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In the usual course of economic activity, economic agents become linked in many ways. Many of the linkages create networks where the actions of individual network members have significant effects on the well-being of the other members of the network. Among the most important issues in the analysis of networks are the coordination of the actions of the network members and the sustainability of the network. In particular, an important question concerns the motivation underlying any observed cooperation among network members. What is the relative importance of social norms compared to economic incentives in producing that cooperation?

Empirical research on the source motivating network coordination, however, faces a severe identification problem. For example, observed cross-sectional differences in the nature of network coordination across countries may be as easily attributed to the differences in the cultures or social norms across these countries as by differences in their economic environments. Furthermore, empirical tests are hampered by the paucity of micro-level data on individual members of functioning networks.

The key to both the coordination of the actions of the network members and the sustainability of the network itself is a commitment mechanism. Such a commitment mechanism may be provided by social norms as well as by economic incentives. As long as parties have potential gains from coordinating through repeated interactions, reciprocity provides an economic commitment mechanism. Reciprocity has two general forms: bilateral reciprocity and system reciprocity. Bilateral reciprocity dictates that a pair of individuals with direct network links will take actions consistent with the cooperative outcome as long as the other party does not defect from the cooperative outcome. System reciprocity is more general insofar as the reciprocating behavior can come from any network member, rather than requiring a direct link between each pair of network members.

Under the premise that social norms govern the coordination of the network, to the extent that social norms are slow to change, we should not observe drastic changes in the tendency of network members to cooperate with each other as economic conditions change. Even if social norms do change with changes in economic conditions, the premise that social norms govern network coordination implies that all network members should change their behavior similarly.

In contrast, the premise that the economic incentives underlying reciprocity govern the cooperative behavior of network members has some cross-sectional implications. First, with respect to system reciprocity, the greater is the member's reliance on the network, and thus the greater is the member's commitment to the network, the greater the incentive to cooperate with other network members, both to ensure reciprocation from other members and to enhance the sustainability of the network. Second, given a member's network reliance, the degree of that member's cooperation with another member of the network will be higher the greater the expected benefits from the bilateral reciprocity by that member. Third, when adverse shocks impact the network, those members that benefit the least from the network, and thus also are least committed to the network, are more likely to reduce their network cooperation, or to even defect from the network. Thus, as the network itself or the individual members of the network come under increasing stress, it becomes more important for the members to signal their commitment to the network through their actions in order to ensure reciprocity from other network members.

We exploit a unique dataset of Japanese bank lending behavior that reflects the behavior of individual members of an existing network in order to provide empirical evidence on the determinants of coordination among network members. In the Japanese main bank system, individual banks lend to overlapping sets of firms. Thus, at a point in time, any given pair of

banks may share many borrowers as loan clients, creating a lending network through which the lenders become interdependent. This interdependence of lenders creates externalities, insofar as the extent to which one bank does or does not make credit available to a given firm affects that firm's economic performance, impacting the quality of the outstanding loans made to that firm not only by that bank but also those made by the other network lenders to the firm. Because main banks also serve as secondary lenders to many firms, by focusing on their behavior as secondary lenders we can exploit the differences in the degree to which a bank relies on, and thus is committed to, the network.

Japan provides an ideal laboratory for the examination of the determinants of coordinated lending within a network for a number of reasons. First, and foremost, Japan has a well-defined lending network where banks share many firms as loan clients. Second, the data set we use in this study is particularly appropriate for the study of network coordination, being composed of data for loans to each listed Japanese firm by each of the individual Japanese banks that lend to that firm. Third, because individual banks differ in the degree to which their lending occurs as a firm's main bank, banks differ in the degree to which they are committed to the network, and thus in the strength of the economic incentives they face to cooperate in their role as a secondary lender to a firm with that firm's main bank. Fourth, significant cross-sectional and temporal variation in the strength of the bilateral links that are induced by common loan portfolios is present. Such variation helps identify the role of economic incentives, if any, in the coordination of lending. Fifth, the prolonged malaise of the Japanese economy during the 1990s provides an opportunity to investigate the behavior of a network under adverse conditions, since the change in the environment from the more prosperous 1980s altered the economic incentives faced by network members. Sixth, a significant proportion of Japanese firms have "keiretsu" affiliations

with their largest lender, their main bank. A comparison of lending to same-keiretsu firms with that to firms not in the same keiretsu as their main bank can provide evidence on how additional economic incentives impact the degree of cooperation exhibited by secondary lenders to a firm.

Using a detailed panel dataset, we provide very strong evidence that economic incentives, as opposed to social norms, play the dominant role in the coordination of lending in Japan during two very different time periods. First, we find that both main bank and secondary bank reciprocity matter in the 1990s, and that they matter more for keiretsu firm portfolios than for independent firm portfolios. Bilateral reciprocity matters for both the 1980s and the 1990s.

Taken together, our results cast serious doubt on the hypothesis that social norms govern cooperation in the lending network for a number of reasons. First, if social norms governed cooperation, one should not observe much cross-sectional variation in the role of system and bilateral reciprocity. Second, the time-series variation in the role of system reciprocity is not consistent with social norms. We observe that secondary banks with the greatest commitment to the network substantially increased their cooperation with main banks in the 1990s as the network came under duress. We interpret this result as reflecting the need for the secondary banks with the most dependence on the network to signal to the network that they were still committed to the network.

In the remainder of the paper, Section I contains a background discussion of the coordination of networks and Japanese banking. Section II develops the hypotheses to be tested, and discusses our data set and empirical specification. Section III presents our empirical results. Section IV contains conclusions.

I. Background

Agents repeatedly interact with each other in the course of economic activity. An important part of these interactions takes place anonymously through markets where the actions of agents affect the other agents only indirectly through the price mechanism. To the extent that agents are atomistic, in the sense of having a very small effect on the outcome, economic theory predicts that the non-cooperative behavior of agents can result in an outcome that would have obtained under full cooperation. As early as Cournot's (1838) model of duopoly, however, economists have recognized that non-cooperative interactions of agents may not always produce this cooperative outcome when the actions of agents have direct effects on the well-being of others.

While the theoretical work on network design and network formation is quite advanced (for example, Ellison 1993; Jackson and Wolinsky 1996; Bala and Goyal 2000; Ely 2002; Goyal and Vega-Redondo 2005), empirical work on network coordination is limited primarily to the experimental domain (for example, Corbae and Duffy 2004; Heinemann, Nagel and Ockenfels 2004). While experimental studies are important in highlighting the strong and weak points of the theory, by their very nature, they are limited in their ability to predict the outcomes of much more complicated interactions between individual agents that are members of existing networks. The dearth of such empirical studies on this important issue is due to the lack of suitable data on the bilateral and multilateral interactions of individual network members. The few empirical studies that exist concentrate on the mutual insurance systems in developing economies (for example, Fafchamps and Lund 2002; La Ferrara 2003).

In the context of lending networks, banks may be linked through their bilateral exposures created by the payment system and interbank lending. Such linkages impose potential costs to banks due to the danger of financial contagion (for example, Allen and Gale 2000). Leitner

(2005), however, shows that in the spirit of Goyal and Vega-Redondo (2005) and Bala and Goyal (2000), the threat of contagion is precisely the reason behind the formation of the network and is typically an integral part of network design. When the threat of contagion is present, banks that are not subject to adverse shocks have incentives to bail out the banks that were less fortunate in order to prevent the collapse of the entire network. In order to benefit from the scope of mutual insurance provided by the network, banks may be willing to form links, even though such links create the threat of contagion.

Because Japan is a bank-centered economy and is characterized by a main bank system, it provides an ideal laboratory for investigating how, and how well, an existing network functions, as well as distinguishing between social/cultural norms and economic incentives as the underlying forces that sustain the cooperative behavior of network members. In the main bank system, a firm's main bank has a particularly close relationship with the firm that typically includes cross-shareholding and board of directors relationships, as well as a lending relationship. However, this relationship also comes with certain responsibilities for the main bank. For example, the main bank is expected to serve as the delegated monitor of the firm for secondary banks that also lend to the firm (for example, Kaplan and Minton 1994) and to take a leading role in restructuring the firm should it experience financial difficulties, for example, by requiring changes in management and/or altering the board of directors (Kang and Shivdasani 1995; Morck and Nakamura 1999).

Thus, a Japanese bank has a special responsibility for those firms for which it serves as the main bank arising from some combination of social obligation and economic incentives. However, banks that serve as a main bank to some firms also serve as secondary lenders to many other firms, in which case the motivations and responsibilities underlying their lending behavior

likely differ, at least in degree, from those in their role as a main bank. Because banks lend to large numbers of firms and a given firm typically borrows from a number of lenders, these banks form a network. The interdependencies among the lenders arises from the fact that a given bank's willingness to lend to a given firm, especially a troubled firm, affects the firm's performance, and thus the ability of the firm to make timely interest payments and repayments of principal to other lenders. Furthermore, the economic incentive of a secondary lender to a firm to cooperate with the firm's main bank (and the other secondary lenders) in providing loans to a firm is related to the degree to which the secondary lender relies on other network banks to cooperate with it in its role as the main bank to other firms. In other words, the larger a bank's role as a main bank, the greater its potential reliance on other network lenders in their role as secondary lenders to its main bank firms. Thus, in its role as a secondary lender to a firm, the greater the reliance on other banks in the network, the more likely the bank will cooperate with the firm's main bank in the hope that other network banks will reciprocate when its own main bank firms become troubled.

We can use cross-sectional differences in a bank's dependence on, and thus commitment to, the lending network to distinguish between the cultural/social norm hypothesis and the economic incentives hypothesis as possible explanations for the degree of cooperation of a firm's secondary banks with a firm's main bank. In addition, we can use a comparison of bank behavior in the 1980s with that in the 1990s to further distinguish between the two possible explanations. The combination of the severe problems at many individual firms and the crisis in the banking system during the 1990s altered the economic incentives faced by Japanese banks.

In particular, Peek and Rosengren (2005) find that during the troubled 1990s, banks misallocated credit as a consequence of the perverse incentives they faced associated with a

weak bank supervision system and government pressures to aid unhealthy firms. Their finding that financially troubled banks were more likely to increase loans the weaker was the firm's health and the stronger was the bank's affiliation with the firm suggests that banks were making lending decisions based on criteria other than profit maximization. Indeed, even secondary lenders exhibited such behavior, consistent with bank lending behavior being influenced strongly by their commitment to aid other network members in order to sustain the lending network as it came under severe stress.

Given the impaired health of most Japanese banks in combination with the perverse incentives arising from the unwillingness of bank supervisors to force recognition of asset quality problems, it was in the self interest of banks to follow a policy of forbearance with their problem borrowers in order to avoid having to report impaired loans as nonperforming. A bank can avoid a mandatory increase in its reported nonperforming loans as long as it makes sufficient credit available to the firm to enable the firm to make interest payments on the outstanding loans from the bank and to avoid declaring bankruptcy. Consequently, a bank may continue lending to troubled firms to provide sufficient financing to keep otherwise economically bankrupt firms afloat. This evergreening of loans benefits the firm because it can avoid (or at least delay) bankruptcy. It also enables the bank to avoid (or delay) a further increase in its reported nonperforming loans, so that the bank does not have to make additional loan charge offs and loan loss provisions, which would reduce the bank's earnings, and thus capital. [1]

While the evergreening of loans by a bank aided the bank directly as described above, it also aided the other members of the lending network by maintaining the fiction that the firm was not severely troubled. If the firm were to fail, all lenders to that firm would suffer losses. If the firm were unable to keep its interest payments current, it would be difficult for the other lenders

to the firm to avoid downgrading their own loans to the firm. Thus, by cooperating with the firm's main bank in increasing loans to a troubled firm, the secondary lender was aiding not only the firm's main bank (bilateral reciprocity), but the lending network more generally (system reciprocity) in the hope that other network members would similarly help them with the troubled borrowers for which they served as a main bank.

II. Hypotheses and Empirical Specification

A. Hypotheses

If cultural and social norms are the driving force underlying network cooperation among banks in Japan, then we should observe a persistence in bank cooperation over time. Differences across banks in the degree to which they rely on the network, or even on other individual banks, should be relatively unimportant. In contrast, if economic incentives are the driving force underlying the cooperative behavior, then differences in the degree of commitment should be important, as should the difference in the economic environment in Japan between the 1980s and 1990s as the network, and individual banks, came under severe stress.

We have four primary hypotheses related to the effects of economic incentives on bank cooperation.

1. The greater is a secondary bank's reliance on the lending network, the greater is its cooperation with the firm's main bank. That is, secondary banks with relatively strong links to the network have more of an incentive to cooperate with a firm's main bank. This effect should be stronger in the 1990s as the network came under severe stress and the sustainability of the network became a greater concern.

2. The lower is the main bank's reliance on the lending network, the more secondary banks will cooperate with that main bank in aiding its firms. This occurs because as part of a secondary bank's commitment to the system, it will tend to provide more help to those main banks that have the potential to serve the network more than they are served by the network (because relatively more of their lending is in the role of a secondary bank than as a main bank) in order to keep those banks committed to the network. This effect should be greater in the 1990s (compared to the 1980s) when the network was under greater stress.

3. The greater is a secondary bank's bilateral reliance on the firm's main bank, the greater is the secondary bank's cooperation with that main bank.

4. If the firm is in the same keiretsu as its main bank, a secondary bank has a greater incentive to cooperate with the firm's main bank the greater is the secondary bank's reliance on the network. The argument is that with a same-keiretsu affiliation with the firm, the main bank has a stronger obligation to the firm and thus benefits more from receiving cooperation from the secondary banks. This effect should be greater in the 1990s when the network was under severe stress. Furthermore, the difference between the magnitudes of the effects in the 1980s and 1990s should be greater than for the case when no same-keiretsu affiliation is present. In fact, in the 1990s this effect should be greater when the main bank has a same-keiretsu affiliation with the firm than when no keiretsu affiliation is present.

B. General Approach to Inference

In order to focus on the question of the degree to which secondary banks cooperate with main banks, for each main bank-secondary bank pair we form a portfolio of the firms that borrow from both banks in the pair. We exclude from the analysis any pair where the main bank and the secondary bank are in the same keiretsu, since we want to isolate the lending network

links among banks separate from any influences associated with an additional linkage between banks that are in the same keiretsu network. For each main bank-secondary bank pair, we form two portfolios of firms based on the keiretsu membership of the firms. The firms in the "independent" portfolio are either not in a keiretsu, or, if they are in a keiretsu, they are not in the same keiretsu as either the main bank or the secondary bank. The firms in the "keiretsu" portfolio are in the same keiretsu as the main bank of the pair in question. Note that by construction, the firms in the keiretsu portfolios cannot be in the same keiretsu as the secondary bank, since we have omitted main bank-secondary bank pairs for which the two banks are in the same keiretsu.

Once these portfolios are formed, we calculate the following two variables to measure the degree of cooperation between the main bank and the secondary bank associated with each portfolio. The first variable, $COOP_{ijt}$, is calculated as the proportion of firms that obtained increased loans from both the main bank and the secondary bank; that is, the secondary bank cooperated with the main bank in increasing loans to the firm. The second variable, $NCOOP_{ijt}$, is calculated as the proportion of firms that obtained increased loans from the main bank, but not from the secondary bank; that is, the secondary bank did not cooperate with the main bank in increasing loans to the firm. In addition to these probabilities, we are also interested in the probability that the secondary bank increases its loans to a firm in a given portfolio conditional on the main bank having done so. This conditional probability can be interpreted as the probability that the secondary bank cooperates with the main bank in increasing loans to the firm, and is calculated as $\frac{COOP_{ijt}}{COOP_{ijt} + NCOOP_{ijt}}$.

We choose a reduced-form approach instead of directly modeling the conditional probability of cooperation for several reasons. First, the observed frequency of the main bank

increasing loans to the firms in a portfolio is zero in some portfolios, causing the empirical counterpart of the conditional probability to be ill-defined. Second, even when this is not the case, the precision of the empirical measure of the conditional probability is low.

We specify reduced-form models for the expectations of $COOP_{ijt}$ and $NCOOP_{ijt}$ conditional on a set of regressors. Once these models are estimated, we can make statements about the effects of the regressors on the conditional probability using the standard formula for the conditional probability. For this purpose, we estimate fractional logit models (Papke and Wooldridge 1996), since our two dependent variables are restricted to lie between zero and one, inclusive. While the signs of the estimated coefficients of the logit model indicate the direction of the effects, inferences about the economic magnitude of the effects are not as straightforward. In order to conduct inference on the economic significance of the effects, we calculate the derivative of the estimated conditional probability with respect to the regressors of interest for each observation in our data set, and then average those derivatives. It is tedious, but otherwise easy, to obtain the standard errors for these "average marginal effects."

C. Data and Specification

We use a rich panel data set to examine Japanese bank lending patterns in order to determine the extent to which secondary bank lenders to a firm cooperate with the firm's main bank. By using Japanese firm-level data, we are able to link individual Japanese firms to their individual lenders. For our tests, we use annual data for 1982 through 1999. We include all firms included in the Pacific-Basin Capital Market Databases (PACAP), which includes all first- and second-section firms that are traded on the Tokyo stock exchange. The PACAP database includes the balance sheet and income statements of firms based on their fiscal year-end reports. The data for loans outstanding to individual firms from each lender are obtained from the Nikkei

Needs Bank Loan database, with loan reporting based on the firm's fiscal year. We identify each firm's main bank as the bank with the largest volume of loans outstanding to the firm in the prior year. Ties are broken by keiretsu membership, or by considering the past and future lending to the firm. In order to attach some smoothness to the main bank definition, we do not always change the designated main bank when another lender becomes the largest lender to the firm. Specifically, if the loans from the largest lender in a given year do not exceed the loans from the main bank designated in the prior year by at least 10 percent, we do not change the main bank. Keiretsu membership is obtained from Industrial Groupings in Japan: The Anatomy of the Keiretsu.

The unit of observation in our empirical work is a main bank-secondary bank pair. For this purpose, we first create a main bank list for each year in our data set. In a given year, any bank that serves as the main bank to at least 15 firms is included in the main bank list. Once the main bank list is formed for a given year, we form ordered pairs consisting of a main bank and a secondary bank. In each year and for each main bank, we form an ordered pair with each remaining bank in the data set, whether or not that secondary bank is on the main bank list for that year. Clearly, some ordered pairs will contain a secondary bank that is also serving as a main bank for other firms. As discussed in the previous section, we omit any pair of banks where both members are in the same keiretsu.

Once the observations are defined as main bank-secondary bank ordered pairs, we form two portfolios for each given pair of banks. The first, the "independent" portfolio, contains all the firms with positive loans outstanding from both banks of the pair in the prior year that are either not in a keiretsu, or, if they are, are not in the same keiretsu as either the main bank or the secondary bank of the pair. Note that by construction, the first member of the pair serves as the

main bank for each of the firms in the portfolio; hence, the second member serves as a secondary lender to each of the firms in the portfolio. The second, the "keiretsu" portfolio, is constructed in the same fashion, except that we require all the firms in the portfolio to be in the same keiretsu as the main bank.

One potential problem with some of the constructed portfolios is that they contain a very small number of firms. The precision of our dependent variables, calculated as empirical frequencies, will be low for such portfolios. Thus, we restrict our analysis to only those portfolios with at least 10 firms. For a given portfolio, the value of COOP is calculated as the proportion of the firms in the portfolio that had increased loans from *both* the main bank and the secondary bank, and the value of NCOOP is calculated as the proportion of the firms in the portfolio that had increased loans from the main bank *but not* from the secondary bank.

In order to control for the persistence in bank cooperation, we need to define measures for prior cooperation for each pair of banks. We choose *not* to use lagged values of COOP and NCOOP, since the composition of the firms in the portfolios are not necessarily identical from year to year. Instead, for a given portfolio, we define LCOOP as the proportion of firms that are in the portfolio in both period t and period t-1 that had increased loans from both the main bank and the secondary bank from period t-2 to period t-1. The variable LNCOOP is defined analogously.

To construct our measure of bilateral reciprocity, BIREC, for a given portfolio, we use information for all of the firms for which both the main bank and the secondary bank had positive loans outstanding in the prior year. For any bank i, let F_{it}^{M} denote the set of firms that had outstanding loans from that bank, and for which that bank served as the firm's main bank. Then our measure of bilateral reciprocity between banks i and j is given by:

$$BIREC_{ijt} = \frac{1}{2}\left[\frac{\sum_{k \in F_{it}^{M}} L_{kit-1}}{\sum_{k \in F_{it}^{M}} L_{kit-1} + L_{kjt-1}} + \frac{\sum_{k \in F_{it}^{S}} L_{kjt-1}}{\sum_{k \in F_{jt}^{S}} L_{kit-1} + L_{kjt-1}} \right], \quad (1)$$

where L_{ki} and L_{kj} represent loans to firm k from bank i and from bank j, respectively.

Our measure of system reciprocity, SYSREC, is defined as the share of loans made in the prior year by bank i in its role as a main bank.

$$SYSREC_{it} = \frac{\sum_{k \in F_{it}^{M}} L_{kit-1}}{\sum_{k \in F} L_{kit-1}}, \quad (2)$$

where F is the set of all firms in the data set. SYSRECMB is defined as the SYSREC value for the main bank in an ordered pair, and SYSRECSB is defined as the SYSREC value for the secondary bank in an ordered pair.

Finally, we will need a measure for the "health" of each bank. In order to construct a uniform measure across time periods, we chose the relative market-to-book value ratio, since many other measures of health that are based on a bank's balance sheet data, such as bank capital-to-asset ratios, nonperforming loan ratios and reported profits, are not reliable, especially in the 1990s when widespread bank regulator forbearance occurred. The relative measure of bank health, HEALTH, is calculated as

$$HEALTH_{it} = \frac{M_{i,t-1} - \overline{M}_{t-1}}{s_{t-1}}, \quad (3)$$

where $M_{i,t-1}$ is the ratio of the market value of equity to the book value of equity, winsorized at the first and ninety-ninth percentiles, $\overline{M}_{t-1}$ is the cross-sectional average of $M_{i,t-1}$ across all banks, and s_{t-1} is the cross-sectional standard deviation of $M_{i,t-1}$. Note that a bank of "average" health would have a value for HEALTH of zero. HEALTHMB is the value of HEALTH for the

main bank in the ordered bank pair, while HEALTHSB is the value of HEALTH for the secondary bank in the ordered bank pair.

The baseline specification for the expected value of COOP, conditional on the set of regressors, is:

$$E\left(COOP_{ijt}\middle|X_{ijt}\right)=F\left(Z_{ijt}\right) \tag{4}$$

$$Z_{ijt}=\alpha_t+\theta_i+\mu_j+\beta_1 LCOOP_{ijt}+\beta_2 LNCOOP_{ijt}+\beta_3 BIREC_{ijt}+$$

$$\beta_4 SYSRECMB_t+\beta_5 SYSRECSB_t+\beta_6 HEALTHMB_t+\beta_7 HEALTHSB_t, \tag{5}$$

where α_t is the set of year fixed effects, θ_i is the set of main bank fixed effects, γ_j is the set of secondary bank fixed effects, and $F\left(Z_{ijt}\right)=\frac{e^{Z_{ijt}}}{1+e^{Z_{ijt}}}$ is the CDF of the standard logistic distribution. Our general specification involves a full set of interaction terms:

$$Z_{ijt}=\alpha_t+\theta_i+\mu_j+\beta_{1o} LCOOP_{ijt}+\beta_{2o} LNCOOP_{ijt}+\beta_{6o} HEALTHMB_t+\beta_{7o} HEALTHSB_t+$$

$$BIREC_{ijt}\times\left(\beta_{0b}+\beta_{1b} LCOOP_{ijt}+\beta_{2b} LNCOOP_{ijt}+\beta_{6b} HEALTHMB_t+\beta_{7b} HEALTHSB_t\right)+$$

$$SYSRECMB_t\times\left(\beta_{0m}+\beta_{1m} LCOOP_{ijt}+\beta_{2m} LNCOOP_{ijt}+\beta_{6m} HEALTHMB_t+\beta_{7m} HEALTHSB_t\right)+$$

$$SYSRECSB_t\times\left(\beta_{0s}+\beta_{1s} LCOOP_{ijt}+\beta_{2s} LNCOOP_{ijt}+\beta_{6s} HEALTHMB_t+\beta_{7s} HEALTHSB_t\right). \tag{6}$$

The specification of the expected value of NCOOP conditional on the same set of regressors is done in a similar fashion. Table I contains the sample means of the dependent variables and each of the independent variables.

III. Results

The estimation results are discussed in two subsections. Subsection A contains the discussion of the results from the estimation of the baseline specification given in equation (5),

while subsection B contains the discussion of the results for the full specification given in equation (6). For each fractional logit model estimated, we present the coefficient estimates as well as their t-statistics, with estimated coefficients that are significant at the 5 percent level or better shown in boldface. This allows inference on the sign of the effect of the independent variables. However, as in the standard logit models, the estimated parameters in the fractional logit model are identified only up to scale. In any case, we are not interested in the magnitudes of those coefficients. Our interest lies in the derivatives of the probability that a secondary bank increases loans to a firm conditional on the main bank having done so. In the rest of the study, we will refer to this as the probability of cooperating with the main bank. In each table, we will present the fractional logit estimates, as well as the average marginal derivative (AMD) of the conditional probability of cooperating with the main bank with respect to each independent variable.

The probability of cooperation is defined as the probability that the secondary bank increases loans conditional on the main bank having done so. Letting X_{ijt} denote the stacked set of regressors, and b_o denote the stacked set of parameters for the COOP and NCOOP equations:

$$E\left(COOP_{ijt} \mid X_{ijt}, COOP_{ijt} + NCOOP_{ijt}\right) = G\left(X_{ijt}, b_o\right) \equiv \frac{E\left(COOP_{ijt} \mid X_{ijt}\right)}{E\left(COOP_{ijt} \mid X_{ijt}\right) + E\left(NCOOP_{ijt} \mid X_{ijt}\right)}. \quad (7)$$

Then, the "average marginal derivative" for the kth regressor is calculated by

$$\hat{d}_k \equiv \frac{1}{n}\sum_{ijt} \frac{\partial \hat{G}\left(X_{ijt}, \hat{b}\right)}{\partial X_{ijt}^{k}}, \quad (8)$$

where $\hat{G}\left(X_{ijt}, \hat{b}\right)$ is the estimated conditional probability. Since $\hat{G}\left(X_{ijt}, \hat{b}\right)$ is also a function of $\hat{b}$, the stacked vectors of estimated parameters for the COOP and NCOOP equations, standard

errors for the estimated average marginal derivative can be obtained easily by using the delta method which relies on a first-order Taylor expansion of $\hat{G}\left(X_{ijt}, \hat{b}\right)$ around b_o.

A. Baseline Specification

The estimation results for the baseline specification are presented in Tables II and III for the independent firm portfolios and for the portfolios of firms that have keiretsu affiliations with their main banks (referred to as keiretsu firms), respectively. In each table, the first three columns report the results for the 1982-1990 period, denoted "early period" hereafter, and the last three columns report the results for the 1991-1999 period, denoted "later period" hereafter. Asymptotic t-statistics for the estimated coefficients and for the calculated AMDs for the conditional probability of cooperation are reported below the point estimates in parentheses. Each estimated model includes main bank fixed effects, secondary bank fixed effects and a set of annual dummy variables. For brevity, coefficient estimates for these fixed effects are not reported. In Section A.1, we discuss in detail the results for the independent firm portfolios, while in Section A.2 we briefly discuss the results for the keiretsu firm portfolios.

A.1 Independent Firm Portfolios

The first set of independent variables in Table II is related to the degree to which the main bank and the secondary bank are committed to the network, as measured by the share of the loans they make in their capacity as a main bank. These variables are intended to capture the effects of system reciprocity on the coordination of lending. In the early period, both main bank (SYSRECMB) and secondary bank (SYSRECSB) system reciprocity have AMDs for the probability of cooperation with a sign opposite that predicted, although neither has a statistically significant impact on the coordination of lending. However, this does not necessarily mean that system reciprocity does not impact the coordination of lending. Remember that our

specifications include individual dummy variables for each main bank and for each secondary bank (the main bank and secondary bank fixed effects). To the extent that the banks with high network dependence are the same ones that also cooperate the most, a separate, identifiable effect of system reciprocity may not be observed. Especially during the relatively stable early period, the absence of a statistically significant effect should not be surprising, since a stable equilibrium would necessarily entail such a correlation.

During the more turbulent later period, however, changes in the economic environment generate a scope for distinguishing the effects of system reciprocity, if any. In fact, we find that during this later period when the lending network came under severe stress, both secondary bank system reciprocity and main bank system reciprocity have AMDs for the probability of cooperation with the predicted sign that indicate statistically significant impacts on the coordination of lending. Furthermore, all four of the associated individual fractional logit estimated coefficients are now of the predicted sign. That is, in the COOP equation the probability that both the main bank and the secondary bank increase loans to an independent firm is higher the greater is the network dependence of the secondary bank and the lower is the network dependence of the main bank, while in the NCOOP equation the probability that the secondary bank does not increase loans to an independent firm when the main bank does is lower the larger is the network dependence of the secondary bank and the smaller is the network dependence of the main bank.

In order to obtain an understanding of the economic magnitudes, consider two banks with differing values of SYSREC. Suppose that the first bank, say IBJ, has a SYSREC value of 0.50, while the second bank, say Tokai, has a SYSREC value of 0.20. Our estimates indicate that the probability that IBJ, in its role as a secondary bank, will cooperate with a main bank is higher by

about 12 percentage points compared to that of Tokai cooperating with the same main bank. On the other hand, the probability of a secondary bank cooperating with IBJ when it is serving as a main bank is about 9 percentage points less than the probability of that same secondary bank cooperating with Tokai.

The next independent variable shown in Table II is our measure of bilateral reciprocity, BIREC. In both the early and the later periods, BIREC has a statistically significant effect on the coordination of lending. As expected, the COOP equation shows that the higher the bilateral reciprocity, the higher is the probability that the main bank and the secondary bank will cooperate in increasing loans to an independent firm. The NCOOP equation shows that the probability that a secondary bank does not cooperate with the main bank in increasing loans decreases with increasing bilateral reciprocity.

In addition to their statistical significance, the estimated effects are also economically significant. For example, increasing BIREC from zero to 0.25 implies that the probability of cooperation increases by about 14 percentage points in the early period, and by about 12 percentage points in the later period. Given that the sample averages of the estimated probability of cooperation with the main bank are 55 percent and 49 percent in the early and the later periods, respectively, these estimated impacts of bilateral reciprocity on the coordination of bank lending are quite high.

The next set of independent variables in Table II is related to the persistence of coordination. The coordination of lending to the independent firms is statistically and economically quite persistent. For example, consider two pairs of banks that were at opposite extremes of coordination in the prior year. Let the first pair have LCOOP=0 and LNCOOP=0.5, and let the second pair have LCOOP=0.5 and LNCOOP=0. In this case, the second pair of banks

that exhibit full prior cooperation has a probability of the secondary bank cooperating with the main bank in increasing loans that is 19 percentage points higher in the early period and 14 percentage points higher in the later period compared to the first pair of banks that exhibited no prior cooperation.

The final set of regressors in Table II is intended to control for bank health. Only one of the AMDs for the probability of cooperation is statistically significant, that for HEALTHSB in the early period. While that effect is negative, it is of such a small magnitude that it is unlikely to be economically significant.

A.2 Keiretsu Firm Portfolios

Table III indicates that the effects of system and bilateral reciprocity differ for the portfolios of keiretsu firms relative to those for independent firms, especially during the 1990s. While system reciprocity has no discernible effect in the early period, as was the case for the independent portfolios, the magnitude of the effect of secondary bank system reciprocity is almost double that for independent firm portfolios in the later period. Continuing with our IBJ-Tokai example, the probability that IBJ (the bank with the higher value of SYSREC), in its role as a secondary bank, will cooperate with a main bank is about 25 percentage points higher compared to Tokai, while the probability that a secondary bank will cooperate with Tokai (for which SYSREC is lower), is about 9 percentage points higher than for cooperating with IBJ.

The finding that secondary bank system reciprocity is a stronger driver of the coordination of lending for the keiretsu firms during the troubled 1990s is a result of the fact that all main banks in our sample belong to a keiretsu. As the health of firms and banks deteriorated in the 1990s, it became more important for banks to obtain cooperation from other network banks in increasing loans to their troubled same-keiretsu firms. Thus, in their role as a secondary

lender, they had a stronger need to signal their commitment to the network by cooperating with the main banks when the main bank had a keiretsu affiliation with the firm.

The second striking difference between the results for the keiretsu and independent portfolios is for the effect of bilateral reciprocity. In the early period, the estimated effect is statistically insignificant for the keiretsu portfolios. In the later period, however, bilateral reciprocity retains its statistically significant and economically meaningful effect on the coordination of lending to the keiretsu firms. For example, raising BIREC from zero to 0.25 increases the probability that a secondary bank will cooperate with the main bank in increasing loans by about 9 percentage points, compared to the sample average of 40 percent. Why is bilateral reciprocity a much more important factor in determining the coordination of lending to the keiretsu firms in the 1990s than in the 1980s? The answer lies in the results of Peek and Rosengren (2005). They have shown that during this lost decade of the 1990s, Japanese banks faced perverse incentives to evergreen loans to "zombie" firms. Thus, the objective of network coordination became keeping zombie firms alive. Hence, the interests of the main bank and the secondary bank were now aligned.

B. Full Specification

In this subsection, we discuss the estimation results for the full specification. As in the previous subsection, we present the estimates of the fractional logit model, as well as the AMDs for the conditional probability of cooperation. However, the full model has many interaction terms; hence, teasing out the effects of individual variables may be cumbersome. Therefore, we discuss the economic significance of the results in a simplified manner by making use of the estimated AMDs in calculating the effects of the independent variables under several scenarios.

In what follows, Section B.1 contains the discussion of the results for the independent firm portfolios, while Section B.2 contains the discussion of the results for the keiretsu firms.

B.1 Independent Firm Portfolios

Table IV contains the results of the estimation of the fractional logit model in equation (6) for the sample of firms that do not have a keiretsu affiliation with their main banks. As before, the first three columns contain the results for the early period, while the last three columns contain the results for the later period. Note that the two groups of control variables are interacted with SYSRECMB, SYSRECSB and BIREC. The first group is related to the persistence of correlated lending: LCOOP and LNCOOP. The second group is related to the bank health measures: HEALTHMB and HEALTHSB.

In order to understand the effect of the past history of coordination on the sensitivity of the current degree of coordination to system reciprocity and bilateral reciprocity, we calculate the average marginal derivatives of the probability of cooperation under three scenarios for the values of LCOOP and LNCOOP. Under all three scenarios, the proportion of firms that the main bank has increased loans to in the prior year (i.e., the sum of LCOOP and LNCOOP) is fixed at 0.5 for comparability; that is, one-half of firms in the portfolio receive increased loans from the main bank. For the first scenario, LCOOP=0.5 and LNCOOP=0. Under this scenario, the prior probability of cooperation is one, since LNCOOP=0 indicates that no secondary banks fail to cooperate with the main bank when it increases loans. The second scenario is at the opposite extreme, with LCOOP=0 and LNCOOP=0.5. Here, since LCOOP=0, the prior probability of cooperation is zero. The third scenario is the intermediate case, with LCOOP=LNCOOP=0.5; hence, the prior probability of cooperation is 0.5. Under all three scenarios, we take

HEALTHMB=HEALTHSB=0; that is, both the main bank and the secondary bank have "average" health.

Table V presents the results for this exercise. The first three columns contain the results for the early period, while the last three columns contain the results for the later period. The reported number in each cell represents the average marginal derivative of the probability of cooperation with respect to the variable in the column heading. The first finding is that in the early period coordination is inversely related to main bank system reciprocity; that is, to the degree of dependence of the main bank on the network. However, the estimated effect is relatively insensitive to differences in the prior history of cooperation. In contrast, the table shows some sensitivity of the SYSRECMB effect to the degree of prior cooperation in the later period. For the middle scenario, coordination is not sensitive to the main bank's dependence on the network. However, coordination depends positively on the main bank's network dependence when the prior probability of cooperation is high, and negatively when the prior probability of cooperation is low. Thus, secondary banks cooperate more with the main bank in increasing loans to independent firms the higher the network dependence of the main bank when there is a history of cooperation, and they are less likely to cooperate with the main bank if there is no history of cooperation.

The effects of secondary bank system reciprocity are much stronger than those for main bank system reciprocity. Furthermore, the effects differ by subperiod, being negative in the early period but positive in the later period. The magnitude of the effect is sensitive to the degree of prior cooperation in both subperiods. In the early period, the greater is secondary bank reliance on the network, the less cooperation, and that cooperation is even less the stronger is prior cooperation. In contrast, in the later period the larger is SYSRECSB, the greater is the

probability of cooperation, and that effect is stronger the stronger is the prior cooperation between the banks. One interpretation of these results is that in the early (relatively stable) period prior cooperation decreases a secondary bank's need to signal to the network that it is cooperating. On the other hand, the results for the later period when the network and the individual banks themselves are under severe stress indicate that secondary banks feel the need to signal to the network that they are cooperating, even if they have cooperated in the prior year. Their need to signal their commitment to the network increases even more when there has been little prior cooperation.

Greater bilateral reciprocity leads to an increased probability of coordination in both the early and later subperiods, although the effect is somewhat smaller in the later subperiod. In both subperiods, the greater is prior cooperation, the larger is the effect of bilateral reciprocity on the conditional probability of cooperation. In fact, comparing the two extreme cases, the effect for complete prior cooperation is about double that for complete non-cooperation in the early period, and larger by an even larger factor in the later subperiod.

In order to assess the effect of the health of the main bank and the secondary bank on the sensitivity of coordinated lending to system and bilateral reciprocity, we perform a similar exercise. Setting LCOOP and LNCOOP at the intermediate value of 0.25, we compare the sensitivity of the conditional probability to SYSRECMB, SYSRECSB and BIREC under four different scenarios based on the extreme values of one and minus one for HEALTHMB and HEALTHSB. Table VI contains the results from this exercise.

The sensitivity of the coordination of lending to the main bank's dependence on the network varies somewhat with both the health of the main bank and the health of the secondary bank in the early subperiod, but is insensitive to bank health in the later period when the

SYSRECMB effect is essentially zero under all four scenarios. Secondary bank reciprocity is somewhat more sensitive to secondary bank health than to main bank health in the early subperiod, but sensitive only to secondary bank health in the later subperiod. This increased cooperation by secondary banks the weaker their health suggests that secondary banks have a greater need to signal that they are committed to the network if they are among the least healthy banks during the difficult 1990s period.

The BIREC effect on lending cooperation is somewhat sensitive to main bank and secondary bank health in both the early period and the later period. However, the patterns differ for the effect of secondary bank health. While better main bank health reduces the BIREC effect in both subperiods, better secondary bank health reduces the BIREC effect in the early period and strengthens the BIREC effect in the later subperiod.

B.2 Keiretsu Firm Portfolios

In this subsection, we perform for the keiretsu firm portfolios the same exercise as in Tables V and VI. The estimates of the fractional logit model used for this exercise are presented in Table VII. The results are presented in Tables VIII and IX. For brevity, we highlight only the important differences from the prior discussion.

Compared to the results for the independent firm portfolios, the AMDs of the conditional probabilities of cooperation for SYSRECMB are stronger, those for BIREC are weaker and those for SYSRECSB are weaker in the early period and stronger in the later period. In particular, as expected, both SYSREC effects are stronger in the 1990s for the keiretsu firm portfolios than for the independent firm portfolios. In addition, for both subperiods, the relationship between prior cooperation and the SYSRECMB effect is in the opposite direction from that for the independent

firm portfolios, and now the SYSRECSB effect in the later subperiod is no longer sensitive to the degree of prior cooperation.

With respect to the sensitivity to bank health, for the keiretsu firm portfolios, the SYSRECSB effect is no longer sensitive to bank health in the early period. Compared to the results for the independent firm portfolios, SYSRECMB is now more sensitive to main bank health and responds in the opposite direction to secondary bank health in the early period, and now has sensitivity to main bank health in the later period. BIREC has lost its sensitivity to bank health in the early period and has somewhat greater sensitivity to secondary bank health in the later period.

IV. Conclusions

Interaction among economic actors as members of networks is widespread. Economists view cooperative behavior that sustains such networks as being the result of incentives facing the economic actors, and are mainly interested in the factors affecting the dynamics of the cooperation. Sociologists view the structure of the network as given, posit that social norms sustain networks, and are concerned with the effects of social capital generated by network membership on the well being of the network members. Our study fills an important gap in the empirical network literature by testing the implications of these rival views of networks using a database that has rich sources of cross-sectional and time series variation that allows identification.

The results of our empirical study provide very strong support for the economist's view of the networks, while casting strong doubt on the sociological point of view. Since the second

half of our data set is from a turbulent period in Japan, our study also sheds light on the behavior of networks when they are under duress.

References

Allen, Franklin and Douglas Gale, 2000, Financial Contagion, *Journal of Political Economy* 108, 1-33.

Kang, Jun-Koo. and Anil Shivdasani, 1995, Firm Performance, Corporate Governance, and Top Executive Turnover in Japan, *Journal of Financial Economics* 38, 29-58.

Bala, Vankateesh and Sanjeev Goyal, 2000, A Noncooperative Model of Network Formation, *Econometrica* 68, 1181-1229.

Corbae, Dean and John Duffy, 2004, Experiments with Network Formation, unpublished paper.

Ellison, Glenn, 2003, Learning, Local Interaction, and Coordination, *Econometrica* 61, 1047-71.

Ely, Jeffrey C., 2002, Local Conventions, *Advances in Theoretical Economics* 2(1), Article 1.

Fafchamps, Marcel and Susan Lund, 2003, Risk Sharing Networks in Rural Philippines, *Journal of Development Economics* 71, 261-87.

Goyal, Sanjeev and Fernando Vega-Redondo, 2005, Network Formationand Social Coordination, *Games and Economic Behavior* 50, 178-207.

Heinemann, Frank, Rosemarie Nagel and Peter Ockenfels, 2004, The Theory of Global Games on Test: Experimental Analysis of Coordination Games with Public and Private Information, *Econometrica* 72, 1583-1599.

Hoshi Takeo and Anil Kashyap, 2001, *Corporate Financing and Governance in Japan*, Cambridge MA, The MIT Press.

Kaplan, Steven N. and Bernadette Minton, 1994, Appointment of Outsiders to Japanese Corporate Boards: Determinants and Implications for Managers, *Journal of Financial Economics*, 36, 225-58.

La Ferrara, Eliana, 2003, Kin Groups and Reciprocity: A Model of Credit Transactions in Ghana, *American Economic Review* 93, 1730-1751.

Leitner, Yaron, 2005, Financial Networks: Contagion, Commitment, and Private Sector Bail-Outs, *Journal of Finance*, forthcoming.

Morck, Randall and Masao Nakamura, 1999, Banks and Corporate Control in Japan, *Journal of Finance* 54, 319-39.

Peek, Joe and Eric S. Rosengren, 2005, Unnatural Selection: Perverse Incentives and the Misallocation of Credit in Japan, *American Economic Review* 95(4), 1144-1166.

TABLE I
Sample Means of Independent Variables

	Independent Sample		Keiretsu Sample	
	82-90	91-99	82-90	91-99
SYSRECMB	0.311	0.313	0.375	0.378
SYSRECSB	0.200	0.195	0.155	0.157
BIREC	0.130	0.124	0.114	0.108
LCOOP	0.281	0.226	0.271	0.192
LNCOOP	0.242	0.283	0.261	0.297
HEALTHMB	1.788	1.658	1.988	1.936
HEALTHSB	1.262	1.119	0.952	0.934
COOP	0.247	0.216	0.238	0.185
LCOOP	0.198	0.226	0.228	0.226

TABLE II
Fractional Logit Estimates and AMDs of the Probability of Cooperation
Baseline Specification: Independent Firm Portfolios

The unit of observation is a bank pair consisting of a main bank and a secondary bank that do not have a keiretsu affiliation. For a given pair, we form portfolios of firms such that each firm in the portfolio has positive loans outstanding from both the main bank and the secondary bank, and the firms do not have a keiretsu affiliation with the main bank. Any main bank-secondary bank pair that does not share at least 15 clients is omitted from the analysis. COOP is the proportion of firms in the portfolio whose loans from both the main bank and the secondary bank have increased. NCOOP is the proportion of firms in the portfolio whose loans from the main bank increased but whose loans from the secondary bank did not increase. SYSRECMB is our measure of system reciprocity for the main bank. SYSRECSB is our measure of system reciprocity for the secondary bank. BIREC is our measure of bilateral reciprocity. LCOOP is the proportion of firms in the portfolio whose loans from both the main bank and the secondary bank have increased in the prior year. LNCOOP is the proportion of firms in the portfolio whose loans from the main bank have increased but whose loans from the secondary bank did not increase. HEALTHMB and HEALTHSB are based on the market-to-book ratio of the main bank and the secondary bank, respectively, in the prior year, and are measured as the number of standard deviations away from the mean for all banks in that year. Each regression includes a set of dummy variables for each year, for each main bank, and for each secondary bank. AMD is obtained by using the fractional logit estimates of both the COOP and NCOOP equations, and is calculated as the sample average of the derivatives of the probability that the secondary bank increases loans conditional on the main bank having done so.

	1982-1990			1991-1999		
	COOP	NCOOP	AMD	COOP	NCOOP	AMD
SYSRECMB	0.1551	0.0910	0.0105	**-0.8902**	0.7245	**-0.2964**
	(0.21)	(0.12)	(0.04)	(2.15)	(1.82)	(2.20)
SYSRECSB	-0.8267	0.2632	-0.1977	0.9026	**-1.2457**	**0.3938**
	(1.13)	(0.35)	(0.81)	(1.91)	(2.67)	(2.53)
BIREC	**1.3260**	**-1.7594**	**0.5704**	**1.4338**	**-1.2115**	**0.4855**
	(4.09)	(5.25)	(5.25)	(5.52)	(4.72)	(5.77)
LCOOP	**1.9602**	**0.9743**	**0.1660**	**1.8766**	**0.6423**	**0.2288**
	(14.74)	(7.08)	(3.78)	(13.19)	(4.44)	(4.89)
LNCOOP	**2.1985**	**3.2169**	**-0.2162**	**1.7794**	**3.2405**	**-0.2635**
	(15.00)	(21.22)	(4.49)	(14.32)	(27.89)	(6.80)
HEALTHMB	-0.0269	-0.0085	-0.0032	0.0101	0.0113	-0.0002
	(1.13)	(0.32)	(0.38)	(0.61)	(0.69)	(0.04)
HEALTHSB	**-0.0642**	0.0388	**-0.0188**	0.0280	-0.0078	0.0066
	(2.50)	(1.49)	(2.26)	(1.72)	(0.47)	(1.18)
Log L	-906.55	-806.34		-950.9	-960.05	
R-Squared	0.480	0.469		0.421	0.555	
Mean of Dependent Variable	0.247	0.198		0.216	0.226	
No. of Observations	1,681	1,681		1,878	1,878	

TABLE III
Fractional Logit Estimates and AMDs of the Probability of Cooperation
Baseline Specification: Keiretsu Firm Portfolios

The unit of observation is a bank pair consisting of a main bank and a secondary bank that do not have a keiretsu affiliation. For a given pair, we form portfolios of firms such that each firm in the portfolio has positive loans outstanding from both the main bank and the secondary bank, and the firms have a keiretsu affiliation with the main bank. Any main bank-secondary bank pair that does not share at least 15 clients is omitted from the analysis. COOP is the proportion of firms in the portfolio whose loans from both the main bank and the secondary bank have increased. NCOOP is the proportion of firms in the portfolio whose loans from the main bank increased but whose loans from the secondary bank did not increase. SYSRECMB is our measure of system reciprocity for the main bank. SYSRECSB is our measure of system reciprocity for the secondary bank. BIREC is our measure of bilateral reciprocity. LCOOP is the proportion of firms in the portfolio whose loans from both the main bank and the secondary bank have increased in the prior year. LNCOOP is the proportion of firms in the portfolio whose loans from the main bank have increased but whose loans from the secondary bank did not increase. HEALTHMB and HEALTHSB are based on the market-to-book ratio of the main bank and the secondary bank, respectively, in the prior year, and are measured as the number of standard deviations away from the mean for all banks in that year. Each regression includes a set of dummy variables for each year, for each main bank, and for each secondary bank. AMD is obtained by using the fractional logit estimates of both the COOP and NCOOP equations, and is calculated as the sample average of the derivatives of the probability that the secondary bank increases loans conditional on the main bank having done so.

	1982-1990			1991-1999		
	COOP	NCOOP	Conditional	COOP	NCOOP	Conditional
SYSRECMB	-0.2633	-0.5233	0.0484	**-1.2189**	0.5629	**-0.3241**
	(0.30)	(0.65)	(0.17)	(2.49)	(1.42)	(2.21)
SYSRECSB	-0.3443	0.1798	-0.0955	**2.2966**	**-2.5825**	**0.8735**
	(0.37)	(0.23)	(0.34)	(3.11)	(4.75)	(4.13)
BIREC	0.1143	0.4727	-0.0662	**-1.0462**	**-1.0324**	**0.3730**
	(0.28)	(1.24)	(0.50)	(2.46)	(2.98)	(2.91)
LCOOP	**1.1687**	**0.8473**	0.0563	**2.0360**	**1.3230**	**0.1507**
	(6.48)	(5.46)	(1.01)	(10.54)	(8.27)	(2.64)
LNCOOP	**1.2109**	**3.0956**	**-0.3494**	**2.1593**	**3.5144**	**-0.2047**
	(7.35)	(20.87)	(6.91)	(13.02)	(27.05)	(4.27)
HEALTHMB	-0.0867	-0.0204	0.0022	-0.0520	0.0214	-0.0134
	(0.19)	(0.48)	(0.15)	(1.91)	(1.04)	(1.73)
HEALTHSB	-0.0187	-0.0435	0.0046	**0.0439**	-0.0142	0.0106
	(0.60)	(1.46)	(0.48)	(2.11)	(0.79)	(1.68)
Log L	-674.36	-667.79		-631.77	-742.27	
R-Squared	0.491	0.469		0.464	0.563	
Mean of Dependent Variable	0.238	0.228		0.185	0.226	
No. of Observations	1,283	1,283		1,376	1,376	

TABLE IV
Fractional Logit Estimates and AMDs of the Probability of Cooperation
Full Specification: Independent Firm Portfolios

The unit of observation is a bank pair consisting of a main bank and a secondary bank that do not have a keiretsu affiliation. For a given pair, we form portfolios of firms such that each firm in the portfolio has positive loans outstanding from both the main bank and the secondary bank, and the firms do not have a keiretsu affiliation with the main bank. Any main bank-secondary bank pair that does not share at least 15 clients is omitted from the analysis. COOP is the proportion of firms in the portfolio whose loans from both the main bank and the secondary bank have increased. NCOOP is the proportion of firms in the portfolio whose loans from the main bank increased but whose loans from the secondary bank did not increase. SYSRECMB is our measure of system reciprocity for the main bank. SYSRECSB is our measure of system reciprocity for the secondary bank. BIREC is our measure of bilateral reciprocity. LCOOP is the proportion of firms in the portfolio whose loans from both the main bank and the secondary bank have increased in the prior year. LNCOOP is the proportion of firms in the portfolio whose loans from the main bank have increased but whose loans from the secondary bank did not increase. HEALTHMB and HEALTHSB are based on the market-to-book ratio of the main bank and the secondary bank, respectively, in the prior year, and are measured as the number of standard deviations away from the mean for all banks in that year. Each regression includes a set of dummy variables for each year, for each main bank, and for each secondary bank. AMD is obtained by using the fractional logit estimates of both the COOP and NCOOP equations, and is calculated as the sample average of the derivatives of the probability that the secondary bank increases loans conditional on the main bank having done so.

	1982-1990			1991-1999		
	COOP	NCOOP	Conditional	COOP	NCOOP	Conditional
SYSRECMB	**-1.8361**	1.2803	-0.5704	**-1.2879**	-0.4014	-0.1640
	(2.03)	(1.30)	(1.88)	(2.03)	(0.65)	(0.81)
SYSRECSB	-0.7608	1.0212	-0.3292	**1.6218**	**-2.2408**	**0.7072**
	(0.92)	(1.13)	(1.16)	(2.68)	(3.78)	(3.61)
BIREC	-0.4985	**-2.6295**	0.4082	-0.5463	0.9911	-0.2813
	(0.41)	(2.12)	(1.03)	(0.51)	(1.03)	(0.84)
LCOOP	**1.3234**	**1.9702**	-0.1360	**2.1107**	0.6253	**0.2748**
	(3.55)	(4.89)	(1.05)	(5.24)	(1.53)	(2.15)
LNCOOP	**1.2029**	**3.9965**	**-0.5408**	**0.9363**	**2.8683**	**-0.3504**
	(2.54)	(8.44)	(3.45)	(2.29)	(7.29)	(2.76)
HEALTHMB	**-0.2007**	-.1842	-0.0010	-0.0593	-0.0734	0.0025
	(2.53)	(1.67)	(0.04)	(1.15)	(1.28)	(0.14)
HEALTHSB	-0.1125	**0.1502**	**-0.0485**	0.0485	**2.8683**	0.0173
	(1.77)	(2.36)	(2.31)	(1.22)	(7.29)	(1.36)
SYSRECMBx LCOOP	0.7255	-1.8004	0.4702	-1.4781	**2.0309**	**0.6425**
	(0.84)	(1.86)	(1.56)	(1.54)	(2.06)	(2.04)
SYSRECMBx LNCOOP	1.0262	**-2.6539**	**0.6854**	0.9636	1.2789	-0.0556
	(0.99)	(2.44)	(1.99)	(1.01)	(1.36)	(0.18)
SYSRECMBx HEALTHMB	**0.7694**	0.2539	0.0885	**0.3109**	0.1939	0.0219
	(4.12)	(0.99)	(1.25)	(2.57)	(1.49)	(0.53)
SYSRECMBx HEALTHSB	0.1261	**-0.2514**	0.0701	0.0277	0.0818	-0.0098
	(1.15)	(2.19)	(1.93)	(0.34)	(1.05)	(0.36)
SYSRECSBx LCOOP	**-2.8261**	0.2869	**-0.5595**	**-2.1498**	**2.2460**	**-0.8054**
	(3.92)	(0.35)	(2.21)	(2.61)	(2.70)	(3.00)
SYSRECSBx LNCOOP	0.0035	-2.0754	0.3931	0.4780	0.9266	-0.0809
	(0.00)	(2.01)	(1.18)	(0.59)	(1.09)	(0.30)
SYSRECSBx HEALTHMB	**0.2745**	-0.0763	0.0635	-0.0778	-0.0245	-0.0099
	(2.26)	(0.56)	(1.48)	(1.40)	(0.41)	(0.52)

SYSRECSB x HEALTHSB	0.3759	-0.3913	**0.1412**	**-0.2617**	**0.2307**	**-0.0902**
	(1.87)	(1.88)	(2.09)	(2.72)	(2.39)	(2.82)
BIREC x LCOOP	**6.8896**	**-4.1802**	**2.0223**	4.2422	**-8.2799**	**2.2907**
	(3.80)	(2.21)	(3.28)	(1.90)	(3.74)	(3.14)
BIREC x LNCOOP	**5.8340**	2.6853	0.5351	3.8037	-1.6405	0.9996
	(2.40)	(1.05)	(0.65)	(1.68)	(0.81)	(1.40)
BIREC x HEALTHMB	**-0.8355**	**0.6475**	**-0.2718**	-0.1746	0.1245	-0.0549
	(2.92)	(2.24)	(2.85)	(1.23)	0.95)	(1.22)
BIREC x HEALTHSB	-0.2488	0.2032	-0.0820	0.2328	-0.2460	0.0878
	(0.90)	(0.80)	(0.94)	(1.40)	(1.47)	(1.60)
Log L	-904.99	-805.58		-950.01		-959.35
R-Squared	0.502	0.479		0.434		0.563
Mean of Dependent Variable	0.247	0.198		0.216		0.226
No. of Observations	1,681	1,681		1,878		1,878

TABLE V
Average Marginal Derivatives of Conditional Probability by Prior Cooperation: Independent Firm Portfolios

Calculations in this table are based on the AMDs in Table IV, where HEALTHMB and HEALTHSB are taken to be 0.0, i.e., the average value for banks in a given year.

	1982-1990			1991-1999		
	SYSRECMB	SYSRECSB	BIREC	SYSRECMB	SYSRECSB	BIREC
LCOOP=0.50, LNCOOP=0.00	-0.34	-0.61	1.42	0.16	0.31	0.86
LCOOP=0.25, LNCOOP=0.25	-0.28	-0.41	1.05	-0.02	0.49	0.54
LCOOP=0.00, LNCOOP=0.50	-0.23	-0.13	0.68	-0.19	0.67	0.22

TABLE VI
Average Marginal Derivatives of Conditional Probability by Bank Health: Independent Firm Portfolios

Calculations in this table are based on the AMDs in Table IV, where LCOOP and LNCOOP are both taken to be 0.25, i.e., the prior probability of cooperation is 0.5.

	1982-1990			1991-1999		
	SYSRECMB	SYSRECSB	BIREC	SYSRECMB	SYSRECSB	BIREC
HEALTHMB= -1, HEALTHSB= -1	-0.44	-0.62	1.40	-0.03	0.59	0.51
HEALTHMB= -1, HEALTHSB= 1	-0.30	-0.34	1.24	-0.05	0.41	0.68
HEALTHMB= 1, HEALTHSB= -1	-0.26	-0.49	0.86	0.01	0.57	0.40
HEALTHMB= 1, HEALTHSB= 1	-0.12	-0.21	0.69	0.00	0.39	0.57

TABLE VII
Fractional Logit Estimates and AMDs of the Probability of Cooperation
Full Specification: Independent Firm Portfolios

The unit of observation is a bank pair consisting of a main bank and a secondary bank that do not have a keiretsu affiliation. For a given pair, we form portfolios of firms such that each firm in the portfolio has positive loans outstanding from both the main bank and the secondary bank, and the firms have a keiretsu affiliation with the main bank. Any main bank-secondary bank pair that does not share at least 15 clients is omitted from the analysis. COOP is the proportion of firms in the portfolio whose loans from both the main bank and the secondary bank have increased. NCOOP is the proportion of firms in the portfolio whose loans from the main bank increased but whose loans from the secondary bank did not increase. SYSRECMB is our measure of system reciprocity for the main bank. SYSRECSB is our measure of system reciprocity for the secondary bank. BIREC is our measure of bilateral reciprocity. LCOOP is the proportion of firms in the portfolio whose loans from both the main bank and the secondary bank have increased in the prior year. LNCOOP is the proportion of firms in the portfolio whose loans from the main bank have increased but whose loans from the secondary bank did not increase. HEALTHMB and HEALTHSB are based on the market-to-book ratio of the main bank and the secondary bank, respectively, in the prior year, and are measured as the number of standard deviations away from the mean for all banks in that year. Each regression includes a set of dummy variables for each year, for each main bank, and for each secondary bank. AMD is obtained by using the fractional logit estimates of both the COOP and NCOOP equations, and is calculated as the sample average of the derivatives of the probability that the secondary bank increases loans conditional on the main bank having done so.

	1982-1990			1991-1999		
	COOP	NCOOP	Conditional	COOP	NCOOP	Conditional
SYSRECMB	-1.3215	1.2527	-0.4686	-1.9995	1.7801	-0.6782
	(0.67)	(0.55)	(0.68)	(1.62)	(1.77)	(1.90)
SYSRECSB	.0859	.1919	-0.0197	**4.1921**	**-4.9244**	**1.6275**
	(0.08)	(0.21)	(0.06)	(4.66)	(7.02)	(6.33)
BIREC	1.1915	1.0979	0.0141	-2.6829	**4.1065**	**-1.2061**
	(0.82)	(0.94)	(0.03)	(1.77)	(3.75)	(2.81)
LCOOP	1.7157	1.0518	0.1174	**2.7065**	**2.4960**	0.0728
	(1.25)	(0.83)	(0.27)	(2.97)	(6.67)	(0.28)
LNCOOP	2.3960	3.2721	-0.1667	**1.7924**	**4.5165**	-0.4446
	(1.95)	(2.73)	(0.41)	(2.00)	(3.75)	(1.77)
HEALTHMB	-0.3780	0.3731	-0.1368	**-0.3176**	0.1251	**-0.0806**
	(1.71)	(1.61)	(1.85)	(2.71)	(1.50)	(2.48)
HEALTHSB	0.0630	-0.0716	0.0245	0.0804	0.0073	0.0137
	(0.44)	(0.36)	(0.42)	(1.02)	(0.12)	(0.60)
SYSRECMB x LCOOP	-0.9498	-0.2235	-0.1308	-2.5946	-1.2321	-0.2698
	(0.27)	(0.07)	(0.12)	(1.20)	(0.67)	(0.43)
SYSRECMB x LNCOOP	-2.6203	-0.6278	-0.3587	0.0361	-2.1080	0.3699
	(0.84)	(0.20)	(0.34)	(0.02)	(1.24)	(0.61)
SYSRECMB x HEALTHMB	**1.1567**	-1.0220	**0.3965**	**0.7596**	-0.2321	**0.1811**
	(2.10)	(1.79)	(2.17)	(2.68)	(1.12)	(2.30)
SYSRECMB x HEALTHSB	-0.3735	0.4039	-0.1416	-0.1388	0.0755	-0.0388
	(1.03)	(0.79)	(0.97)	(0.86)	(0.59)	(0.84)
SYSRECSB x LCOOP	-1.8670	0.2959	-0.3918	**-2.9558**	**2.2518**	**-0.9372**
	(1.82)	(0.31)	(1.19)	(2.45)	(2.18)	(2.57)
SYSRECSB x LNCOOP	1.7894	-0.8382	0.4772	-1.5991	**3.6496**	**-0.9260**
	(1.72)	(0.82)	(1.45)	(1.67)	(4.35)	(3.25)
SYSRECSB x HEALTHMB	-0.0497	0.0420	-0.0147	-0.0988	0.1614	-0.0462
	(0.26)	(0.23)	(0.27)	(0.72)	(1.54)	(1.16)

SYSRECSB x HEALTHSB	0.0342	-0.2752	0.0567	**-0.3568**	0.1469	**-0.0916**
	(0.14)	(1.17)	(0.75)	(2.49)	(1.22)	(2.12)
BIREC x LCOOP	0.5583	-1.3843	0.3548	**6.8509**	**-9.6884**	**2.9424**
	(0.23)	(0.63)	(0.47)	(2.42)	(3.97)	(3.42)
BIREC x LNCOOP	-4.0487	1.5600	-1.0181	**6.1648**	**-7.5039**	**2.4385**
	(1.39)	(0.65)	(1.17)	(2.77)	(4.20)	(3.83)
BIREC x HEALTHMB	-0.2757	-0.1731	-0.0181	-0.0033	-0.3257	0.0555
	(0.59)	(0.43)	(0.13)	(0.00)	(1.21)	(0.52)
BIREC x HEALTHSB	0.5722	**-0.7291**	**0.2371**	0.6346	**-0.5548**	**0.2135**
	(1.51)	(2.05)	(1.97)	(1.89)	(2.13)	(2.14)
Log L	-673.75	-667.48		-630.96	-741.43	
R-Squared	0.499	0.476		0.476	0.576	
Mean of Dependent Variable	0.238	0.228		0.185	0.226	
No. of Observations	1,283	1,283		1,376	1,376	

TABLE VIII
Average Marginal Derivatives of Conditional Probability by Prior Cooperation: Keiretsu Firm Portfolios

Calculations in this table are based on the AMDs in Table VII, where HEALTHMB and HEALTHSB are both taken to be 0.0, i.e., the average value for banks in a given year.

	1982-1990			1991-1999		
	SYSRECMB	SYSRECSB	BIREC	SYSRECMB	SYSRECSB	BIREC
LCOOP=0.50, LNCOOP=0.00	-0.53	-0.22	0.19	-0.81	1.16	0.26
LCOOP=0.25, LNCOOP=0.25	-0.59	0.00	-0.15	-0.65	1.16	0.14
LCOOP=0.00, LNCOOP=0.50	-0.74	0.22	-0.50	-0.49	1.17	0.01

TABLE IX
Average Marginal Derivatives of Conditional Probability by Bank Health: Keiretsu Firm Portfolios

Calculations in this table are based on the AMDs in Table VII, where LCOOP and LNCOOP are both taken to be 0.25, i.e., the prior probability of cooperation is 0.5.

	1982-1990			1991-1999		
	SYSRECMB	SYSRECSB	BIREC	SYSRECMB	SYSRECSB	BIREC
HEALTHMB= -1, HEALTHSB= -1	-0.85	-0.04	-0.37	-0.80	1.30	-0.13
HEALTHMB= -1, HEALTHSB= 1	-1.13	0.08	0.10	-0.87	1.12	0.30
HEALTHMB= 1, HEALTHSB= -1	-0.05	-0.07	-0.40	-0.43	1.21	-0.02
HEALTHMB= 1, HEALTHSB= 1	-0.34	0.04	0.07	-0.51	1.02	0.41

Endnotes

[1] Japanese banks also likely were responding to significant government pressure to avoid a credit crunch or a precipitous decline in economic conditions that might occur if they were to reduce credit to troubled firms. The government, faced with a growing budget deficit and a voting public weary of funding bank bailouts, preferred banks to continue their policies of forbearance in order to avoid the alternative scenario of massive firm, and perhaps bank, failures and, in particular, the associated costs, both financial and political. The use of accounting gimmicks and the lack of transparency allowed bank supervisors to implement forbearance policies that allowed banks to understate their problem loans and overstate their capital so that they appeared to be sufficiently capitalized.