11	100%	0.116%	60.498%	0.011%
26	3	9,478	1	100%	0.011%	60.509%	0.000%
25	5	9,452	15	100%	0.158%	60.438%	0.014%
25	1	9,480	0	100%	0.000%	60.509%	0.000%
25	3	9,473	4	100%	0.042%	60.488%	0.021%
25	2	9,476	2	100%	0.021%	60.498%	0.000%
23	1	9,480	0	100%	0.000%	60.509%	0.000%
23	2	9,479	1	100%	0.011%	60.509%	0.000%
23	2	9,475	5	100%	0.053%	60.502%	0.007%
22	1	9,479	0	100%	0.000%	60.509%	0.000%
22	1	9,479	0	100%	0.000%	60.509%	0.000%
22	1	9,479	0	100%	0.000%	60.501%	0.000%
22	3	9,478	1	100%	0.011%	60.503%	0.006%
21	1	9,480	0	100%	0.000%	60.509%	0.000%
21	1	9,477	0	100%	0.000%	60.506%	0.000%
20	1	9,480	0	100%	0.000%	60.509%	0.000%
20	2	9,478	1	100%	0.011%	60.509%	0.000%
20	1	9,479	0	100%	0.000%	60.507%	0.000%
20	1	9,479	0	100%	0.000%	60.509%	0.000%
19	5	9,424	35	99%	0.369%	60.478%	0.012%
19	1	9,480	0	100%	0.000%	60.509%	0.000%
19	2	9,476	2	100%	0.021%	60.507%	0.000%
19	3	9,478	1	100%	0.011%	60.509%	0.000%

[9] The first column, Director Count, represents the number of firms connected to each director. In this exercise, we dropped one by one each director connected to over 20 firms. The following columns are some statistics that we calculate after taking out each director: number of groups in the new network structure, maximum and second maximum group size, percentage of total firms that belong to the super-network, percentage of firms that belong to the second largest group and total lending concentrated in the super network and the second largest network.

Appendix Table 5: Big Group after excluding one firm[10]

Firm Count	Number of Groups	Maximum Group Size	Second Maximum Group Size	Maximum Group Size/Total number of Firms	Second Maximum Group Size / Total number of Firms	Maximum Group (% of Total Lending)	Second Maximum Group (% of Total Lending)
215	8	9,465	6	99.85%	0.063%	60.146%	0.001%
202	2	9,478	1	99.99%	0.011%	59.854%	0.016%
199	1	9,479	0	100.00%	0.000%	60.477%	0.000%
177	2	9,478	1	99.99%	0.011%	60.178%	0.000%
175	2	9,478	1	99.99%	0.011%	59.762%	0.000%
169	2	9,476	3	99.97%	0.032%	60.471%	0.001%
167	1	9,479	0	100.00%	0.000%	60.455%	0.000%
163	1	9,479	0	100.00%	0.000%	60.367%	0.000%
156	3	9,466	8	99.86%	0.084%	60.463%	0.003%
153	1	9,479	0	100.00%	0.000%	60.451%	0.000%
152	2	9,478	1	99.99%	0.011%	60.470%	0.000%
143	2	9,478	1	99.99%	0.011%	60.469%	0.020%
140	1	9,479	0	100.00%	0.000%	60.424%	0.000%
138	3	9,477	1	99.98%	0.011%	60.369%	0.000%
133	1	9,479	0	100.00%	0.000%	60.493%	0.000%
131	1	9,479	0	100.00%	0.000%	60.491%	0.000%
128	2	9,478	1	99.99%	0.011%	60.477%	0.000%
126	1	9,479	0	100.00%	0.000%	60.478%	0.000%
126	4	9,468	8	99.88%	0.084%	60.453%	0.012%
125	2	9,478	1	99.99%	0.011%	60.428%	0.000%
124	2	9,478	1	99.99%	0.011%	60.424%	0.000%
120	2	9,478	1	99.99%	0.011%	60.493%	0.000%
118	3	9,470	8	99.91%	0.084%	60.240%	0.006%
115	2	9,477	2	99.98%	0.021%	60.468%	0.006%
112	1	9,479	0	100.00%	0.000%	60.436%	0.000%
109	1	9,479	0	100.00%	0.000%	60.475%	0.000%
108	1	9,479	0	100.00%	0.000%	60.509%	0.000%
107	4	9,474	3	99.95%	0.032%	60.116%	0.001%
98	1	9,479	0	100.00%	0.000%	60.472%	0.000%
96	7	9,451	16	99.70%	0.169%	60.471%	0.015%
93	4	9,475	2	99.96%	0.021%	60.405%	0.000%
90	6	9,435	37	99.54%	0.390%	60.476%	0.031%
87	1	9,479	0	100.00%	0.000%	60.453%	0.000%
86	3	9,477	1	99.98%	0.011%	60.503%	0.000%
84	1	9,479	0	100.00%	0.000%	60.462%	0.000%
83	5	9,471	4	99.92%	0.042%	60.481%	0.009%
81	3	9,468	10	99.88%	0.106%	60.424%	0.029%
79	1	9,479	0	100.00%	0.000%	60.499%	0.000%
78	1	9,479	0	100.00%	0.000%	60.478%	0.000%
76	1	9,479	0	100.00%	0.000%	60.465%	0.000%
75	1	9,479	0	100.00%	0.000%	60.506%	0.000%

Firm count represents number of firms a borrower is connected to through at least one director within the Super-Network (includes firm itself)

[10] Please see Appendix Table 4 for a detailed explanation of the statistics in this Table. For design purposes we have not included in the table all the firms that have been taken out. Figures 11 and 12 do include all available information.