

Interbank Networks in Prewar Japan: Structure and Implications

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Abstract

In this paper, we explore the structure and implications of interbank networks in prewar Japan, focusing on director interlocking. We find that approximately 60% of banks had at least one connection with another bank through director interlocking, and that a bank that had a network with other banks was less likely to fail than a bank without a network. The failure probability of a bank with a network was negatively associated with the profitability of the connected banks. On the other hand, a bank performing well suffered from a decrease in deposits when the deposits of banks in the same network decreased. In this sense, contagion did occur. Thus, the financial networks stabilized the financial system to the extent that good banks in the networks could withstand contagious deposit withdrawals, and the net effect of the financial networks was positive in prewar Japan. In addition, interbank networks contributed to the stabilization of the financial system by coordinating bank mergers.

JEL Classification: **G21, G34, L14, L22, N25**

Key Words: Network, Bank, Director Interlocking, Merger, Japan

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1. Introduction

Social network analysis has been developing in the fields of sociology and mathematics for the past 50 years. In the field of economics also, the number of studies on networks has surged over the past decade. Some of these studies use game-theoretic models to investigate how networks form when a person strategically constructs links with others, and how stable and efficient such networks are (Jackson 2003, 2006; Goyal 2007). Other studies have applied network analysis to investigate economic phenomena such as mutual insurance among villagers (Fafchamps and Gubert 2007), informal credit among firms (Macmillan and Woodruff 1999), and welfare participation (Bertland et al. 2000). These studies focus on the effects of networks on economic behavior and outcomes.

In particular, financial economists have been interested in the role of networks in financial contagion in interbank markets. They investigate how a shock to one bank may spread contagiously to other banks and how the possibility of contagion is associated with the structure of interbank networks (Allen and Gale 2000; Freixas et al. 2000; Leinter 2005). Allen and Gale (2000) classified the structure of interbank networks into two types. Under a complete structure of claims, each bank is symmetrically connected with all other banks, while under an incomplete structure of claims, banks are linked only to neighboring banks. Allen and Gale (2000) also showed theoretically that contagion is less likely under the former structure than under the latter.

Based on these theoretical frameworks, several studies have investigated empirically the possibility of financial contagion (Sheldom and Maurer 1998; Furine 2003; Upper and Worms 2004; Boss et al. 2004b; Boissay 2006). These studies mainly focus on interbank loan networks in considering financial contagion. However, potential channels of contagion are not limited to interbank loan markets. For example, the

suspension or failure of a certain bank may cause runs of depositors on another bank with which it has a transactional, personal, or regional relationship. In this paper, we analyze broader potential channels of contagion. Hence, we focus on financial networks based on director interlocking.

Financial networks based on director interlocking may constitute a channel of financial contagion. On the other hand, networks among banks may enhance the durability of bank management, as did the shift from unit banking to branch banking (Calomiris 1990). Furthermore, as some sociology literature suggests, director interlocking may contribute to shared information about business practices and strategies, and thereby contribute to the stability of the financial system (Useem 1982; Palmer et al. 1993; Mizruchi 1996). Thus, we need empirical studies to determine whether financial networks based on director interlocking decrease or increase the stability of the financial system.

To address this question, we focus on the interbank networks that prevailed in Japan before the Second World War. The banking sector in prewar Japan is particularly interesting from the standpoint of financial network studies, because at that time many large investors held blocks of shares in, and directorships of, multiple banks (Okazaki et al. 2005, 2007). As a result, many banks connected with other banks through director interlocking and ownership to form complex interbank networks. These interbank networks are identifiable by using datasets compiled from company directories. Meanwhile, the Japanese financial system became unstable and experienced financial crises in the 1920s and the early 1930s. We explore whether interbank networks promoted or mitigated this instability.

The remainder of the paper is organized as follows. In Section 2, we describe the characteristics of interbank networks based on director interlocking. In Section 3, we examine the effects of interbank networks on the survivability of banks and on financial

contagion. In Section 4, we analyze how an interbank network affects the choice of counterpart banks in consolidations and examine how consolidations based on interbank networks differ from other consolidations in terms of postmerger performance. Section 5 concludes the paper.

2. Structure and Quality of Networks

First, focusing on director interlocking, we identify interbank networks. The data source is the 1926 issue of the *Directory of Banks and Companies (Ginko Kaisha Youroku)* used by Okazaki et al. (2005).¹ This source covers the directors and auditors of the banks and nonbanking firms existing in 1926 whose paid-in capital was at least 200,000 yen.² That year was chosen for analysis because the market structure of the banking industry drastically changed thereafter. This change resulted from the huge wave of bank mergers and exits caused by the financial crisis and the government's merger promotion policy based on the 1927 Bank Law (Okazaki and Sawada 2007; Okazaki et al. 2007).³ The financial data for each bank for 1926 are taken from the 1927 issue of the *Yearbook of the Bank Bureau (Ginkokyoku Nenpo)* published by the Ministry of Finance, which covers all banks in Japan, excluding its colonies. The number of banks commonly included in these two sources is 1007.⁴

By using the *Directory of Banks and Companies*, we determine that a given pair of banks has a connection if a person serves concurrently as a director of both banks. Even if a certain bank (Bank A) had two directors who also held director positions in the

¹ Tokyo Koshinjo, one of the largest private credit bureaus in prewar Japan, published a directory of corporate directors, *Ginko Kaisha Youroku*, every year from 1897 to 1942.

² Conveniently, this source includes a name index. This index lists all the banks and nonbanking companies in which named individuals had directorships.

³ The Bank Law set banks' minimum capital requirements, which many were unable to meet. Those banks were practically obliged to merge with another bank or be liquidated. We discuss this law in more detail in Section 4.

⁴ *Ginkokyoku Nenpo* covers 1417 ordinary banks in Japan, excluding its colonies, as of the end of 1926. Complete financial data are available for 1398 of the 1417 banks. Data on directors and auditors are available from *Ginko Kaisha Youroku* for 1007 banks.

other bank (Bank B), the number of connections between Bank A and Bank B is counted as one. Table 1 presents the distribution of the numbers of connections that individual banks had. As shown in this table, 587 of 1007 banks (58.3%) had at least one connection with another bank through director interlocking.

The number of connections in Table 1 corresponds to the “degree” concept from the social network analysis literature. In this literature, the degree, *i.e.*, the number of relations a certain unit has with other units, is supposed to be a measure of the “centrality” of the former unit in the network. That is, the more relations a unit has with other units within a network, the more central or important in the network that unit is considered to be (Wasserman and Faust 1994).

Table 2 summarizes the structure of interbank networks in prewar Japan. In Panel A, the number of connections classifies 587 banks that had at least one connection with another bank. A bank with four or more connections is defined as a “core bank”. A bank with fewer than four connections, but linked with a core bank, is defined as a “periphery bank”. The remaining banks, with at least one connection, are defined as “independent network banks”.

Panel A indicates that core banks and periphery banks constituted relatively small portions of the total number of banks with networks. This implies that Japan’s prewar banking industry cannot be characterized as having either a simple core–periphery structure or a star-network structure. The independent network banks, which dominate the group of banks connected to networks, can be further classified into two types. One type is represented by those banks that are indirectly connected to core banks, namely the indirect subsidiaries of core banks. The other type is represented by those banks that form among themselves independent small networks that are not connected to core banks, either directly or indirectly.

To determine the regional characteristics of interbank networks, in Panel B, we

classify banks with networks based on another criterion. A bank with an “intraregional network” is one connected only with banks operating in the same prefecture.⁵ By contrast, a bank with an “interregional network” is a bank with at least one connection with a bank operating in a different prefecture. Panel B indicates that about 70% of banks were part of an intraregional network. Thus, interbank networks were mainly formed within prefectures.

Table 3 reports basic statistics on the financial performance of banks both with and without networks. A comparison of these two types of banks reveals that banks with and without networks perform similarly, except that banks with networks are significantly larger in terms of deposits and total assets.

We also examine the quality of bank networks. We measure the quality of the network of a bank (such as Bank A) by the average performance of the banks with which Bank A was connected. Figure 1 shows the distribution of the quality of the networks for the 587 connected banks. Network quality varies substantially, in terms of all financial ratios. Thus, there was substantial heterogeneity in the quality of networks. This fact is significant in considering the implications of interbank networks. For instance, a bank connected with banks that were performing well might expect support in times of emergency and might also expect the sharing of useful information and knowledge. By contrast, a bank connected with banks that were performing badly might be adversely affected as a result. This issue is addressed in the next section.

3. Networks and Bank Performance

3.1 The Effects of Networks on Survivability

As revealed in the previous section, many interbank networks were formed through director interlocking in 1920s Japan. In this section, we examine how those

⁵ Operating in the same prefecture means that the headquarters of both banks were in the same prefecture.

interbank networks affected bank performance and, thereby, the stability of the financial system. During the 1920s and 1930s, there were many bank failures in Japan because of a sequence of financial crises. Thus, to begin with, we explore the relationship between interbank networks and the probability of bank failure. Okazaki et al. (2007) and Okazaki (2007) investigated the determinants and implications of bank exits in prewar Japan. We follow their basic approach, but add variables representing interbank networks.⁶

The following empirical specification is estimated by the probit model from cross-section data on 1926:

$$\Pr(\text{FAIL}_i = 1) = F(\alpha_0 + \alpha_1 * \text{NT}_i + \alpha_2 * \text{EQ}_i + \alpha_3 * \text{SIZE}_i + \alpha_4 * \text{BOJ}_i + \alpha_5 * \text{MS}_i) \quad (1)$$

where FAIL_i is a dummy variable that takes a value of unity if a bank exited because of failure between 1927 and 1931, and is zero otherwise. The explanatory variable NT is included to capture the effect of interbank networks. NT is a dummy variable that equals unity if bank i had at least one connection with another bank, and is zero otherwise. An interbank network may affect the survivability of a bank in various ways. First, a bank with a network may receive from its connected banks relief loans in the case of emergency.⁷ Second, a bank with a network may be able to share information and useful knowledge that enhances its survivability (Useem 1982; Carpenter and Westphal 2001). Hence, in (1), the expected sign of the coefficient of NT is negative.

⁶ Since the work of Okazaki et al. (2007), and particularly because of their focus on the effects of connections between banks and nonbanking companies, it has been standard practice to include variables relating to those connections in empirical models. In this paper, the model is altered by replacing this variable with one designed to capture the effect of interbank networks.

⁷ Imuta (1980) cites the history of Shikoku-Ginko and points out that banks belonging to large networks may have benefited from efficient asset portfolio allocation because they expected to be able to obtain relief loans in times of emergency from banks in their networks.

A number of control variables are included in equation (1). EQ is used to control for the effect of the Great Kanto Earthquake of 1923. Many banks in the south Kanto District (comprising Tokyo, Kanagawa, Chiba, and Saitama prefectures) experienced serious bad loan problems because of the collateral destruction caused by the earthquake. EQ is a dummy variable that is unity if the bank's headquarters was located in Tokyo, Kanagawa, Chiba, or Saitama prefecture, and is zero otherwise. We expect banks operating in those prefectures to have had higher failure rates. Hence, the coefficient of EQ is expected to be positive. SIZE is defined as the log of total assets.⁸ It is likely that large banks can more easily diversify their assets and are better able to endure negative shocks. Hence, the coefficient of SIZE is expected to be negative. The variable BOJ is a dummy variable that equals unity if a bank had a transaction relationship with the Bank of Japan and is zero otherwise. Okazaki (2007) investigated the role of the Lender of Last Resort (LLR) in prewar Japan and found that having a transaction relationship with the BOJ lowered the probability of failure for solvent banks. Hence, the variable BOJ is included to capture the effect of LLR loans. MS denotes the market share of the top three banks in a prefecture, in terms of the number of operating units (*i.e.*, the headquarters and branches in the prefecture).⁹ Because banks in competitive markets are more likely to fail than those in less competitive markets, the coefficient of MS is expected to be negative.

In addition to these control variables, we have added several financial ratios. These include the return on equity (ROE), the ratio of capital to deposits (CAPDEPO), the ratio of bank deposit reserves to total assets (LIQUID), and the ratio of security holdings to loans (SECURITY), following Okazaki et al. (2007) and Okazaki (2007). These variables were chosen primarily to capture the components of the CAMEL rating,

⁸ Total assets are the sum of total capital and total deposits.

⁹ This variable is common for all banks in the same prefecture. Because data on the amount of deposits or loans of individual banks by prefecture are not available, we used the number of branch offices to represent market share.

which has become a standard guideline for the risk of bank failure (Wheelock and Wilson 2000). CAPDEPO is used to capture the capital adequacy of a bank. A low value for this variable indicates a high risk. LIQUID is used to capture the liquidity of assets. If a bank has sufficient liquid assets, it is likely to survive an abrupt withdrawal of deposits. A higher ROE is expected to reduce the probability of bank failure. Note that the profit data on individual banks used to measure ROE are censored at zero by our source (*Ginkokyoku Nenpo*). That is, bank losses (negative profits) are not reported by this source.¹⁰ SECURITY is used to capture the risk associated with asset portfolios. In existing studies of the banking industry in prewar Japan, securities are treated as relatively safe assets with lower risk. This is because these securities comprise mainly government bonds and corporate bonds issued by major companies (Nanjo and Kauya 2006). Hence, we expect the coefficient of SECURITY to be negative.

Table 4 reports the estimation results for equation (1). In column 1, the coefficient of NT is negative and statistically significant at the 1% level, which suggests that banks with networks were less likely to fail than those without networks. Hence, interbank networks had a positive effect on the survival of banks. The coefficients of SIZE, EQ, and MS are statistically significant and have the expected signs. Thus, smaller banks in more competitive markets or those in areas damaged by the Great Kanto Earthquake in 1923 were more likely to fail. This finding is consistent with those of Okazaki et al. (2007) and Okazaki (2007). In column 2, in which the financial ratio variables are added, the coefficient of NT remains negative and highly significant. With respect to the financial ratio variables, ROE has an especially strong effect: the coefficient of ROE is negative and statistically significant at the 1% level. This indicates that profitable banks were less likely to exit because of failure.

In columns 3–5, the structure and quality of the network are taken into account.

¹⁰ The percentage of banks with censored observations is 6.3.

In column 3, to examine the effect of the structure of the network, banks with networks are split into three groups according to their position in the networks. That is, the variable NT is split into three dummy variables, CORE, PERIPHERY, and INDEPENDENT, which indicate that the bank was a core bank, a periphery bank, or an independent network bank, respectively. Column 3 shows that only the coefficient for INDEPENDENT is negative and statistically significant. This suggests that networks were beneficial only for banks operating outside the core–periphery structure. However, the point estimates of the effects of the three dummy variables are quite similar.¹¹

We now examine the implications of the quality of the network. It is hypothesized that a bank that had connections with banks that were performing well would be more likely to survive than others. To capture the quality of the network, we add to equation (1) the interaction term NT*WA(ROE), where WA(ROE) denotes the weighted average of the return on equity of the connected banks. Column 4 reports the estimation results. Although the coefficient of NT is no longer negative, the coefficient of NT*WA(ROE) is negative and statistically significant, which is consistent with the hypothesis. That is, banks that had connections with profitable banks were less likely to fail. However, as values of ROE are censored at zero because of data limitations, the coefficient of the interaction term NT*WA(ROE) may be biased.

To check the robustness of the results, we split NT into two dummy variables, NTP and NTN, according to the ROE of connected banks. That is, NTP is unity if the values of ROE are positive for all connected banks, and NTN equals unity if ROE was not positive at least for one of the connected banks. We then add NTP, NTN, and NTP*WA(ROE) to equation (1). By using the new interaction term NTP*WA(ROE), the

¹¹ To examine the effect of the geographical features of networks, we reestimated the model having split NT into intraregional networks and interregional networks. Both coefficients remained negative and statistically significant. In addition, the magnitudes of these point estimators were almost the same. Hence, with respect to the effect of interbank networks on bank survivability, the geographical structure of the networks did not matter.

effect of network quality is estimated more accurately. Column 5 reports the estimation results. The coefficient of the interaction term $NTP*WA(ROE)$ is negative and statistically significant. Its magnitude is slightly larger than that of $NT*WA(ROE)$ in column 4. We can calculate the marginal effects based on these estimates. According to our calculation, a 1% increase in the weighted average ROE of its connected banks lowers the probability of a bank's failure by 0.56%. In this sense, banks benefited from being connected to banks performing well.

To examine the effect of having a network with a bank performing badly, in column 6, we present estimates based on slightly different definitions of NTP and NTN. That is, NTN equals unity if ROE is not positive for all connected banks, and NTP equals unity if at least one connected bank has a positive ROE. As shown in column 6, the coefficient of NTN is positive, which indicates that banks connected to banks performing badly were more likely to fail. However, this coefficient is statistically insignificant. Therefore, we find no clear evidence that banks were adversely affected by being connected to banks performing badly.

3.2 Endogeneity of Interbank Network

In the above analyses, network variables were treated as exogenous. However, we cannot *a priori* deny the possibility that interbank networks were formed endogenously. For example, a bank may want to form networking links with a bank performing well because the former expects the latter will bring benefits in the future. If so, a bank performing well has more chance of having networks with other banks, and network variables are endogenous. Hence, to control the potential endogeneity of interbank networks, we consider the following equation, which includes three instrumental variables for the network variable (NT):

$$NT_i = \beta_0 + \beta_1 * N_BANK_i + \beta_2 * N_DIRECTOR_i + \beta_3 * AGE_i + \theta X_i + \varepsilon_i \quad (2)$$

where the dependent variable, NT, denotes the network variables. As for the explanatory variables, N_BANK denotes the total number of banks in the prefecture where a bank operated. We employ this variable as an instrument for the network variable, because, as shown in Table 2, interbank networks were mostly formed within the same prefecture, and hence a bank in the prefecture where there were many banks was more likely to have a network with another bank. N_DIRECTOR is the number of directors working for a bank. As our measure of networking is director interlocking, the more directors a bank had, the more likely that bank had a network with other banks. AGE indicates the age of a bank, which Okazaki et al. (2005) used as an instrument for the interlocking variable between a bank and nonbanking companies. The basic idea for this variable is that while a young bank could be firmly controlled by its founders, who held director positions there, their influence would be attenuated over time. Hence, an older bank would be less likely to have a network with other banks. X denotes the vector of the exogenous variables. As for the estimation method, we use the bivariate probit model, because the endogenous variable NT is a binary variable.¹² Namely, we estimate equations (1) and (2) simultaneously.

The estimation results of equations (1) and (2) are in the upper and lower parts of Table 5, respectively. In column 1, it is confirmed that the coefficient of NT is still negative and statistically significant at 1%, even after controlling for the endogeneity of the interbank network. As for the result of equation (2), all instrumental variables have the expected signs. In particular, the number of directors (N_DIRECTOR) has a strong effect. In column 2, where the financial ratios are included as the explanatory variables,

¹² The probit model with instrument variables by maximum likelihood estimation or by the minimum chi-squared two-step estimation proposed by Newey (1987) assumes that endogenous variables are continuous. Hence, they are not appropriate when endogenous variables are binary.

the coefficient of NT is still negative and statistically significant at 1%. Hence, we have strong evidence that the interbank network had a positive effect on bank survivability, even if controlling for the endogeneity of the interbank network.

Furthermore, in column 3, we estimate the bivariate probit model, replacing endogenous variables with NTP. As defined above, NTP is the dummy variable that takes unity if the values of ROE are positive for all connected banks, and zero otherwise.¹³ The estimated result shows that the coefficient of NTP is still negative and statistically significant at 1%, after controlling for the endogeneity of the interbank network. In column 4, we also estimate the bivariate probit model, replacing the endogenous variable with NTN, which denotes the dummy variable that takes unity if the values of ROE are negative for all connected banks, and zero otherwise.¹⁴ The coefficient of NTN is positive and statistically significant, which indicates that a bank that had a connection with a poorly performing bank was more likely to fail. However, it should be noted that the instrumental variables do not always have the expected signs and statistical significance in column 4, probably because there are not many cases where NTP takes unity.¹⁵ In column 5, we use $NTP*WA(ROE)$, which denotes the interaction term between NTP and the weighted average of ROE of the connected banks, as the endogenous variable.¹⁶ It is confirmed again that the coefficient of $NTP*WA(ROE)$ is negative and statistically significant. These results are consistent with those of Table 4.

In summary, even after controlling for the endogeneity of interbank networking, we obtained robust evidence that interbank networking had a positive effect on bank survivability, and that the quality of networks was significant. In particular, if a bank

¹³ We used this variable in the analysis in column 5 of Table 4.

¹⁴ We used this variable in the analysis in column 6 of Table 4.

¹⁵ Only 19 banks (1.9%) take unity in the value of NTP.

¹⁶ In the estimation, we use the probit model with instrument variables by maximum likelihood estimation because the endogenous variable is not binary.

had a network, especially a network with well-performing counterparts, it benefited from the network. On the other hand, if a bank had a network with badly performing counterparts, it arguably received a negative impact from that.

3.3 Bank Networks and the Contagious Withdrawal of Deposits

We now examine the effect of interbank networks on the ability of banks to collect deposits. As discussed in the existing studies, it is possible that financial contagion spreads through interbank networks. For instance, if a bank closes because there is a run on that bank, the banks connected with it are more likely to be exposed to contagious runs. This is because depositors would suspect that connected banks would become insolvent and illiquid due to the closed bank's defaults on its interbank loans. There is anecdotal evidence that this occurred during Japan's financial crisis of 1927 (the Showa Financial Crisis).¹⁷ Thus, we examine whether this type of contagious deposit withdrawal occurred in prewar Japan. For this purpose, we estimate the following equation for deposit growth:

$$\begin{aligned} \text{GDEPO}_i = & \gamma_0 + \gamma_1 \cdot \text{NTP}_i + \gamma_2 \cdot \text{NTN}_i + \gamma_3 \cdot \text{M\&A}_i + \gamma_4 \cdot \text{SIZE}_i + \gamma_5 \cdot \text{CAPDEPO}_i + \gamma_6 \cdot \text{LIQUID}_i \\ & + \gamma_7 \cdot \text{ROE}_i + \gamma_8 \cdot \text{SECURITY}_i + u_i \end{aligned} \quad (3)$$

where the dependent variable, GDEPO, is the deposit growth rate from the end of 1926 to the end of 1927. This period includes the Showa Financial Crisis of 1927, when nationwide bank runs occurred and, consequently, 44 banks closed. The network variables, NT, NTP, and NTN, are included among the explanatory variables to examine the contagious effect of a bank's deposit shock on banks in the same network. The

¹⁷ At the beginning of the Showa Financial Crisis of 1927, the run on the Tokyo Watanabe Bank immediately triggered a run on its family bank, the Akaji Savings Bank. Consequently, these two banks closed.

dummy variable NTP is unity if the weighted average of the deposit growth rate of the connected banks in the same network is positive, and is zero otherwise. The NTN dummy variable is unity if the weighted average of the deposit growth rate of the connected banks is negative, and is zero otherwise. If the deposits of a bank decreased because of contagious withdrawals from within the same network, the coefficient of NTN would be negative. The dummy variable M&A is unity if a bank experienced mergers or acquisitions in 1927, and zero otherwise. For banks that experienced mergers or acquisitions in 1927, in calculating GDEPO, deposits of 1926 for the *pro forma* banks are used.¹⁸ In addition, measures of bank size and the financial ratios used in equation (1) are included as the explanatory variables. We also include the area dummies to control for area-specific shocks. In calculating standard errors, robust-cluster standard errors, where clusters are defined by areas, are used to control correlations of errors within area, because contagious bank runs or withdrawals of deposits were likely to spread within the area. Our sample size is reduced because 183 of the 1007 observations used previously were lost because of exits. In addition, we excluded eight banks classed as outliers because their deposit growth rate exceeded 100%. Consequently, 816 observations remain.

Table 6 reports the estimation results. In column 1, NT is the network variable. Although the coefficient of NT is positive, it is not statistically significant. In column 2, NTN and NTP are the network variables. The coefficient of NTN is negative, which is consistent with the contagious withdrawals of deposits. However, this effect is not statistically significant. Although the coefficient of NTP is positive, it is not statistically significant. Furthermore, although its coefficient is not reported in Table 5, we include an interaction term between the network dummy (NT) and the weighted average

¹⁸ The value of a *pro forma* bank denotes the combined values of the balance sheets of participating banks. With respect to other variables, the values of acquiring banks are used.

deposit growth rate of the connected banks in the same network. However, the coefficient on the interaction term is not statistically significant.

On the other hand, as shown in Table 6, the coefficients on ROE and CAPDEPO are positive and statistically significant, which implies that banks performing well were more likely to collect deposits. In other words, fundamental factors explain the change in deposits well. This is consistent with the findings of Yabushita and Inoue (1993) and Okazaki (2007), who examined the factors affecting the probability of bank closures during the Showa Financial Crisis of 1927 to investigate the hypothesis that depositors discipline bank management. In summary, there is no strong evidence for the contagious effect of interbank networks, at least with respect to all the sampled banks.

Next, we conduct subsample analyses to examine the possibility that the contagious effects differed between banks performing well and ones performing badly. That is, splitting the 816 sample banks into two equal groups according to their ROEs, we estimate equation (3) for these two subgroups. The estimation results for the less profitable banks (below the 50th percentile) and those for the more profitable banks (above the 50th percentile) are shown in columns 3 and 5, respectively. In column 3, the coefficient of NTN is positive, which is inconsistent with the presence of contagion effects. The coefficient of NTP is positive and statistically significant at the 5% level, which suggests that less profitable banks with connections to banks whose deposits increased were capable of collecting more deposits. One interpretation of this result is that banks performing badly enhanced their credibility by having connections with credible banks. In column 5, the coefficient of NTN is negative and statistically significant, which is consistent with contagion effects in interbank networks. This implies that banks that performed well were exposed to contagious withdrawals of deposits prompted by deposit withdrawals from connected banks. In this sense, contagious interbank network effects did not necessarily enhance the stability of the

financial system. In columns 4 and 6, we check the robustness of our results by excluding the area dummies, and find that our estimation results do not change substantially.

Furthermore, we check robustness with respect to the endogeneity of the interbank network, as investigated in the subsection 3.2. In addition to the three variables used in the previous section, namely, N_BANK, N_DIRECTOR and AGE, we use the natural logarithm of the average of the total assets of the connected banks as an instrumental variable, because we consider this variable correlates with the ability of the connected banks to collect deposits. In the estimation, we conduct two-stage least square regression where the network variables are endogenous.¹⁹ Appendix Table 1 reports the results of the second stage regressions. They confirm that the positive coefficient of NTP is no longer statistically significant in the more profitable banks (columns 3 and 4), if we control for the endogeneity of the interbank network. On the other hand, the coefficient of NTN is still negative and statistically significant at the 5% level in the more profitable banks (columns 5 and 6). From these results, we can safely conclude that banks performing well were exposed to contagious withdrawals of deposits prompted by deposit withdrawals from connected banks. In this sense, interbank networks worked as a transmitter of contagious deposit withdrawals.

Finally, to correct the selection bias arising from bank exits, we estimate equation (3) by employing the sample selection model. In this model, the selection equation explains the probability of exit, and includes as explanatory variables SIZE, EQ, BOJ, MS, CAPDEPO, LIQUID, ROE, and SECURITY, which are the variables used in equation (1). The estimation results for the main equation are reported in Appendix Table 2. The coefficients of NTN are negative for the more profitable banks. Hence, our estimation results are robust to correcting for potential sample selection bias.

¹⁹ As for standard errors, we also used robust-cluster standard errors.

4. Bank Networks and Consolidation

As mentioned above, a large wave of bank consolidations occurred in Japan in the late 1920s and early 1930s, after the implementation of the Bank Law of 1927. This law prescribed that a bank should, in principle, have capital of no less than one million yen and that an existing bank whose capital was smaller than this minimum level was required to meet this requirement within five years. Although more than half of the ordinary banks did not meet this criterion when the law was enacted in 1928, no individual bank was allowed to increase its own capital in principle. Therefore, these banks were obliged to implement consolidations or liquidations. Thus, in this section, we address the question of how interbank networks were related to the process and result of these consolidations.

4.1 Bank Networks and the Choice of Partner Banks

First, we examine the effects of interbank networks on the process of consolidations. Most banks whose capital was below the minimum requirement searched for consolidation counterparts in order to avoid liquidations. How did these banks choose their counterparts? Moreover, what role did interbank networks play in the process? It is possible that interbank networks affected the choice of counterparts. For instance, a bank may be uncertain about the soundness of another bank with which it intends to merge, because complete information about counterparts is difficult to obtain. In this case, the interbank network based on director interlocking may mitigate such information asymmetry between the two banks and thereby resolve the adverse selection problem. Moreover, the directors who serve both banks may be able to coordinate the negotiations on consolidation to reduce transaction costs.²⁰ Therefore,

²⁰ D'aveni and Kesner (1993) show that target firms are less likely to resist a takeover

one would expect banks were more likely to be consolidated with banks in the same network than with those outside the network.

Before testing this hypothesis directly, we first used *Ginko Jiko Geppo* (*Monthly Bank Affairs*) edited by the BOJ to trace the 1007 banks to see whether they participated in consolidations between Jan. 1927 and Dec. 1929. Table 7 compares the share of banks within networks among the total number of merged banks to the share of banks within networks among the total number of banks that were not merged. This comparison reveals that the share of banks within networks is significantly larger among merged banks. This suggests that interbank networks had a significant effect on the process of consolidation.

Next, we test this hypothesis by using data on the individual events of bank consolidations that occurred between Jan. 1927 and Dec. 1932. From the consolidation events reported in *Ginko Jiko Geppo*, we selected those on which information on the directors involved was available for all participating banks. This yielded information on 173 events. Table 8 shows the number and proportion of intranetwork consolidations in which the participating banks were connected with each other before the consolidation, out of the 173 consolidation events. In cases where the number of participating banks was more than two, an event was regarded as an intranetwork consolidation if there had been at least one connection among the participants. In Panel A, consolidations are classified into three categories according to *Ginko Jiko Geppo*: absorption, acquisition, and combination into a new bank. In this context, combination into a new bank is a form of consolidation under which a new bank is established after the dissolution of all participants.

In more than 30% of the consolidations, networks already existed among the participating banks. By observing the different types of consolidations, we found that

when their managers and the acquiring firm's outsiders have shared connections to the same prestigious networks.

the proportion of intranetwork consolidations was approximately twice as high in the category of combination into a new bank as in the other combination categories. In addition, Panel B distinguishes between “one-to-one consolidation” and “more-than-two consolidations”, with respect to the number of participating banks. The results therein indicate that this proportion is higher in the “more-than-two consolidations” case than in the “one-to-one consolidation” case.

In interpreting the above findings, Kin'yu Kenkyu-Kai(1934), which comprehensively surveyed bank consolidations in Japan in this period, is a basic reference. According to this reference, participant banks tended to combine into a new bank when the banks were equally powerful. However, in general, negotiations over consolidations are thought to be more likely to break off when many equally powerful participants are involved. Integrating these points into the results in Table 8, our interpretation is that interbank networks facilitated coordination among merger participants, particularly when negotiation costs were high.

Panel C classifies consolidations into intraregional consolidations and interregional consolidations. Whereas the former refers to consolidations in which all participating banks operated in the same prefecture, the latter refers to other consolidations. Panel C shows that the ratio of intranetwork consolidations was higher among the intraregional consolidations than among the interregional.

One should be careful in interpreting the results reported in Panels A and C. In the context of the former, it is possible that the participating banks were more likely to have connections among themselves when combining into a new bank simply because the number of participants was larger. In addition, in relation to the results in Panel C, the proportion of intranetwork consolidations is higher in the case of intraregional consolidations simply because the density of networks is higher within the same prefecture, as we showed in Section 2.

Thus, it is necessary to examine the role of interbank networks in determining merger partners, controlling for these other factors. Thus, using data on 320 banks, which participated in 173 consolidations, we tested whether a connection between a pair of banks raised the probability of consolidation between them. The equation to be estimated is as follows:

$$\Pr(\text{MERGE}_{ij} = 1) = F(\beta_0 + \beta_1 \cdot \text{NT}_{ij} + \beta_2 \cdot \text{PREF}_{ij}), i \neq j \quad (4)$$

where MERGE_{ij} is a dummy variable that is unity if bank i and bank j merged from 1927 to 1929, and is zero otherwise. The NT_{ij} dummy variable is unity if there was director interlocking between bank i and bank j , and is zero otherwise. A positive coefficient of NT_{ij} suggests that a network between the two banks made it easier for them to merge. The dummy variable PREF_{ij} is unity if the headquarters of banks i and j were located in the same prefecture, and is zero otherwise. We estimated equation (4) as a logit model for all pairs of banks.²¹

The estimation results are reported in Table 9. The results in column 1 relate to the full sample of consolidation observations. The coefficient of NT is positive and statistically significant, which suggests that each bank preferred to merge with a bank with which it already had a connection. In columns 2–4, the consolidations are classified into abortions, acquisitions, and combinations into a new bank, respectively. Although the coefficient of NT is positive and statistically significant in all cases, it is larger in magnitude for combinations into new banks, which is consistent with the results in Panel A of Table 8. Hence, it can be concluded that interbank networks facilitated coordination among merger participants, particularly when negotiation costs were high.

²¹ The total number of pairs of banks i and j is $N \cdot (N - 1) / 2$, after removing pairings of the same bank. Therefore, among 320 banks, there are 51,040 pairs.

In Panel B, consolidations are classified into intraregional and interregional consolidations. The explanatory variable $PREF_{ij}$ is excluded. The coefficient of NT is positive and statistically significant for both intraregional and interregional consolidations. However, the magnitude of the former is larger than that of latter, which is also consistent with the results in Panel C of Table 8.

In summary, we can conclude that interbank networks facilitated consolidation with other banks.

4.2 Bank Networks and Postmerger Performance

We have presented evidence that the interbank networks facilitated consolidations within those networks. How, then, were the interbank networks associated with the results of the consolidations? To be more specific, did the intranetwork consolidations have a better effect on bank performance than did other consolidations? Premerger networks might have reduced the costs of unifying different organizations. To address this issue, we estimated the effects of intranetwork consolidation on postmerger financial performance. We follow the methodology of Okazaki and Sawada (2007), who used data on the 1927–1932 event to examine the effect on the financial performance of banks of consolidation promoted by the 1927 Bank Law. These authors estimated the effect of consolidation on bank performance by comparing the change in the return on assets (ROA) and the change in the deposit growth rate from year $T - 1$ to years $T + 2$ and $T + 3$ between consolidated banks and nonconsolidated banks, with T being the event year in which the consolidation occurred.²² In our analysis, we focus on consolidation events from 1927 to 1929.

First, the consolidation events must be selected. To identify clearly the effects of consolidation, we excluded from the analysis banks that participated in multiple

²² Furthermore, to capture the effect of policy-promoted consolidation, the authors split the effect of consolidations into a policy-promoted effect and a strategic effect.

consolidations from $T - 1$ to the end of year $T + 3$.²³ In addition, we limited our focus to consolidation events on which data on director interlocking were available for all participating banks. This yielded information on 66 consolidation events. Next, the control samples for each event year (1927–1929) were chosen to be compared with the consolidated banks. The control sample banks, which correspond to the consolidated banks in event year T , refer to the banks that were not involved in any consolidations from the beginning of year $T - 1$ to the end of year $T + 3$. For example, the control samples for the event year 1927 are the banks that were not involved in any consolidations from 1926 to 1930. These are compared with the banks that were consolidated in 1927. Event observations for the year 1927 were the consolidated banks in 1927 and their control sample banks. In the same way, event observations were constructed for 1928 and 1929, to yield unbalanced panel data in three groups of event years, 1927–1929, which consist of 1075 bank-event year observations. Table 10 shows the number of consolidations and control samples by event year. The consolidations are classified into intranetwork consolidations and other consolidations. Approximately 30% of the consolidations are classed as intranetwork consolidations, in which the participating banks had a mutual connection thorough director interlocking.

For our empirical specification, the model of Okazaki and Sawada (2007) was modified slightly to explicitly capture the effects of intranetwork consolidations. We estimated the following model:

$$\Delta Y_{it} = \lambda_0 + \lambda_1 * M\&A_{it} + \lambda_2 * NT_{it} * M\&A_{it} + \theta X_{it} + \varepsilon_{it} \quad (5)$$

where i indexes the bank and t indexes the event year group. The dependent variable,

²³ We include in these events the case in which one bank merges with other banks twice in the same year. These consolidations were treated as single incidences of merger. There were four such cases: Dai-Hachiju-go Bank (1927); Ju-ni Bank (1928); Ogaki-Kyoritsu Bank (1928); and Goju-roku Bank (1928).

ΔY_{it} , is the change in either the ROA or the deposit growth rate from the end of year $T - 2$ to the end of year $T + 2$ or $T + 3$.²⁴ For the values of Y_{it} for the consolidated banks in year $T - 2$, those of the pro forma banks were used. This means that we used the sum of the balance sheets of the banks participating in consolidations. The explanatory variable $M\&A$ is a dummy variable that is unity if a bank participated in consolidations. A positive coefficient of $M\&A$ indicates that consolidation had a positive effect on bank performance. The dummy $NT*M\&A$ is unity if a bank participated in an intranetwork consolidation in year T . A positive coefficient of $NT*M\&A$ indicates that intranetwork consolidation had a more beneficial effect on bank performance than did other consolidations. We are particularly interested in the effect of this variable. X is a vector of other explanatory variables. Following Okazaki and Sawada (2007), we include the natural log of total assets ($SIZE$), the change in the number of branch offices ($\Delta BRANCH$), and the dummy variable $URBAN$, which indicates whether the headquarters of the bank was located in an urban area (*i.e.*, in Tokyo, Kanagawa, Aichi, Kyoto, Osaka, or Hyogo prefectures).²⁵ In addition, for the model in which the dependent variable is the change in the ROA, the loan–asset ratio ($LOAN/ASSET$) is included to capture the asset risk of banks. Equation (5) is estimated by using pooled OLS with heteroskedasticity robust standard errors (White 1980).

Table 11 reports the estimation results for the model of the deposit growth rate. Columns 1–4 report results based on the whole sample of banks; the results reported in columns 5–8 are based on excluding outliers, defined as cases in which a bank’s deposit growth rate exceeded 100%. In columns 1 and 2, the dependent variable is the deposit

²⁴ Because consolidations were frequently accompanied by asset reevaluation, the value of the assets of the postconsolidation bank was adjusted according to the following equation: $ASSET_{T+i}^* = ASSET_{T-1} + (ASSET_{T+i} - ASSET_T)$, $i = 2, 3$.

²⁵ Moreover, in the estimation, the event year dummies were included as explanatory variables to control for shocks common to observations relating to the same event year group. However, the estimated coefficients of these year dummies are not reported in the table.

growth rate from the end of year $T - 2$ to the end of year $T + 2$. In columns 3 and 4, the dependent variable is the deposit growth rate from the end of year $T - 2$ to the end of year $T + 3$. Column 1 reports estimation results based on excluding NT*M&A. The coefficient of the consolidation dummy (M&A) is positive and statistically significant. This suggests that consolidations enhanced the ability of banks to collect deposits, which is consistent with the findings of Okazaki and Sawada (2007). In column 2, the variable NT*M&A is added to capture the effect of intranetwork consolidation. Although the coefficient of M&A remains positive and statistically significant, the coefficient of NT*M&A is negative, but statistically insignificant. This suggests that intranetwork consolidations do not have greater beneficial effects on deposit growth rates than do other consolidations. Columns 3 and 4 report results based on using changes in deposits from $T - 2$ to $T + 3$ as the dependent variable. In column 4, the coefficient of NT*M&A is positive, but statistically insignificant. Thus, there is no evidence that the effect of intranetwork consolidations exceeds that of other consolidations. Excluding outliers did not qualitatively change the results (see columns 5–8). In summary, in prewar Japan, consolidation itself had a positive effect on the deposit growth rate, but this positive effect was not significantly larger for intranetwork consolidation.

Table 12 reports the estimation results for equation (5), with the change in the ROA being the dependent variable. Columns 1 and 2 (columns 3 and 4) report results for performance changes from the end of year $T - 2$ to year $T + 2$ (from the end of year $T - 2$ to year $T + 3$). In columns 1 and 3, the coefficients of the consolidation dummy (M&A) are negative, but not statistically significant. In columns 2 and 4, the coefficients of NT*M&A are negative and positive, respectively, but not statistically significant. Therefore, there is no clear evidence that intranetwork consolidations had a more beneficial effect on bank profitability than did other consolidations.

In columns 5–8, we report results for equation (5) with the change in the ROA being the dependent variable, taking into account that the profit data are censored at zero. Having eliminated from the sample those banks with a recorded profit of zero, we estimated equation (5) by maximum likelihood, correcting for sample selection. Following Okazaki and Sawada (2007), we included in the selection equation the consolidation dummy (M&A), SIZE, URBAN, LOAN/ASSET, and event year dummies, which are expected to explain cross-sectional differences in bank profits. (The estimated selection equation is not reported.) The estimation results for the main equation are reported in columns 5–8. These results provide no evidence that intranetwork consolidation had a more beneficial effect on bank profitability than did other consolidations.

In summary, the results obtained in this section indicate that interbank networks facilitated within-network consolidations by reducing the costs of coordination, but that intranetwork consolidations did not strongly enhance postmerger performance.

5. Concluding Remarks

In this paper, we investigated the structure and implications of interbank networks in prewar Japan, focusing on director interlocking. We found that approximately 60% of the banks had at least one connection with another bank through director interlocking. These connections resulted in the construction of complex networks of banks, which were not necessarily simple core–periphery structures.

Based on this finding, we examined the impact of the interbank networks on the survivability of banks. We found that a bank with a network was less likely to fail than a bank without one. Furthermore, we found that a bank that had a network with profitable banks was less likely to fail. That is, it is not the networks *per se* but the quality of networks that mattered. These results suggest that interbank networks

contributed to the stability of the financial system. This is not consistent with the view that financial networks propagate shocks thorough contagion. We then directly examined whether financial contagion spread through interbank networks (Allen and Gale 2000; Freixas et al. 2000; Leinter 2005). Regression analyses revealed that a bank performing well suffered reduced deposits when banks in the same network experienced deposit withdrawals. In this sense, there was contagion. In this context, network quality was again important. These findings enable us to conclude that financial networks stabilized the financial system to the extent that the good banks in those networks could withstand contagious deposit withdrawals. Thus, the net effect of the financial networks was positive in prewar Japan.

Finally, financial networks also affected bank consolidations, which surged in Japan in the 1920s and 1930s. We found that banks tended to consolidate with banks in the same network. This suggests that interbank networks played a role in coordinating bank mergers. Moreover, we find that postmerger performance was not significantly affected by whether banks merged with other banks from inside or outside their networks. However, in the sense that bank mergers positively affected deposits (Okazaki and Sawada 2007), and given that interbank networks helped coordinate bank mergers, interbank networks contributed to stabilizing the financial system.

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Table1 Distribution of the number of connections through director interlocking

Number of connections	Observations	%
0	420	41.71%
1	297	29.49%
2	146	14.50%
3	63	6.26%
4	40	3.97%
5	16	1.59%
6	10	0.99%
7	4	0.40%
8	1	0.10%
9	5	0.50%
10	2	0.20%
11	2	0.20%
13	1	0.10%
Total		100.00%

Table2 Structure of interbank networks

Panel A Positions in networks

Types	Observations	%
Core bank	81	13.8%
Periphery bank	142	24.2%
Independent network bank	364	62.0%
Total	587	100%

Panel B Regional characteristics of interbank network.

Types	Observations	%
Intra-regional network	402	68.5%
Inter-regional network	185	31.5%
Total	587	100.0%

Table3 Basic Statistics

Variable	Banks with networks		Banks without networks		T-statistics
	Mean	Std. Dev.	Mean	Std. Dev.	
Number of connections	2.068	1.659	-	-	-
Capitals/Deposits	0.898	4.370	1.24	9.64	-0.77
Deposits/Loans	0.896	0.667	1.49	12.32	-1.16
Reserves/Total assets	0.088	0.081	0.09	0.07	-0.33
ROE	0.135	0.079	0.130	0.080	0.86
Amount of Total deposits (thousand yen)	11904.8	46882.6	4213.30	22107.00	3.12
Amount of Total assets (thousand yen)	14938.4	57851.8	5401.8	26252.4	3.15

T-statistic tests the hypothesis that there is no difference between banks with networks and ones without networks

Table4 Interbank networks and survivability

Variables	[1]	[2]	[3]	[4]	[5]	[6]
NT	-0.2923*** (0.1105)	-0.3193*** (0.1177)		0.3160 (0.2367)		
CORE			-0.3765 (0.2612)			
PERIPHERY			-0.3155 (0.1941)			
INDEPENDENT			-0.3099** (0.1326)			
NT*WA(ROE)				-5.5024*** (1.8381)		
NTP			-0.0764 (0.2371)		0.3653 (0.3257)	0.3017 (0.3066)
NTP*WA(ROE)					-5.7587** (2.4987)	-5.3988** (2.3348)
NTN					-0.0764 (0.2371)	0.3407 (0.3081)
SIZE	-0.2496*** (0.0623)	-0.1305** (0.0615)	-0.1289** (0.0629)	-0.1400** (0.0622)	-0.1406** (0.0627)	-0.1397** (0.0624)
EQ	0.6062*** (0.1372)	0.4842*** (0.1571)	0.4866*** (0.1599)	0.4976*** (0.1543)	0.5000*** (0.1548)	0.4967*** (0.1547)
BOJ	0.2018 (0.1761)	0.1838 (0.1873)	0.1843 (0.1863)	0.2253 (0.1884)	0.2191 (0.1880)	0.2253 (0.1884)
MS	-0.0129** (0.0051)	-0.0125** (0.0055)	-0.0125** (0.0055)	-0.0126** (0.0056)	-0.0125** (0.0055)	-0.0126** (0.0056)
CAPDEPO		0.0634* (0.0346)	0.0632* (0.0345)	0.0555 (0.0360)	0.0535 (0.0359)	0.0558 (0.0362)
LIQUID		-1.2215 (1.0920)	-1.2298 (1.0869)	-1.2225 (1.0607)	-1.3545 (1.0646)	-1.2153 (1.0586)
ROE		-5.8092*** (1.7062)	-5.8165*** (1.7016)	-5.7735*** (1.6657)	-5.8682*** (1.6577)	-5.7630*** (1.6635)
SECURITY		-0.2304 (0.3651)	-0.2344 (0.3663)	-0.1939 (0.3195)	-0.1988 (0.3157)	-0.1938 (0.3204)
INTERCEPT	2.7276*** (0.8897)	1.7556** (0.8728)	1.7327* (0.8952)	1.8833** (0.8931)	1.9103** (0.8999)	1.8786** (0.8985)
Pseudo R2	0.1	0.205	0.205	0.224	0.22	0.224
Observations	1007	1007	1007	1007	1007	1007

Notes:

Significance at 1%,5% and 10% level are denoted by "***" "**" and "*".

The figures in parentheses are standard errors.

Table5 Interbank networks and survivability, controlling the endogeneity of interbank network

Methodology	Bivariate probit [1]	Bivariate probit [2]	Bivariate probit [3]	Bivariate probit [4]	IV probit [5]
Primary equation (equation (1))					
Explanatory variables					
NT	-1.6304*** (0.2219)	-1.5278*** (0.2250)			
NTP			-1.6956*** (0.1762)		
NTN				2.5652*** (0.4716)	
NTP*WA(ROE)					-13.2659*** (0.6920)
SIZE	-0.1358** (0.0581)	-0.0505 (0.0579)	-0.0262 (0.0550)	-0.1473** (0.0606)	0.0118 (0.0532)
EQ	0.3101** (0.1460)	0.2697* (0.1472)	0.1744 (0.1406)	0.4858*** (0.1501)	0.0137 (0.1497)
BOJ	0.2147 (0.1508)	0.2002 (0.1615)	0.2028 (0.1533)	0.1739 (0.1798)	0.2380** (0.1191)
MS	-0.0120*** (0.0041)	-0.0117** (0.0046)	-0.0135*** (0.0042)	-0.0120** (0.0051)	-0.0111*** (0.0039)
CAPDEPO		0.0500 (0.0311)	0.0503* (0.0283)	0.0622* (0.0376)	0.0235 (0.0212)
LIQUID		-1.1829* (0.6523)	-0.9595 (0.6273)	-0.9980 (0.7134)	-0.3229 (0.6113)
ROE		-4.5175*** (0.9122)	-3.7504*** (0.9005)	-5.2923*** (0.8640)	-1.6983 (1.4234)
SECURITY		-0.2117 (0.2241)	-0.1792 (0.2190)	-0.2056 (0.2459)	-0.0807 (0.1774)
INTERCEPT	2.1379*** (0.7497)	1.3800* (0.8019)	1.0661 (0.7723)	1.7071* (0.8791)	0.6732 (0.6951)
Equation of determinants of network variables (equation (2))					
Endogenous variable	NT	NT	NTP	NTN	NTP*WA(ROE)
Explanatory variables					
N_BANK	0.0017 (0.0014)	0.0022 (0.0014)	0.0019 (0.0014)	-0.0011 (0.0045)	0.0000 (0.0001)
N_DIRECTOR	0.0643*** (0.0143)	0.0683*** (0.0146)	0.0460*** (0.0133)	-0.0181 (0.0386)	0.0026** (0.0011)
AGE	-0.0002 (0.0032)	-0.0009 (0.0033)	0.0017 (0.0032)	-0.0127 (0.0083)	0.0001 (0.0001)
SIZE	0.0921** (0.0403)	0.0832** (0.0419)	0.0925** (0.0411)	-0.0824 (0.1103)	0.0041* (0.0025)
EQ	-0.2082* (0.1208)	-0.1909 (0.1228)	-0.3031** (0.1226)	0.3311 (0.2740)	-0.0117 (0.0073)
BOJ	0.2215* (0.1220)	0.2279* (0.1240)	0.2384* (0.1216)	-0.0018 (0.3265)	0.0141* (0.0075)
MS	-0.0018 (0.0040)	-0.0014 (0.0040)	-0.0057 (0.0039)	0.0133 (0.0109)	-0.0005** (0.0002)
CAPDEPO		-0.0014 (0.0059)	-0.0005 (0.0058)	-0.0920 (0.1103)	-0.0000 (0.0003)
LIQUID		-0.0801 (0.5190)	0.3533 (0.5174)	-8.4878*** (2.9964)	0.0167 (0.0295)
ROE		0.2188 (0.5258)	0.4754 (0.5243)	-4.8770*** (1.7092)	0.0592* (0.0318)
SECURITY		0.0194 (0.1500)	0.0497 (0.1503)	-0.3165 (0.6783)	0.0022 (0.0065)
INTERCEPT	-1.7381*** (0.5928)	-1.6866*** (0.6054)	-1.7502*** (0.5934)	0.3709 (1.6113)	-0.0087 (0.0345)
rho	0.832**	0.759**	0.848***	-0.890**	0.912***
P-value	0.012	0.012	0.001	0.012	0.006
Log likelihood	-958.8	-922.9	-933.6	-351.1	903.4
Observations	1007	1007	1007	1007	1007

Table6 Interbank networks and contagious withdrawals of deposits

	Dependent variable: Deposit Growth Rate					
	[1]	[2]	Subsample			
			Low ROE [3]	Low ROE [4]	High ROE [5]	High ROE [6]
NT	0.00578 (0.0147)					
NTN		-0.00332 (0.0162)	0.0329 (0.0254)	0.0407* (0.0221)	-0.0417** (0.0161)	-0.0366** (0.0150)
NTP		0.0191 (0.0167)	0.0508** (0.0191)	0.0593** (0.0253)	0.00221 (0.0258)	0.00340 (0.0230)
M&A	0.0368* (0.0193)	0.0374* (0.0189)	0.0960 (0.0557)	0.0891 (0.0581)	0.0231 (0.0223)	0.0189 (0.0222)
SIZE	-0.0120 (0.00763)	-0.0121 (0.00760)	-0.0191* (0.00998)	-0.0213 (0.0122)	-0.0111 (0.0133)	-0.0129 (0.0114)
ROE	0.284* (0.145)	0.286* (0.148)	0.854** (0.269)	1.038*** (0.189)	-0.193 (0.178)	-0.200 (0.171)
CAPDEPO	0.001*** (0.0003)	0.001*** (0.0003)	0.0016*** (0.0002)	0.0009*** (0.0002)	0.0422 (0.0609)	0.0392 (0.0584)
LIQUID	-0.131 (0.109)	-0.134 (0.110)	-0.279** (0.117)	-0.328** (0.137)	0.141 (0.155)	0.0760 (0.136)
SECURITY	0.0758** (0.0251)	0.0756** (0.0248)	0.0734** (0.0240)	0.0590** (0.0192)	0.0862 (0.0472)	0.0856* (0.0466)
INTERCEPT	0.109 (0.0931)	0.110 (0.0930)	0.148 (0.161)	0.129 (0.170)	0.149 (0.225)	0.167 (0.194)
Area dummies	Yes	Yes	Yes	No	Yes	No
R2	0.058	0.059	0.114	0.062	0.063	0.043
Observations	816	816	408	408	408	408

Notes:

Significance at 1%,5% and 10% level are denoted by "***" "**" and "*".

The figures in parentheses are standard errors.

Table 7 Comparison of the ratio of banks with networks among merged banks to that among banks not merged

	Banks not merged	Merged banks
With networks	265	155
Without networks	292	295
% of banks with networks	52.4%	65.6%

Table8 Interbank networks and bank consolidation in 1927–29

Panel A: Form of consolidation

Types	Number of events	Number of Intra-network	%
Absorptions	94	27	28.7%
Combination into a new bank	25	14	56.0%
Acquisitions	54	14	25.9%
Total	173	55	31.8%

Panel B: Number of participants

Types	Number of events	Number of Intra-network	%
One-to-one	154	42	27.3%
More than two	19	13	68.4%
Total	173	55	31.8%

Panel C: Regional characteristics

Types	Number of events	Number of Intra-network	%
Intra-regional	146	49	33.6%
Inter-regional	27	6	22.2%
Total	173	55	31.8%

Table9 Interbank networks and choice of partner banks

Panel A: Type of Consolidations

Variables	All consolidations [1]	Absorptions [2]	Acquisitions [3]	Combination into a new bank [4]
NT	2.8113*** (0.2466)	1.9442*** (0.2724)	2.0950*** (0.3582)	2.6166*** (0.3054)
PREF	5.0681*** (0.2116)	5.0545*** (0.2919)	4.2533*** (0.3484)	6.9611*** (1.0466)
INTERCEPT	-7.4196*** (0.1817)	-8.0405*** (0.2495)	-8.2492*** (0.2772)	-10.8191*** (0.9982)
Pseudo	0.472	0.398	0.299	0.498
Observations	51040	51040	51040	51040

Panel B: Regional characteristics

	Intra-regional [1]	Inter-regional [2]
NT	5.5278*** (0.1878)	4.4878*** (0.4640)
INTERCEPT	-5.9221*** (0.0859)	-7.6589*** (0.2041)
Pseudo	0.190	0.080
Observations	51040	51040

Notes:

Significance at 1%,5% and 10% level are denoted by "***" "**" and "*".

The figures in parentheses are standard errors.

Table10 Number of samples by event year

Event Year	Intra-network consolidations	Other consolidations
1927	5	12
1928	9	19
1929	6	15
Total	20	46

Table11 The effect of consolidations on deposit growth rate

Window Variables	All samples				Excluding outliers			
	Dependent variable: Deposit growth rate from T-2 to T+2 or T+3							
	[T-2, T+2]	[T-2, T+2]	[T-2, T+3]	[T-2, T+3]	[T-2, T+2]	[T-2, T+2]	[T-2, T+3]	[T-2, T+3]
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
M&A	0.1309*** (0.0396)	0.1317*** (0.0456)	0.1019** (0.0440)	0.0863* (0.0477)	0.1558*** (0.0388)	0.1518*** (0.0439)	0.1399*** (0.0434)	0.1169** (0.0466)
M&A*NT		-0.0027 (0.0758)		0.0511 (0.0882)		0.0130 (0.0814)		0.0764 (0.0945)
SIZE	-0.0241 (0.0168)	-0.0242 (0.0169)	-0.0105 (0.0176)	-0.0103 (0.0176)	-0.0016 (0.0097)	-0.0016 (0.0097)	0.0120 (0.0099)	0.0123 (0.0099)
URBAN	-0.0073 (0.0479)	-0.0073 (0.0479)	-0.0245 (0.0489)	-0.0244 (0.0489)	-0.0499** (0.0245)	-0.0499** (0.0245)	-0.0566** (0.0250)	-0.0565** (0.0250)
△BRANCH	0.0299*** (0.0045)	0.0299*** (0.0045)	0.0339*** (0.0061)	0.0340*** (0.0061)	0.0431*** (0.0056)	0.0432*** (0.0056)	0.0466*** (0.0064)	0.0469*** (0.0063)
d28	-0.0375 (0.0484)	-0.0375 (0.0484)	-0.0390 (0.0512)	-0.0391 (0.0512)	-0.1041*** (0.0248)	-0.1041*** (0.0248)	-0.1037*** (0.0266)	-0.1039*** (0.0266)
d29	-0.1473*** (0.0309)	-0.1473*** (0.0310)	-0.0893** (0.0360)	-0.0893** (0.0360)	-0.1580*** (0.0255)	-0.1580*** (0.0255)	-0.1040*** (0.0273)	-0.1041*** (0.0273)
INTERCEPT	0.3714 (0.2443)	0.3715 (0.2445)	0.0811 (0.2571)	0.0779 (0.2575)	0.0421 (0.1427)	0.0414 (0.1425)	-0.2553* (0.1460)	-0.2597* (0.1460)
Observations	1075	1075	1075	1075	1053	1053	1055	1055
R2	0.0395	0.0395	0.0341	0.0342	0.0832	0.0833	0.0837	0.0843

Notes:

Significance at 1%,5% and 10% level are denoted by "***" "**" and "*".

The figures in parentheses are standard errors.

Table12 The effect of consolidations on ROA

Window	OLS				Selection model			
	Dependent variable: Change of ROA from T-2 to T+2 or T+3							
	[T-2, T+2]	[T-2, T+2]	[T-2, T+3]	[T-2, T+3]	[T-2, T+2]	[T-2, T+2]	[T-2, T+3]	[T-2, T+3]
[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	
M&A	-0.0035 (0.0027)	-0.0043 (0.0027)	-0.0025 (0.0028)	-0.0020 (0.0028)	-0.0031 (0.0030)	-0.0041 (0.0030)	-0.0008 (0.0033)	-0.0004 (0.0032)
M&A*NT		0.0028 (0.0049)		-0.0017 (0.0059)		0.0031 (0.0050)		-0.0015 (0.0060)
SIZE	0.0015* (0.0009)	0.0015* (0.0009)	0.0018* (0.0009)	0.0017* (0.0009)	0.0018* (0.0009)	0.0018* (0.0009)	0.0017* (0.0010)	0.0017* (0.0010)
URBAN	0.0037 (0.0026)	0.0037 (0.0026)	0.0041 (0.0026)	0.0041 (0.0026)	0.0059** (0.0023)	0.0059** (0.0023)	0.0065*** (0.0025)	0.0065*** (0.0025)
△BRANCH	0.0004 (0.0003)	0.0004 (0.0003)	0.0005 (0.0003)	0.0005 (0.0003)	0.0004 (0.0003)	0.0004 (0.0003)	0.0005 (0.0003)	0.0005 (0.0003)
LOAN/ASSET	-0.0193* (0.0101)	-0.0193* (0.0101)	-0.0252** (0.0115)	-0.0251** (0.0115)	-0.0076 (0.0099)	-0.0077 (0.0099)	-0.0099 (0.0118)	-0.0098 (0.0118)
d28	-0.0037* (0.0021)	-0.0037* (0.0021)	-0.0031 (0.0024)	-0.0031 (0.0024)	-0.0036 (0.0022)	-0.0036 (0.0022)	-0.0024 (0.0025)	-0.0024 (0.0025)
d29	-0.0040** (0.0020)	-0.0041** (0.0020)	-0.0009 (0.0021)	-0.0009 (0.0021)	-0.0029 (0.0022)	-0.0029 (0.0022)	-0.0004 (0.0023)	-0.0004 (0.0023)
INTERCEPT	-0.0217 (0.0181)	-0.0217 (0.0181)	-0.0232 (0.0188)	-0.0232 (0.0188)	-0.0302* (0.0179)	-0.0302* (0.0179)	-0.0283 (0.0191)	-0.0283 (0.0190)
Pho					-0.6082***	-0.6087***	-0.6336***	-0.6334***
Observations	894	894	844	844	1075	1075	1075	1075
Censored					181	181	231	231
R2/log likelihood	0.032	0.032	0.038	0.038	1561.0710	1561.1583	1318.4681	1318.4841

Notes:

Significance at 1%,5% and 10% level are denoted by "***" "**" and "*".

The figures in parentheses are standard errors.

Appendix Table1 Interbank networks and contagious withdrawal of deposits (IV)

	Dependent variable: Deposit Growth Rate					
	[1]	[2]	Subsample			
			Low ROE [3]	Low ROE [4]	High ROE [5]	High ROE [6]
NT	0.00614 (0.0139)					
NTN		-0.245 (0.244)	0.0775 (0.152)	0.0721 (0.131)	-0.282** (0.132)	-0.269* (0.146)
NTP		0.361 (0.357)	-0.0121 (0.205)	0.0118 (0.188)	0.369* (0.209)	0.348 (0.213)
M&A	0.0368** (0.0182)	0.0544 (0.0371)	0.0923 (0.0608)	0.0867 (0.0550)	0.0561 (0.0561)	0.0399 (0.0551)
SIZE	-0.0120* (0.00715)	-0.0144 (0.00954)	-0.0169 (0.0112)	-0.0196** (0.00975)	-0.00168 (0.0184)	-0.00157 (0.0202)
ROE	0.284** (0.136)	0.332 (0.219)	0.823*** (0.288)	1.027*** (0.202)	-0.246 (0.251)	-0.251 (0.239)
CAPDEPO	0.00112*** (0.000311)	0.00121*** (0.000209)	0.00153*** (0.000293)	0.000890*** (0.000305)	0.0552 (0.0609)	0.0518 (0.0621)
LIQUID	-0.131 (0.102)	-0.215 (0.138)	-0.216 (0.205)	-0.286 (0.188)	0.394 (0.251)	0.316 (0.277)
SECURITY	0.0758*** (0.0236)	0.0712*** (0.0236)	0.0689** (0.0347)	0.0541* (0.0324)	0.0279 (0.0790)	0.0307 (0.0667)
INTERCEPT	0.109 (0.0873)	0.141 (0.133)	0.114 (0.177)	0.102 (0.134)	-0.00362 (0.290)	-0.0103 (0.314)
Area dummies	Yes	Yes	Yes	No	Yes	No
Observations	816	816	408	408	408	408

Notes:

Significance at 1%,5% and 10% level are denoted by "***" "**" and "*".

The figures in parentheses are standard errors.

Appendix Table2 Interbank networks and contagious withdrawal of deposits (Selection model)

	Dependent variable: Deposit Growth Rate					
	[1]	[2]	Subsample			
			Low ROE [3]	Low ROE [4]	High ROE [5]	High ROE [6]
NT	0.0054 (0.0144)					
NTP		-0.0034 (0.0172)	0.0328 (0.0291)	0.0403 (0.0284)	-0.0429** (0.0197)	-0.0402** (0.0190)
NTN		0.0182 (0.0163)	0.0507** (0.0255)	0.0593** (0.0247)	0.0004 (0.0216)	-0.0013 (0.0210)
M&A	0.0372 (0.0228)	0.0378* (0.0228)	0.0962** (0.0399)	0.0910** (0.0375)	0.0174 (0.0265)	0.0114 (0.0273)
SIZE	-0.0103 (0.0073)	-0.0105 (0.0073)	-0.0184** (0.0093)	-0.0194* (0.0099)	-0.0049 (0.0128)	-0.0046 (0.0124)
ROE	0.2738** (0.1301)	0.2761** (0.1303)	0.8202** (0.3286)	0.9182*** (0.3266)	-0.1863 (0.1492)	-0.1796 (0.1522)
CAPDEPO	0.0014** (0.0007)	0.0014** (0.0006)	0.0016*** (0.0005)	0.0010** (0.0005)	0.0713 (0.0477)	0.0707 (0.0476)
LIQUID	-0.0888 (0.1249)	-0.0936 (0.1249)	-0.2710* (0.1580)	-0.3041* (0.1716)	0.2417 (0.1592)	0.2095 (0.1572)
SECURITY	0.0760*** (0.0255)	0.0759*** (0.0252)	0.0718*** (0.0242)	0.0533** (0.0263)	0.0937* (0.0483)	0.0919** (0.0464)
INTERCEPT	0.1013 (0.1077)	0.1030 (0.1077)	0.1442 (0.1406)	0.1303 (0.1462)	0.0535 (0.2138)	0.0503 (0.2067)
Area dummies	Yes	Yes	Yes	No	Yes	No
Log likelihood	-306.0472	-305.4279	-179.0996	-190.0748	-70.3357	-73.5454
rho	-0.4502	-0.4314	-0.0962	-0.3014	-0.6077	-0.6301
Censored	191	191	93	93	98	98
Observations	1007	1007	501	501	506	506

Notes:

Significance at 1%,5% and 10% level are denoted by "***" "**" and "*".

The figures in parentheses are standard errors.