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Bank-Firm Relationship and Small Business Innovation

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Abstract

This paper empirically investigates the effect of banks' soft information on small business innovations. Using data from a sample of Japanese small and medium enterprises (SMEs), we find that multiple banking prevails. Moreover, besides the main bank, the sub bank also acquires soft information for a number of multiple banking firms. Nonetheless, there coexists no bank information: the main bank's information monopoly and multiple bank information competition. Importantly, such information competition in multiple banking is positively related to both product and process innovation while the main bank's information monopoly has no significant effects on innovation. Also, we offer additional consistent evidence that information competition decreases the likelihood of worsening of the lending attitude of the main bank during the financial crisis. For single banking firms, bank information monopolies have a negative effect on product and process innovation.

Keywords: Banks, Information monopoly, Information competition, Innovation

JEL classification: G21; O30

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1. Introduction

Technological progress plays important roles in economic growth. In the last decades, a number of empirical studies have analyzed the effect of bank information on corporate innovations. Herrera and Minetti (2007) find that the duration of credit relationships promotes innovation. Benfratello et al. (2008) look at the effects of local banking industry development. More recently, Amore Schneider and Žaldokas (2013); Chava, Oettl , Subramanian and Subramanian (2013) find that banking industry deregulation and innovation had significant beneficial effects on the quantity and quality of innovation activities for firms highly dependent on external capital and located closer to entering banks. In Japan, Goto (2010) finds that R&D in small and medium-sized enterprises is more strongly affected than large corporations by adverse financial conditions. Also, Isogawa, Nishikawa and Ohashi (2012) show that new-to-market product innovation in Japan significantly improves firm performance and it is associated with technological spillovers.

A large body of literature shows that the intensity of credit relationship increase credit availability, reduce interest rates of loans and collateral requirements (Petersen and Rajan, 1994 and 1995; Berger and Udell, 1995, 2002; Degryse and van Cayseele, 2000; Ongena and Smith, 2001; Hoshi, Kashyap, and Scharfstein, 1990, 1991; Morck and

Nakamura, 1999; Petersen and Rajan, 1994; Berger and Udell, 1995; Hellmann, Lindsey, and Puri, 2003).

So far, however, the theoretical literature offers ambiguous predictions on the effect of banks' information on innovation. Bank's information is more crucial to monitor innovative firms, since moral hazards regarding innovation can be more severe (Carpenter and Petersen, 2002; Hall, 2002; Rajan and Zingales, 2001). Only in a limited range of circumstances, venture capital with more intensive monitoring is optimal when the innovation is not too profitable; the innovation uncertainty is high (Winton and Yerramilli, 2008). Hellmann and Puri (2000) find that innovators are more likely to use venture capital financing than are imitators. Thus, venture capital complements bank debt.

On the other hand, the innovative firm is more likely to be exposed to the hold-up of due to information monopoly of the bank (Rajan, 1992; Ueda, 2004; Landier, 2003; Rajan and Zingales, 2001; Diamond and Rajan, 2001; Habib and Johnsen, 1999). Also, there can be a leakage of bank's information to the rivals (Bhattacharya and Ritter, 1983; Bhattacharya and Chiesa, 1995; Yosha, 1995). Conversely, banks can evaluate innovations and improve the probability of successful innovation (King and Levine, 1993) in the context of an endogenous growth model.

Nonetheless, it is a thorny challenge to figure out the circumstances in which the positive aspect of informed finance or the negative aspect of information monopoly is important for innovation. Theoretically, a single bank relationship is efficient to avoid duplicate monitoring. Empirically, however, Ongena and Smith (2000) find multiple bank relationships in several European countries. Detragiache, Garella, and Guiso (2000) develop a theory of the optimal number of banking relationships in circumstances in which multiple banking can reduce the probability of an early liquidation of the project. Ogawa, Sterken and Tokutsu (2009) find that even small firms with a main bank relation have multiple bank relationships in Japan.

Multiple bank relationships possibly mitigate the hold-up problem (Rajan, 1992; Petersen and Rajan, 1994). Empirically, the reliance on bank debt is negatively related to growth opportunities for firms with a single bank relationship but the relationship is positive among firms borrowing from multiple banks (Houston and James, 1996). Thus, it is highly possible that the effect of bank's information on innovation depends on the number of banks the firm uses. Moreover, we need to know whether a single bank or multiple banks have information in addition to information on the number of lending banks.

The objective of this paper is to address this issue using a unique dataset that provides

details on the soft information of their single lender or multiple lenders and firm innovations. We investigate the differences among the impact on innovation of the bank' monopolistic information for firms with a single bank relationship, the effect of the main bank's monopolistic information for firms borrowing from multiple banks, and , the effect of information competition of multiple banks. We find bank information monopolies have a significant negative effect on product innovation for single banking firms. In contrast, information competition of multiple banks is positively related to both product innovation and process innovation among firms with multiple lending banks.

This paper contributes to two strands of empirical literature. First, this paper provides new evidence on the negative effect of information on innovation for firms with a single relationship, whereas only information competition has a positive effect on innovation among firms with multiple bank relationships. Secondly, besides the main bank, the sub bank acquires soft information of a firm. In particular, information for a relatively large private firm is more available for the sub bank.

The paper is organized as follows. In Section 2, we review the literature on single bank relationship; multiple bank relationships in conjunction to information monopoly. In Section 3, we describe our surveys and econometric methodologies. Section 4 describes the data and the measurement of the variables. In Section 5, we present empirical results.

Section 6 concludes.

2. Information monopoly vs. information competition

Our main concern is to figure out the circumstances in which the negative aspects due to information monopoly are more important for innovation. According to Houston and James (1996), we first look into the bank's information for firms with a single bank relationship. In single banking cases, the bank' information is equivalent to information monopoly. Most of the literature presumes that the main bank acquires information through a scope of transactions over time. Also, geographically the only one bank may have local market power and thus probably the main bank has both the local market power and information monopoly power. Hence a single bank with information monopoly power is more likely to hold up the firm.

However, we have scant evidence on the role of multiple bank relationships, though a growing literature has investigated multiple borrowing recently. In comparison with the circumstance of a single lender, multiple banks tend to be more competitive. Also, it is possible that only a part of multiple banks have information. As presumed almost in all extant studies, only the main bank has soft information and thus the sub bank does not have soft information. Or, it is assumed all multiple banks have soft information in some

analyses on multiple banking. To the best of our knowledge, not event literature on multiple banking has examined which banks have information and how bank information configurations affect borrowing firms' activities such as innovation.

Our 2007 survey asks each firm "How much does the largest lender know the soft strength of the firm?" The survey, then asks, "How much does the second largest lender know the soft strength of the firm?" if a firm transact with two or more banks. Thus, we know whether the second largest bank (hereafter the sub-bank) has information besides the main bank. The main bank's information is equivalent to information monopoly among single banking firms. However, it quite complicated to classify banks' information configurations even we only consider the top two largest banks. It is unnatural to consider that the sub bank has soft information, whereas the main bank does not have information. Indeed, among 789 firms there are only six firms with this unnatural response and we exclude them. All results remain same including these six firms, however.

Different from extant studies, the highlight of this paper is the effect of information competition, namely, the sub bank's information besides the main bank's information. We implement a variety of endogenous treatment estimators to figure out the effect of information monopoly on small business innovations among firms with a single bank

relationships as well as the effect of information competition on innovations of firms using multiple banks. In the next section, we describe our data and methodology.

3. Data and Methodology

3.1 Surveys

We use the Survey on Inter-firm and Firm–Bank Transactions conducted by the RIETI in 2007. Covering 17,018 enterprises, this dataset provides wide-ranging bank-firm information related to bank duration, the scope of financial services, the distance between the firm and its main bank, collateral and guarantees for loans. One of the unique strengths is that this survey asks each firm, "How much does the second largest bank know soft strengths of the firm?" besides the main bank. Also, the survey provides information on bank duration, the scope of financial transactions, the distance between the firm and its top two largest banks.

The data source on innovation is the Survey on the Aftermath of the SME Financing Facilitation Act (the 2014 survey hereafter). This survey is also conducted by the RIETI in 2014. Covering 20,000 enterprises, this dataset provides innovation information during the period between December 2009 and 2014. The response rate is around 30%.

Combining the two surveys, we investigate banks' information on small business

innovation. To utilize the strength of our surveys, we employ treatment effect estimator methodology to sort out the effect of bank information on innovation. In particular, we distinguish information monopoly and information competition among firms with multiple bank relationships.

3.2. Firms with a single bank relationship

Among single banking firms, some of them are with informed main bank and the rest are not. We would like to know if the main bank's information has an effect on innovation *y*. It would be ideal for us to observe *y* when the main bank knows information (which we denote as y_I), and *y* when the main bank is uninformed (which we denote as $y_{U.I}$). We could then average the difference between y_I and $y_{U.I}$ across all the firms with a single bank relationship to obtain a measure of the average impact of the main bank's information monopoly. Unfortunately, it is impossible to observe a specific firm having informed main bank and having uninformed main bank. Also, it is impossible to observe the firm's innovation under both circumstances of the informed main bank and the uninformed main bank.

We employ the treatment-effect estimators to estimate the efficacy of the main bank's information using observational data. Consider a firm's main bank is uninformed so that

we observe $y_{U.I}$. What would y_I be for the same firm if its main bank were informed? We call y_I the potential outcome or counterfactual for that firm with the uninformed main bank. For a firm with informed main bank subject, we observe y_I, so $y_{U.I}$ would be the counterfactual outcome. Treatment-effect methods can account for this missing-data problem.

We estimate three parameters. The potential-innovation means (POmeans) are the means of y_I and $y_{U.I}$ among all firms with a single bank relationship. The average information effect (ATE) is the mean of the difference (y_I - $y_{U.I}$). Finally, the average conditional effect on innovation of information (ATET) is the mean of the difference (y_I - $y_{U.I}$) among the firms that actually has informed main bank.

y_i is the observed innovation variable, t_i (1 for I, 0 for $U.I$ is the information variable, x_i is a vector of covariates that affect innovation outcome, and z_i is a vector of covariates that are related to the main bank's information. The innovation functional forms conditionally on its main bank's information are.

$$y_{U.I} = \begin{cases} 1 & if \;\; x'\beta_0 + \epsilon_0 > 0 \\ 0 & if \;\; x'\beta_0 + \epsilon_0 \leq 0 \end{cases}$$

$$y_I = \begin{cases} 1 & if \;\; x'\beta_1 + \epsilon_1 > 0 \\ 0 & if \;\; x'\beta_1 + \epsilon_1 \leq 0 \end{cases}$$

where β_0 and β_1 are coefficients to be estimated, ϵ_0 and ϵ_1 are error terms that are not related to x or z. This potential-outcome model separates each potential

outcome into a predictable component, $x'\beta_t$, and an unobservable error term, ϵ_t. We let $\mu(x, t, \beta_t)$ denote a conditional-mean innovation $E(y|x, t)$ conditional on covariates x and information level t. The innovation functional form for $\mu(x, t, \beta_t)$ is $\Phi(x\beta_t)$. $\Phi(\cdot)$ is the cumulative function of normal distribution.

The main bank's information depends on bank-firm relationship which is related to costs acquiring information as follows

$$t = \begin{cases} 1 & if \ \ z'\gamma + \eta > 0 \\ 0 & otherwise \end{cases}$$

where γ is a coefficient vector, and is η an unobservable error term that is not related to either x or z. $p(z, t, \gamma)$ denotes the conditional probability model for the probability that a firm has an informed main bank conditional on covariates z. The functional form is the normal cumulative distribution function $\Phi(z\gamma)$.

The three parameters of interest are

(1) the potential-innovation mean (POmean) $\alpha_0 = E(y_0)$

(2) the average information (ATE) $\tau = E(y_1 - y_0)$; and

(3) the average information effect conditional on informed main bank (ATET) $\delta = E(y_t|t = 1)$.

The potential innovation estimators and the average information effect estimators use normalized inverse probability weights. The unnormalized weights for individual i and information level t are $d_i(t) = t_i(t)/p(z_i, t, \hat{\gamma})$, and the normalized weights are $\overline{d_i}(t) = N_t d_i(t)/\sum_i^N d_i(t)$. Here, N_t is the number of observations in information level t, and $t_i(t) = 1 \ if \ t_i(t) = t;\ t_i(t) = 0 \ if \ t_i(t) \neq t$.

The unnormalized conditional inverse probability weights are $f_i = p(z_i, \tilde{t}, \hat{\gamma})/p(z_i, t, \hat{\gamma})$, and the normalized conditional inverse probability weights are $\overline{f_i} = Nfd_i/\sum_i^N f_i$. The normalized conditional inverse probability weights are used to estimate the average information effect conditional on informed main bank.

3.3 Firms using multiple banks

Among firms using multiple banks, information configurations of banks are complicated. First, only the main bank has soft information. This circumstance is information monopoly of the main bank. We let $Y_{I.M}$ denote counterfactual innovation in the circumstance of information monopoly. It is possible that both the main bank and the sub bank have soft information. This information configuration is information competition and $Y_{I.C}$ denotes counterfactual innovation in the circumstance of information competition. Alternatively, $Y_{N.I}$ denotes counterfactual innovation in the

circumstance of no information when neither the main bank nor the sub bank has soft information.

The counterfactual innovation functional forms conditionally on its bank information configuration are.

$$y_{N.I} = \begin{cases} 1 & if \;\; x'\theta_0 + \eta_0 > 0 \\ 0 & if \;\; x'\theta_0 + \eta_0 \leq 0 \end{cases}$$

$$y_{I.M} = \begin{cases} 1 & if \;\; x'\theta_1 + \eta_1 > 0 \\ 0 & if \;\; x'\theta_1 + \eta_1 \leq 0 \end{cases}$$

$$y_{I.C} = \begin{cases} 1 & if \;\; x'\theta_2 + \eta_2 > 0 \\ 0 & if \;\; x'\theta_2 + \eta_2 \leq 0 \end{cases}$$

where θ_0, θ_1 and θ_2 are coefficients to be estimated, η_0, η_1 and are error terms that are not related to x or w. The innovation functional form for expected innovation probability $\mu(\mathrm{x}, \mathrm{t}, \theta_t)$ is $\Phi(\mathrm{x}'\theta_t)$. $\Phi(\cdot)$ is the cumulative function of normal distribution.

The bank information configuration depends on bank-firm relationships which are related to costs acquiring information for the main bank or the sub bank. Here banks' information is the multivalued-treatment case, $\mathrm{p}(\mathrm{w}, \mathrm{t}, \lambda)$ is specified as a multinomial logit with $\mathrm{p}(\mathrm{w}, \mathrm{t}, \lambda) = \exp(\mathrm{w}\lambda_t) / \{1 + \sum_{k=1}^{q} \exp(w\lambda_k)\}$. For the base with information level 0 (no information), $\lambda_0 = 0$. For information monopoly we denote $\mathrm{t} = 1$, and, $\mathrm{t} = 2$ for information competition. The normalized inverse probability weights are calculated to estimate information effect and conditional information effect as well as normalized

conditional inverse probability weights.

4. Descriptive Statistics

We draw a sample of firms in which each firm identified the largest bank as its main bank. Firms with a single bank relationship are dropped if the data on the largest bank is not available. We also exclude firms using multiple banks if information on the top two largest banks is not available. The sample of firms with a single bank relationship comprises 191 firms and the sample of firms using multiple banks is consists of 783 firms. We estimate banks' information effect on innovation separately using the two samples.

4.1 Firms with a single bank relationship

As shown in Panel A of Table 1, the average (median) bank duration is approximately 29 (30) years. The lowest quartile length of credit relationships is shorter than fifteen years, and the highest quartile has a relationship longer than 40. In comparison with the average (median) duration 17 (15) years of the Italian firms, the credit relationship is longer in Japan. In regard to the scope of financial services, the survey asks each firm to identify transactions with its main bank including overdraft account, employee salary

transfer account, the owner's personal asset management, introducing new clients to the firm and dispatching directors or executives. The lowest quartile number of transactions is 2 and the highest quartile firms have transactions more than 3. Approximately 14% of firms are with the main bank located within 500m, 18% if firms report the bank distance is within 500m-1000m, and, approximately 53% of firms answer the bank is located within 10km. A rest of 12% of firms, the main bank is at a moderate distance of 10km-30km. Only 2% of firms report the main bank is more than 30km away. For the bank's information, approximately 37% of the firms answer that the main bank well knows its soft strength.

The mean (median) number of employees in 2009 is 32 (15) and the mean firm age is 45, with a median age of 41 for firms with a single bank relationship. They are smaller and older than 2000 Italian firms in Herrera and Minetti (2007). About 20.9% of the firms realized product innovations, and, approximately 22.5% realized process innovations, since December 2009.

4.2 Firms with multiple banks

Panel B of Table 1 indicates that the average (median) bank number for firms using multiple banks is 4.2 (4). In Herrera and Minetti (2007), the mean (median) number of

credit relations is 5.31 (4). According to the international comparison in Detragiache, Garella, and Guiso (2000) report, 44.5% of U.S. firms have single relation, whereas only 11% of Italian firms are single banking. Also, the median number of bank relations in Italy is 5 and that is contrasted with the median of 2 in the United States. The share of single banking firms here 20%. Thus multiple banking is quite prevalent in Japan.

The average (median) main bank duration is approximately 33 (31) years. There are almost no substantial differences in the length of credit relationship with the main bank between the single banking sample and the multiple banking samples. The lowest quartile length of credit relationship is shorter than twenty years, and the highest quartile firms have a relationship longer than 44. In comparison, the average (median) sub bank duration is approximately 23 (20) years with the lowest quantile of 7 years and the highest quantile of 35 years. On average, the sub bank duration is about ten year shorter than the main bank duration. Farinha and Santos (2001) document that almost all firms borrow for the first time in their life from a single bank, but afterward some of them start borrowing from additional banks. Probably, for most of our multiple banking firms, the first bank is the main bank and an afterward additional bank is the sub bank.

Also, on average the main bank is closer to a firm than is the sub bank. For instance, the share of firms which main bank distance is 30 km or more is less than 4%, while

more than 11% of firms have the sub bank located 30 km far or father away from a firm. Besides longer credit relationship and closer distance, the main bank has a wider scope of transactions with a firm than the sub bank. The lowest quartile number of transactions with the main bank is 2 and the highest quartile firms have 3 transactions or more. For more than 25% of firms, in contrast, the sub bank has no other transactions other than lending and the highest quartile number of transactions is 2. Approximately, 51% of firms are with informed main bank. Meanwhile, among 34% of these firms the sub bank is also informed. This difference might be attributed to the differences in the length of credit relationship, geographical closeness and the scope of transactions between the main bank and the sub bank.

Interesting, the fraction of informed main bank among multiple banking firms is much higher than the fraction of informed main bank among firms with a single bank relationship. This suggests that borrowing from multiple banks rather strengthens the main bank's incentives to generate information though it is sometimes argued that multiple bank relationships may weaken banks' incentives to produce information (Petersen and Rajan, 1994). Importantly, for quite a few firms the sub bank is informed besides the main bank. As a result, only 17% of multiple banking firms can be potentially held up by the main bank due to information monopoly, while 37% of the firms with a

single bank relationship are exposed to information monopoly. In sum, borrowing from multiple banks enhances information competition and thus mitigates information monopoly. As mentioned above, we have excluded 6 firms with an unnatural response that the main bank has no information but the sub bank has information from the sample. But all results including the 6 firms remain the same.

The mean (median) number of employees is 78 (36) and the mean firm age is 51, with a median age of 49 among firms using multiple banks. They are larger and older than the firms with a single bank relationship. The firm size is not so different from the Italian firms in Herrera and Minetti (2007). But our multiple banking firms are much older.

About 38% of the firms realized product innovations, and, approximately 40% realized process innovations in 2009-2013. On average, multiple banking firms are more likely to realize innovation than do single banking firms. Herrera and Minetti (2007) report 25% for product innovations and 37% for process innovations in 1998-2000 Italian manufacturing firms. Benfratello, Schiantarelli and Sembenelli (2008) document 64.23% of firms introduced process innovation and 49.00% of firms declared product innovation 1992-1994, and, in 1995-1997 68.49 % and 34.34% of firms respectively realized process, product innovation. Small business innovation in Japan is comparable with that in Italy.

5. Empirical Results

5.1 Innovation and single bank relationship

The unique question on bank soft information and details on bank-firm relationship allow us to examine the acquisition of soft information and its effect on corporate innovation. We implement inverse probability weighted regression-adjustment (IPWRA) estimators for the bank soft information on innovation as described above. The IPWRA estimators are known as "Wooldridge's double-robust" estimators (Wooldridge, 2007, 2010).

The independent variables for bank information estimator are the length of bank-firm relationship, the scope of the financial services provided by the main bank and bank-firm distance. As mentioned, the length of credit relationships has been used as the proxy for bank information. In the literature, there is substantial evidence that banks acquire information over time through contacts with the firm and its owner. There is evidence for Italy that distance between borrowers and bank branches still matters (Bonaccorsi di Patti and Gobbi, 2001; Alessandrini, Presbitero, and Zazzaro, 2009). Physical proximity between the bank and the firm decreases transportation and monitoring costs and thus increases the likelihood of information monopoly among firms with a single bank relationship. Also, a close location of the main bank from the firm may generate

greater market power for the main bank. In sum, it is more likely for a close single bank to hold up the firm. The control variables are ln (assets) and TSR credit rating score in 2007. Smaller firms tend to be more opaque than larger firms and firms with poorer credit qualities need to be monitored more intensively.

Table 2 indicates that bank soft information is significantly related to natural logarithm of bank duration, the scope of transactions with the main bank. The distance has no significant effect on information. Neither firm size nor credit quality has a significant effect on bank information. This result suggests that the main bank is more likely to acquire information thorough a scope of financial services over time. Our findings are consistent with extant evidence.

IPWRA estimators use the inverse of the estimated bank soft information probability weights to estimate missing-data-corrected regression coefficients that are subsequently used to compute the average bank soft information effect on innovations. Table 2 exhibits that the effect on product innovation of main bank's information (AIT) is -4% without significance at the 10% level. The conditional effect of main bank's information (AIEI) is -13% with significance at the 5% level. The estimated production innovation probability is 24%-25% among firms with a single bank relationship if the main bank has no information. Economically, the adverse effect of bank's information on product

innovation conditional on observed information is significant.

For potential product innovation probit regressions, we include the natural logarithm of firm age in 2009, the natural logarithm of number of employees in 2009 and TSR credit rating score in 2009 in addition to bank duration, bank distance and the scope of financial services from the bank. Auxiliary potential product innovation regressions suggest that credit quality significantly increases the probability of product innovation regardless of bank information. TSR credit rating score data on private firms is provided commercially and it is publicly available with costs. This result suggests costly public information has a significant effect on product innovation among single banking firms. Interestingly, the length of credit relationship with the bank has a negative effect on product innovation when the bank has soft information. In other words, the negative effect of information monopoly is stronger the longer is the credit relationship.

Table 3 shows that the effect on process innovation of main bank's information (ATE) is -5.3% but it is not significant at the 10% level. The conditional effect of main bank's information (ATET) is -11.7% with significance at the 10% level. The estimated process innovation probability is 26%-28% among firms with a single bank relationship if the main bank has no information. Information monopolies also have a significant adverse effect on process innovation of firms with observed informed bank. Potential process

innovation regressions indicate that credit quality significantly increases the probability of process innovation in cases of no bank information. Also, bank duration reduces the probability of process innovation. But the scope of bank services increases process innovation for informed single banking firms.

To the best of our knowledge, it is the first for us to sort out a circumstance in which the negative aspects of information are more important for product innovation as well as for process innovation. Next, we turn to the effect of information configurations on innovation among firms with multiple banks.

5.2 Innovation and information in multiple bank relationships

There are three categories of information configurations. First, neither the main bank nor the sub bank of a firm has soft information. Second, only the main bank has soft information and thus it is information monopoly. Third, the sub bank also acquires soft information besides the main bank and this is an information competition circumstance. Multiple bank relationships imply greater competition leading to an increase in supply of credit and a decrease in funding rates for all investment projects, including those involving product or process innovations. Rightfully, the sub bank competes with the main bank and this in turn weakens market power of the main bank. Moreover, the sub

bank's information is a resolution to avoid the hold-up due to information monopoly by the main bank. Therefore, the competition between the informed main bank and the informed sub bank may generate a larger increase in funding supply and a greater decrease in loan costs than does the competition between the uninformed sub bank and the informed main bank.

We implement multi-value treatment estimators. To figure out whether the sub bank also has soft information, the independent variables for bank information estimator are the length of credit relationship with the sub bank, the scope of the financial services provided by the sub bank and distance between the sub bank and the firm, in addition to variables for main bank-firm relationship. The distance between the firm and the sub bank is related to bank development or deregulation of the banking sector. Geographical closeness between the borrower and the closest competing bank increases, as well as geographical closeness between the lender and its competitors. This may lead to information competition and may reduce funding costs for product or process innovation. In addition to the competition between the main bank and the sub bank, we include the number of banks as a proxy for competition. And we control for firm size ln (assets) and TSR credit rating score in 2007 to capture the effects of informational opaqueness.

Relative to the probability of no bank information, Table 4 indicates that the main

bank's information monopoly is positively related to the main bank duration, the scope of transactions with the main bank, and, the geographical closeness of the main bank. Meanwhile, the scope of transactions with the sub bank, and, the closeness of the sub bank decrease the likelihood of information monopoly of the main bank. Credit quality significantly decreases the likelihood of information monopoly of the main bank. This might suggest that greater competition may induce an increase in information monopoly, to the benefit of more informationally opaque borrowers. This is because information monopoly insulates the main bank from pure price competition. Also, the number of banks is negatively related to the main bank's information monopoly.

Relative to no bank information, the firm size increases the likelihood of the sub bank's information besides the main bank. In Detragiache, Garella, and Guiso (2000), large firms are less likely using single banking. This result suggests that the information costs can be cheaper to acquire soft information of a larger firm. Our result confirms that firm size decreases the probability of the main bank's information monopoly and increases the probability of information competition among multiple banking. The scopes of main bank services and main bank proximity have significant positive effects on information competition. However, the main bank duration is not relevant. Only the sub bank distance is positively related to information competition with significance at the 10%

level. These suggest that the sub bank is able to generate soft information only if the main bank acquires such information. The scopes of main bank services and the main bank distance are crucial to generate information rather than the main bank duration.

In comparison with innovation in circumstance of no bank information, Table 4 shows that the effect on product innovation of information competition (ATE) is 11% with significance at the 1% level. The conditional effect of information competition (ATET) is 13% with significance at the 5% level. The estimated production innovation probability is 31%-34% among firms with multiple bank relationships if neither the main bank nor the sub bank has soft information. Both economically and statistically, information competition has a significant effect on product innovation. By contrast, the main bank's information monopoly under circumstances of multiple banking has no significant effect on product innovation.

The information configurations have similar effects on process innovation as shown in Table 5. The effect of information competition (ATE) is 10% with significance at the 5% level. And the conditional effect of information competition (ATET) is 13% with significance at the 5% level. The estimated process innovation probability is 36% among firms with multiple uninformed bank relationships. By contrast, the main bank's information monopoly in multiple banking has no significant effect on process innovation.

5.3 Bank's lending attitude during the financial crisis

To probe how bank information competition benefits innovation, we provide additional evidence on bank information competition and stable supply of fund. In response to the global financial crisis, the Survey on Inter-firm and Firm–Bank Transactions during the Financial Crisis was subsequently conducted by the RIETI in February 2009, using the sample firms of the 2007 survey. The response ratio is lower than that in 2007.

Our 2009 survey asks each firm "How did the largest lender, the second largest bank change lending attitude from 2008?" We implement inverse probability weighted regression-adjustment (IPWRA) estimators for bank information on worsening of lending attitude. The explanatory variables for bank information are similar. The outcome variable takes a value of 1 if a firm responded that lending attitude worsened from 2008. Otherwise, it takes a value of 0. The explanatory variables included in potential outcome regressions are the natural logarithm of firm age in 2009, the natural logarithm of number of employees in 2009 and the change of TSR credit rating score from 2007 to 2009, in addition to bank duration, bank distance and the scope of financial services from the bank.

Among uninformed single banking firms, Table 6 shows that six percent of the firms

answered the main bank's lending attitude worsened. However, bank information does not significantly decrease lending attitude worsening. The auxiliary outcome regressions suggest that deteriorating credit quality significantly increases worsening of lending attitude among firms with uninformed bank. Meanwhile, deteriorating credit quality is not relevant to worsening of lending attitude for firms with informed bank. In sum, this result suggests that bank information monopoly does not increase credit availability for single banking firms.

Now we turn to the effect of information competition on credit availability among multiple banking firms. As shown in Table 7, around 10% of firms report worsening of lending attitude among uninformed multiple banking. Under circumstance of information monopoly, the fraction of multiple banking firms facing main bank's lending attitude worsening is 4% higher relative to uninformed multiple banking. But it is not significant at the 10% level. Meanwhile, information competition decreases the probability of main bank's lending attitude worsening by 5% with significance at the 5% level. In conclusion, information competition increases the likelihood of stable supply of fund during the crisis and in turn stable supply of fund could benefit innovation among multiple banking firms. We find no significant effects of bank information competition on worsening of lending attitude of the main bank conditional on information monopoly

under multiple banking circumstances, however. Interestingly, potential outcome regressions for multiple uninformed banking suggest that the largest bank's duration significantly reduces the likelihood of worsening of lending attitude.

Looking into the response of the sub bank, we find that approximately 8% of uninformed multiple banking firms report worsening of lending attitude of the sub bank. We find no significant effect of information competition among all multiple banking firms. But we find an adverse effect of information monopoly on change of lending attitude among firms under circumstances in which only the main bank is informed. The magnitude is 7% with significance at the 10% level.

In sum, we find that information competition under multiple banking circumstances decreases the probability of worsening of lending attitude of the main bank, relative to no information, or information monopoly. In other words, information competition results in stable supply of funds. This can be the right reason why information competition benefits innovation.

5.4 Discussions

Our study is related to previous papers on bank competition. The number of bank relationships has been viewed as a proxy for banking competition. Detragiache, Garella,

and Guiso (2000) develop a theory of choice of number of bank relationships and relate exogenous regional judicial efficiency to the choice between single and multiple banking for Italian firms. In Italy, a large fraction of the geographical differences in the financial development has been generated by the banking regulation in effect from 1936 to the end of the 1980s. To open new branches, authorizations were granted province-by-province, based on an evaluation of the total number of branches already operating in each province. As suggested by Guiso, Sapienza, and Zingales (2004a, 2004b), such exogenous geographical variation in banking development allows researchers to identify exogenous shocks to the local banking markets. Likewise, Benfratello, Schiantarelli, and Sembenelli (2008) show bank branch intensity is positively related to corporate innovation. In Herrera and Minetti (2007), such exogenous deregulatory shocks to the local supply of banking services due to deregulation are used to instrument the length of main banks to examine the effect of informed finance on technological change.

More recently, several papers also examine the impact of intrastate and interstate banking deregulation on innovation of US firms (e.g., Amore, Schneider, and Zaldokas, 2013; Cornaggia, Tian, and Wolfe, 2015; Hombert and Matray, 2016). Instead of exogenous regulatory regional differences of banking system, Ongena and Smith (2000) find that firms develop more bank relationships in countries with inefficient judicial

systems and poor enforcement of creditor rights. Also, in Ongena and Smith (2001), a unique panel data set from Norwegian banking market is used to analyze the duration of bank relationship across firms and over time. Farinha and Santos (2002) utilize panel data set on bank lending relationships in Portugal to study switching from single to multiple lending and the ex post effects of the initiation of multiple relationships.

In this paper, we focus on the effects of bank information configurations on innovation and the determinants of bank information, given bank-firm relationships such as duration, distance and the scope of transactions. If multiple banking is a proxy for the intensity of bank competition, our results suggest that regarding corporate innovation bank information competition is crucial. To properly address the determinants of multiple banks' relationships would require considerable data gathering efforts. In particular, we would need information on the first time matching with potential banks in a firm's life and subsequent additional matching or leaving. Moreover, it would require longitudinal data on all matched bank information acquisitions to figure out whether innovative firms are more likely to have multiple informed banks. This is well beyond the scope of this paper.

6. Conclusions

In this paper, we show that no bank information, the main bank's information monopoly and bank information competition coexist among prevalent multiple banking. Moreover, bank information competition is positively related to product and process innovation, while the main bank's information monopoly in multiple banking has no significant effects. Also, we offer evidence on adverse effect on innovation of information monopoly among single banking firms. Overall, we shed new light into the literature on banking and innovation.

Our results suggest that it increases innovation for small business to maintain multiple informed lending relationships, since such bank information competition is linked to stable supply of fund against a shock. Also, information cost effect on multiple informed lending suggests that a firm should actively disclose its soft information not just to the main bank but also to the sub bank. Additionally, public funds focusing on innovation against financial shocks might help innovative small firms under circumstances of information monopoly or no information to avoid premature liquidation of innovation. Further analyses on bank information competition and intensity of bank competition remain a topic for future research.

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Table A

Variables	Definitions	Data sources
Product innovation	1 if a firm realized product innovation in 2009-2013, otherwise 0	2014 survey
Process innovation	1 if a firm realized process innovation in 2009-2013, otherwise 0	2014 survey
Main bank information	1if the main bank well knows soft strength of the firms, otherwise 0	2007 survey
Sub bank information	1if the sub bank well knows soft strength of the firms, otherwise 1	2007 survey
Number of banks	the number of lending banks	2007 survey
Credit rating 2007	TSR credit rating score in 2007	2007 survey
ln (assets 2007)	Natural logarithm of assets in 2007	2007 survey
ln (main bank duration)	Natural logarithm of length of credit relationship with the main bank in 2007	2007 survey
ln(main bank distance)	Natural logarithm of distance of the main bank away from a firm in 2008. The distance is transformed as 0.25km for 0-500m; 0.5km for 500m-1km; 5km for 1km-10km; 20km for 10km-30km; 40km for 30km-50m and 60km for 50km-.	2007 survey
Main bank services	The number of services from the main bank	2007 survey
ln (Sub bank duration)	Natural logarithm of length of credit relationship with the sub bank in 2007	2007 survey
ln(sub bank distance)	Natural logarithm of distance of the sub bank away from a firm in 2008. The distance is transformed as 0.25km for 0-500m; 0.5km for 500m-1km; 5km for 1km-10km; 20km for 10km-30km; 40km for 30km-50m and 60km for 50km-.	2007 survey
Sub bank services	The number of services from the sub bank	2007 survey
ln(firm age 2009)	Natural logarithm of frim age in 2009	2014 survey
ln(number of employees 200	Natural logarithm of number of employees 2009	2014 survey
Credit rating 2009	TSR credit rating score in 2009	2014 survey
Worsening of lending attitude of the main bank	1 if the lending attitude of the main bank worsened, 0 otherwise	2009 survey
Worsening of lending attitude of the sub bank	2 if the lending attitude of the sub bank worsened, 0 otherwise	2009 survey
Change of credit rating	the change of credit rating from 2007 to 2009	2007, 2009 survey

Table 1 Descriptive statistics

Panel A: single banking	variable	mean	p25%	p50	p75	sd	N
	Product innovation	20.94%	0	0	0	40.80%	191
	Process innovation	22.51%	0	0	0	41.88%	191
	Bank information	37.17%	0	0	1	48.45%	191
	Credit rating 2007	54.31	50	53	58	6.51	191
	ln(assets 2007)	19.60	18.73	19.49	20.64	1.42	191
Credit relationship	ln (bank duration)	3.11	2.71	3.40	3.69	0.88	191
	bank duration	29.49	15	30	40	16.97	191
bank proximity	0-500m	13.61%	0	0	0	34.38%	191
	500m-1km	17.80%	0	0	0	38.35%	191
	1km-10km	53.40%	0	1	1	50.02%	191
	10km-30m	12.57%	0	0	0	33.23%	191
	30km-50km	1.05%	0	0	0	10.21%	191
	>50km	1.57%	0	0	0	12.47%	191
	ln(bank distance)	1.03	-0.69	1.61	1.61	1.49	191
	Bank distance	6.67	0.5	5	5	9.64	191
	Bank services	1.94	1	2	3	1.04	191
	ln(firm age 2009)	3.62	3.33	3.71	4.06	0.64	191
	Firm age 2009	44.84	28	41	58	25.64	191
	ln(number of employees 2009)	2.84	2.08	2.71	3.43	1.06	191
	Number of employees 2009	32.46	8	15	31	49.16	191
	Creadit rating 2009	53.55	49	53	57	6.13	191
Panel B: multiple banking	variable	mean	p25	p50	p75	sd	N
	Product innovation	37.55%	0	0	1	48.46%	783
	Process innovation	39.59%	0	0	1	48.94%	783
	Main bank information	50.70%	0	1	1	50.03%	783
	Sub bank information	34.10%	0	0	1	47.43%	783
	Number of banks	4.26	2	4	5	2.69	783
	Credit rating 2007	55.10	51	54	59	6.12	783
	ln (assets 2007)	20.82	19.78	20.74	21.83	1.45	783
Main bank relationship	ln (main bank duration)	3.31	3.00	3.43	3.78	0.69	783
	Main bank duration	32.80	20	31	44	16.45	783
Main bank proximity	0-500m	12.77%	0	0	0	33.40%	783
	500m-1km	18.65%	0	0	0	38.97%	783
	1km-10km	55.94%	0	1	1	49.68%	783
	10km-30m	8.94%	0	0	0	28.55%	783
	30km-50km	1.79%	0	0	0	13.26%	783
	>50km	1.92%	0	0	0	13.72%	783
	Main bank distance	6.57	0.5	5	5	10.21	783
	ln(main bank distance)	1.01	-0.69	1.61	1.61	1.46	783
	Main bank services	2.20	2	2	3	1.04	783
Sub bank relationship	ln (Sub bank duration)	2.74	1.95	3.00	3.56	1.03	783
	Sub bank duration	22.96	7	20	35	16.97	783
Sub bank proximity	0-500m	8.05%	0	0	0	27.22%	783
	500m-1km	16.35%	0	0	0	37.00%	783
	1km-10km	51.34%	0	1	1	50.01%	783
	10km-30m	13.15%	0	0	0	33.82%	783
	30km-50km	3.96%	0	0	0	19.51%	783
	>50km	7.15%	0	0	0	25.79%	783
	Sub bank distance	11.17	5	5	5	16.18	783
	ln(sub bank distance)	1.43	1.61	1.61	1.61	1.56	783
	Sub bank services	1.14	0	1	2	0.94	783
	ln(firm age 2009)	3.80	3.55	3.89	4.14	0.55	783
	Firm age 2009	50.90	35	49	63	24.17	783
	ln(number of employees 2009)	3.64	2.71	3.58	4.58	1.20	783
	Number of employees 2009	78.19	15	36	98	117.78	783
	Creadit rating 2009	53.47	50	53	57	6.18	783

Table 2 Bank information and product innovation among single banking firms

Information effects on product innovation	ATE	ATET		
Information monopoly	−0.044	−0.139		
	(0.77)	(2.31)**		
POmean: No information	0.257	0.251		
	(6.49)***	(4.92)***		
Bank information: probit	I.M.			
ln (assets 2007)	−0.012			
	(0.14)			
Credit rating 2007	−0.016			
	(0.85)			
ln(bank duration)	0.27			
	(2.21)**			
ln(bank distance)	0.025			
	(0.37)			
bank services	0.426			
	(3.80)***			
constant	−0.991			
	(0.74)			
Potential outcome: probit	ATE		ATET	
	N.I	I.M.	N.I	I.M.
ln(firm age 2009)	−0.244	1.043	−0.271	0.496
	(0.91)	(1.73)*	(0.75)	(0.82)
ln(unmber of employees 2009)	0.021	−0.241	−0.144	−0.271
	(0.14)	(0.78)	(0.79)	(0.85)
Credit rating 2009	0.041	0.123	0.065	0.124
	(1.75)*	(2.30)**	(2.25)**	(2.24)**
ln(bank duration)	−0.209	−2.525	−0.208	−1.977
	(1.28)	(3.43)***	(1.02)	(2.72)***
ln(bank distance)	0.134	−0.293	0.162	−0.178
	(1.28)	(1.79)*	(1.18)	(1.10)
bank services	0.102	−0.104	0.126	−0.223
	(0.66)	(0.48)	(0.71)	(0.92)
constant	−2.124	−4.297	−2.964	−3.782
	(1.41)	(1.80)*	(1.53)	(1.56)

Table 3 Bank information and process innovation among single banking firms

Information effects on process innovation	ATE	ATET		
Information monopoly	−0.053	−0.117		
	(0.94)	(1.79)*		
Pomean: No information	0.263	0.285		
	(6.51)***	(5.35)***		
Bank information: probit	I.M.			
ln (assets 2007)	−0.012			
	(0.14)			
Credit rating 2007	−0.016			
	(0.85)			
ln(bank duration)	0.27			
	(2.21)**			
ln(bank distance)	0.025			
	(0.37)			
bank services	0.426			
	(3.80)***			
constant	−0.991			
	(0.74)			
Potential outcome: probit	ATE		ATET	
	N.I	I.M.	N.I	I.M.
ln(firm age 2009)	−0.467	1.167	−0.16	0.826
	(1.75)*	(2.13)**	(0.45)	(1.54)
ln(unmber of employees 2009)	0.075	−0.02	−0.059	−0.041
	(0.50)	(0.08)	(0.34)	(0.16)
Credit rating 2009	0.031	0.065	0.067	0.063
	(1.21)	(1.47)	(2.28)**	(1.38)
ln(bank duration)	−0.018	−2.001	−0.233	−1.614
	(0.11)	(3.25)***	(1.09)	(2.75)***
ln(bank distance)	0.021	−0.139	0.039	−0.02
	(0.21)	(1.04)	(0.31)	(0.14)
bank services	0.181	0.489	0.148	0.487
	(1.21)	(2.28)**	(0.85)	(2.12)**
constant	−1.508	−4.065	−3.434	−3.876
	(1.01)	(2.03)**	(1.84)*	(1.99)**

Table 4 Bank information and product innovation among multiple banking firms

Information effects on product innovation	ATE	ATET				
Information monopoly	−0.045	−0.016				
	(0.90)	−0.31				
Information competition	0.108	0.127				
	(2.62)***	(2.23)**				
Pomean: No information	0.344	0.33				
	(13.46)***	(9.49)***				
Bank information: mlogit	I.M.	I.C.				
ln (assets 2007)	0.1	0.475				
	(0.87)	(4.64)***				
Credit rating 2007	−0.076	−0.019				
	(3.29)***	(1.09)				
ln(main bank duration)	0.32	0.187				
	(1.65)*	(1.19)				
ln(main bank distance)	−0.194	−0.167				
	(2.44)**	(2.62)***				
Main bank services	0.337	0.227				
	(2.93)***	(2.51)**				
ln(sub bank duration)	−0.122	0.1				
	(1.02)	(0.94)				
ln(sub bank distance)	0.169	0.113				
	(1.96)*	(1.94)*				
Sub bank services	−0.486	0.013				
	(3.42)***	(0.12)				
number of banks	−0.501	−0.06				
	(1.82)*	(0.31)				
constant	0.503	−10.616				
	(0.29)	(6.68)***				
Potential outcome: probit	ATE			ATET		
	N.I	I.M.	I.C.	N.I	I.M.	I.C.
ln(firm age 2009)	−0.3	−0.351	0.193	−0.552	−0.065	0.152
	(1.85)*	(1.15)	(0.81)	(2.54)**	(0.23)	(0.54)
ln(unmber of employees 2009)	0.168	0.183	0.144	0.335	0.02	0.052
	(2.11)**	(1.10)	(1.58)	(3.24)***	(0.15)	(0.44)
Credit rating 2009	0.004	−0.018	0.014	0.013	−0.012	0.034
	(0.32)	(0.68)	(0.91)	(0.71)	(0.52)	(1.59)
ln(main bank duration)	0.18	0.135	−0.018	0.219	−0.018	−0.025
	(1.31)	(0.48)	(0.08)	(1.24)	(0.07)	(0.08)
ln(main bank distance)	0.036	−0.124	0.059	−0.06	−0.128	−0.02
	(0.61)	(1.18)	(0.86)	(0.76)	(1.36)	(0.24)
Main bank services	−0.018	0.203	0.179	0.095	0.213	0.203
	(0.22)	(1.50)	(1.74)*	(0.97)	(1.88)*	(1.58)
ln(sub bank duration)	−0.017	0.012	−0.266	−0.05	0.041	−0.264
	(0.20)	(0.09)	(2.19)**	(0.49)	(0.32)	(1.76)*
ln(sub bank distance)	0.055	−0.069	−0.002	0.134	−0.017	0.053
	(1.02)	(0.75)	(0.03)	(1.83)*	(0.20)	(0.57)
Sub bank services	0.071	−0.506	−0.11	−0.001	−0.387	−0.114
	(0.74)	(2.73)***	(1.03)	(0.01)	(2.34)**	(0.82)
number of banks	0.077	0.75	−0.048	0.13	0.803	−0.049
	(0.48)	(2.28)**	(0.24)	(0.62)	(2.69)***	(0.18)
constant	−1.076	−0.608	−2.248	−1.434	−1.095	−2.873
	(1.30)	(0.42)	(2.05)**	(1.36)	(0.83)	(1.93)*

Table 5 Bank information and process innovation among multiple banking firms

Information effects on process innovation	ATE	ATET
Information monopoly	0.041	−0.016
	(0.87)	−0.31
Information competition	0.102	0.127
	(2.35)**	(2.23)**
Pomean: No information	0.357	0.36
	(13.80)***	(10.72)***
Bank information: mlogit	I.M.	I.C.
ln (assets 2007)	0.1	0.475
	(0.87)	(4.64)***
Credit rating 2007	−0.076	−0.019
	(3.29)***	(1.09)
ln(main bank duration)	0.32	0.187
	(1.65)*	(1.19)
ln(main bank distance)	−0.194	−0.167
	(2.44)**	(2.62)***
Main bank services	0.337	0.227
	(2.93)***	(2.51)**
ln(sub bank duration)	−0.122	0.1
	(1.02)	(0.94)
ln(sub bank distance)	0.169	0.113
	(1.96)*	(1.94)*
Sub bank services	−0.486	0.013
	(3.42)***	(0.12)
number of banks	−0.501	−0.06
	(1.82)*	(0.31)
constant	0.503	−10.616
	(0.29)	(6.68)***

Potential outcome: probit	ATE			ATET		
	N.I	I.M.	I.C.	N.I	I.M.	I.C.
ln(firm age 2009)	−0.145	−0.51	0.113	−0.568	−0.538	−0.043
	(0.95)	(1.69)*	(0.48)	(2.68)***	(1.95)*	(0.15)
ln(unmber of employees 2009)	0.055	0.526	0.088	0.106	0.45	0.01
	(0.71)	(2.96)***	(0.97)	(1.11)	(2.78)***	(0.09)
Credit rating 2009	0.002	−0.061	0.015	0.006	−0.029	0.017
	(0.13)	(1.99)**	(0.88)	(0.33)	(1.02)	(0.73)
ln(main bank duration)	0.182	0.00	0.076	0.383	−0.12	0.233
	(1.41)	(0.00)	(0.36)	(1.94)*	(0.43)	(0.89)
ln(main bank distance)	0.054	−0.079	0.093	−0.023	−0.112	0.08
	(0.96)	(0.75)	(1.34)	(0.30)	(1.18)	(0.91)
Main bank services	−0.042	0.372	0.059	0.00	0.27	0.179
	(0.53)	(2.95)***	(0.58)	(0.00)	(2.20)**	(1.42)
ln(sub bank duration)	−0.074	0.159	−0.14	−0.061	0.187	−0.215
	(0.89)	(1.04)	(1.23)	(0.61)	(1.40)	(1.53)
ln(sub bank distance)	0.013	−0.034	0.022	0.033	−0.042	0.057
	(0.25)	(0.37)	(0.32)	(0.46)	(0.52)	(0.62)
Sub bank services	−0.009	−0.115	−0.114	−0.003	−0.143	−0.17
	(0.10)	(0.60)	(1.03)	(0.03)	(0.78)	(1.17)
number of banks	0.076	1.137	0.104	−0.03	1.03	0.021
	(0.47)	(3.63)***	(0.56)	(0.15)	(3.51)***	(0.08)
constant	−0.538	0.701	−2.136	0.153	0.28	−1.891
	(0.65)	(0.51)	(1.75)*	(0.15)	(0.22)	(1.14)

Table 6 Bank information and worsening of lending attitude among single banking firms

Worsening of leding attitude of the main bank	ATE	ATET		
Information monopoly	−0.017	−0.008		
	(0.54)	(0.20)		
Pomean: No information	0.061	0.059		
	(2.51)**	(2.20)**		
Bank information: mlogit	I.M.			
ln (assets 2007)	−0.062			
	(0.67)			
Credit rating 2007	−0.015			
	(0.73)			
ln(bank duration)	0.264			
	(1.96)*			
ln(bank distance)	0.01			
	(0.14)			
bank services	0.404			
	(3.38)***			
constant	0.036			
	(0.02)			
Potential outcome: probit	ATE		ATET	
	N.I	I.M.	N.I	I.M.
ln(firm age 2009)	−0.022	−0.055	−0.018	−0.071
	(0.69)	(1.06)	(0.51)	(1.29)
ln(unmber of employees 2009)	0.022	0.051	0.031	0.064
	(0.73)	(1.45)	(0.95)	(1.47)
Change of credit rating	−0.011	−0.004	−0.016	−0.01
	(1.60)	(0.34)	(1.95)*	(0.59)
ln(bank duration)	0.023	0.036	0.042	0.041
	(0.81)	(0.62)	(1.19)	(0.76)
ln(bank distance)	0.007	−0.02	0.005	−0.023
	(0.37)	(0.90)	(0.19)	(0.94)
bank services	−0.01	−0.002	−0.023	−0.018
	(0.69)	(0.11)	(1.46)	(0.79)
constant	0.041	0.01	−0.014	0.05
	(0.31)	(0.13)	(0.11)	(0.44)
Number of observations	153			

Table 7 Bank information and worsening of lending attitude of main bank among multiple banking firms

Worsening of lending attitude of the main bank	ATE	ATET				
Information monopoly	0.043	0.061				
	(1.20)	(1.38)				
Information competition	−0.048	−0.041				
	(2.17)**	(1.14)				
Pomean: No information	0.094	0.105				
	(5.65)***	(4.32)***				
Bank information: mlogit	I.M.	I.C.				
ln (assets 2007)	0.079	0.452				
	(0.58)	(3.84)***				
Credit rating 2007	−0.062	−0.012				
	(2.30)**	(0.61)				
ln(main bank duration)	0.377	0.25				
	(1.76)*	(1.42)				
ln(main bank distance)	−0.225	−0.185				
	(2.42)**	(2.55)**				
Main bank services	0.358	0.132				
	(2.70)***	(1.30)				
ln(sub bank duration)	−0.19	0.035				
	(1.45)	(0.29)				
ln(sub bank distance)	0.165	0.081				
	(1.69)*	(1.29)				
Sub bank services	−0.421	−0.008				
	(2.64)***	(0.06)				
number of banks	−0.323	−0.111				
	(1.02)	(0.51)				
constant	−0.227	−10.15				
	(0.11)	(5.64)***				
Potential outcome: probit	ATE			ATET		
	N.I	I.M.	I.C.	N.I	I.M.	I.C.
ln(firm age 2009)	−0.109	0.446	0.235	−0.142	0.508	0.27
	(0.51)	(1.17)	(0.77)	(0.55)	(1.38)	(0.64)
ln(unmber of employees 2009)	0.077	−0.19	0.139	0.041	−0.299	0.363
	(0.52)	(1.16)	(0.87)	(0.26)	(1.56)	(1.69)*
Change of credit rating	−0.012	−0.004	−0.15	−0.038	−0.024	−0.228
	(0.37)	(0.07)	(2.40)**	(0.71)	(0.55)	(2.65)***
ln(main bank duration)	−0.33	0.225	−0.119	−0.505	0.206	−0.21
	(2.17)**	(0.57)	(0.33)	(2.56)**	(0.45)	(0.41)
ln(main bank distance)	−0.035	−0.038	−0.223	0.084	0.138	−0.257
	(0.43)	(0.23)	(1.61)	(0.90)	(0.85)	(1.66)*
Main bank services	−0.148	0.046	0.185	−0.154	−0.004	0.168
	(1.52)	(0.27)	(1.13)	(1.37)	(0.02)	(0.68)
ln(sub bank duration)	−0.142	−0.082	−0.689	−0.211	−0.067	−0.789
	(1.11)	(0.42)	(2.95)***	(1.37)	(0.33)	(2.61)***
ln(sub bank distance)	0.001	0.232	0.08	−0.003	0.198	0.249
	(0.01)	(1.69)*	(0.50)	(0.04)	(1.46)	(0.96)
Sub bank services	0.06	−0.326	−0.1	0.023	−0.284	0.135
	(0.51)	(1.48)	(0.58)	(0.15)	(1.15)	(0.58)
number of banks	−0.209	1.093	0.825	−0.404	1.266	0.628
	(0.84)	(2.25)**	(1.84)*	(1.30)	(2.60)***	(1.32)
constant	0.808	−3.73	−2.565	1.815	−3.957	−3.272
	(1.18)	(2.51)**	(2.64)***	(1.93)*	(2.59)***	(2.47)**
Number of observations	613					

Table 8 Bank information and worsening of lending attitude of sub bank among multiple banking firms

Worsening of lending attitude of the sub bank	ATE	ATET				
Information monopoly	0.02	0.07				
	(0.62)	(1.75)*				
Information competition	−0.011	0.013				
	(0.45)	(0.36)				
Pomean: No information	0.082	0.077				
	(5.13)***	(3.59)***				
Bank information: mlogit	I.M.	I.C.				
ln (assets 2007)	0.075	0.437				
	(0.54)	(3.69)***				
Credit rating 2007	−0.068	−0.015				
	(2.43)**	(0.74)				
ln(main bank duration)	0.426	0.295				
	(1.91)*	(1.66)*				
ln(main bank distance)	−0.217	−0.181				
	(2.30)**	(2.47)**				
Main bank services	0.336	0.13				
	(2.52)**	(1.29)				
ln(sub bank duration)	−0.175	0.008				
	(1.30)	(0.07)				
ln(sub bank distance)	0.17	0.085				
	(1.71)*	(1.33)				
Sub bank services	−0.459	−0.028				
	(2.81)***	(0.23)				
number of banks	−0.389	−0.095				
	(1.18)	(0.42)				
constant	0.169	−9.73				
	(0.08)	(5.40)***				
Potential outcome: probit	ATE			ATET		
	N.I	I.M.	I.C.	N.I	I.M.	I.C.
ln(firm age 2009)	−0.09	0.04	0.48	−0.111	0.187	0.571
	(0.42)	(0.10)	(1.54)	(0.48)	(0.50)	(1.21)
ln(unmber of employees 2009)	0.099	−0.19	−0.046	−0.034	−0.266	−0.059
	(0.77)	(1.02)	(0.33)	(0.24)	(1.26)	(0.32)
Change of credit rating	−0.066	−0.102	−0.136	−0.031	−0.078	−0.205
	(1.59)	(1.75)*	(2.30)**	(0.56)	(1.49)	(3.28)***
ln(main bank duration)	−0.298	−0.035	0.124	−0.316	−0.035	0.113
	(1.80)*	(0.08)	(0.36)	(1.71)*	(0.09)	(0.22)
ln(main bank distance)	−0.038	−0.226	−0.05	0.113	−0.152	0.018
	(0.37)	(1.82)*	(0.48)	(0.92)	(1.24)	(0.16)
Main bank services	−0.106	0.01	0.27	−0.122	−0.051	0.449
	(0.93)	(0.06)	(1.76)*	(0.84)	(0.34)	(1.94)*
ln(sub bank duration)	−0.037	−0.386	−0.579	−0.042	−0.261	−0.606
	(0.23)	(2.20)**	(3.21)***	(0.21)	(1.49)	(2.92)***
ln(sub bank distance)	−0.091	0.161	0.045	−0.063	0.185	0.032
	(1.24)	(1.30)	(0.45)	(0.86)	(1.35)	(0.27)
Sub bank services	−0.077	0.117	0.013	0.082	0.205	0.025
	(0.56)	(0.49)	(0.07)	(0.48)	(0.83)	(0.13)
number of banks	0.334	0.432	1.111	0.444	0.79	1.216
	(1.36)	(1.10)	(2.87)***	(1.44)	(1.94)*	(2.41)**
constant	−0.348	−0.552	−4.539	0.138	−1.5	−5.452
	(0.47)	(0.49)	(4.19)***	(0.15)	(1.14)	(4.22)***
Number of observations	597					