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Bank Efficiency and Client Firms' Productivity

Daisuke Miyakawa, Tomohiko Inui, Keishi Shoji

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Economic and Social Research Institute
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Abstract

This paper studies the quantitative impact of the efficiency of lender banks on their client firms' total factor productivity. By using the panel data for bank and firm characteristics including the efficiency of banks, we empirically establish the positive correlation between the growth and the level of client firms' TFP, which generically reflect firm's own characteristics, and the efficiency of the lender bank with high loan share. This implies it is necessary to expand the discussion for the determinants of firm performance to the characteristics of the parties having relationships with them.

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[a] Corresponding Author: Associate Senior Economist, Research Institute of Capital Formation, Development Bank of Japan, 1-9-3 Otemachi Chiyoda-ku, Tokyo, 100-0004 JAPAN. E-mail: damiyak@dbj.jp.

[b] Senior Research Fellow, Economic and Social Research Institute, Cabinet Office 3-1-1, Kasumigaseki, Chiyoda-ku, Tokyo 100-8970, Japan. E-mail: inui. tomohiko@gmail.com

[c] Researcher, Research Office on Budget, Research Bureau, House of Representatives, 1-7-1 Nagatacho, Chiyoda-ku, Tokyo 100-0014, Japan. E-mail: s10425@shugiinjk.go.jp.

1. Introduction

Recent banking crises including the experience in Japan over 1990s have largely necessitated the discussion about the real effect of the malfunctioning banking industries. Unfortunately, the empirical studies based on the micro-data and targeting explicitly this issue have been limited so far.[1] Corresponding to such a consideration, this paper studies the impact of lender banks' efficiency on their client firms' total factor productivity (TFP) by using a unique micro-data. For this purpose, we employ an output measure proposed in the recent discussion for the extension of SNA framework. By combining the bank output measure based on FISIM (Financial Intermediation Services Indirectly Measured) concept with the operational cost information of each bank, we construct the panel data of bank efficiency. The wide varieties of bank and firm characteristics including the bank efficiency as well as the unique loan relationship information between firms and banks allows us to explicitly quantify how the efficiency of lender banks are correlated with their client firms' TFP growth and its ex-post level.

The extant literature in banking research has already paid a large attention to constructing the efficiency measure of banks through various approaches, for example Data Envelopment Analysis (DEA). Only a few studies, however, explicitly studies the connection between the efficiency of lender banks and that of client firms. The central theme of this paper is to provide an additional empirical examination contributing to this discussion.

According to the FISIM concept considered in this paper, the output of a bank is measured by subtracting the interest payment to depositors from the interest receipt

[1] Most of the extant studies are using aggregate or industry-level data. There are a limited number of very recent papers focusing the connection between the conditions in finance sector and the one in real sector from the micro-level perspectives. We will briefly survey this in the following section.

from borrowers. By setting a so-called reference rate, FISIM further splits the output into the outputs associated with lending service and deposit service. Then, the former (latter) is counted as intermediate input (final consumption) in the extended SNA framework. In this paper, we put an adjustment for the credit risk taken by banks to such an original measure proposed in FISIM, and study to what extent such a modification is important. This reflects the consideration pointed out in the recent literature that the original FISM mistakenly estimate bank output if we do not appropriately take into account the degree of risk taken by banks. We use such a modified version of FISIM concept to measure the output of 100 banks in Japan.

Note that for this empirical exercise, we implicitly assume some of the sample firms are facing financial friction. Due to such a friction potentially generated by information asymmetry between firms and outside financiers as well as insufficient internal fund held by firms, the firm's investment and/or financing choices could be distorted (e.g., under-investment, excess cash hoarding, and/or the heavy reliance on costly external finance etc.).[2] A number of studies have already pointed out the possibility that such distorted firm behaviors generate the internal allocative inefficiency, which eventually end up with the deterioration of TFP (e.g., Chari et al. 2005; Pratap and Urrutia 2010). Thus, we conjecture that firms keeping relations with the banks exhibiting relatively high efficiency, which could be the sign of superior screening and/or monitoring abilities, tend to be less suffering from such a financial friction. Based on this perspective, we construct the hypothesis that firms show higher performance when they hold the relations with the banks with higher efficiency.

As we will briefly survey in the following section, some of the existing studies

[2] See, for example, Hennessy et al. (2007) and Miyakawa et al. (2011).

have already explored how the existence of "Mainbank" affects firm's financial availability and performance.[3] This paper intends to follow this strand of the study on the value of intimate loan relationships with explicitly considering the heterogeneity of those banks.

This paper is structured as follows. Section 2 briefly surveys the related literature. Before constructing our panel data, Section 3 reviews the discussion about bank output, which includes FISIM concept. Then, the data we use are described in Section 4. Section 5 constructs and tests the hypotheses relating the lender banks' efficiency to firm TFP. Section 6 concludes and presents future research questions.

2. Related literature

There are only a few studies that examine the relationship between bank activity and the performance of its client firms empirically by using the firm-bank match-level data. As one exception, Fukao et al. (2005) tests whether the intensity of lender banks' monitoring activity are correlated with the client firms' ROA. They introduce the ratio of examination officers at the lender bank's headquarter to the all employees of the bank (EOH ratio) as a proxy for monitoring intensity. Through the estimation based on the firm-level panel data containing this EOH ratio as well as other standard determinants of firms' ROA (e.g., leverage, size, loan dependence etc.), they discuss how the lender bank characteristics are correlated with the client firm performances. We basically apply the same empirical strategy to see the effect of the lender banks efficiency, which is originally measured in this paper, onto client firm's

[3] Mainbank is defined, for example, as a bank owning a major position as a share holder and loan holder. In Japan, banks are allowed to hold up to 5% of a firm's stock. Most European countries have similar rules but this is prohibited in the U.S..

TFP.[4] As another example for the empirical examination between bank efficiency and firm performance, Pratap and Urrutia (2010) studies the effects of unexpected interest rate shock on firm TFP through its intermediate goods procurement. They construct a dynamic two-sector model of a small open economy with a financial friction (i.e., cash-in-advance constraint) and quantitatively analyze the effects of currency crisis on the Mexican economy. The model shows how the interest rate shock induces the decline of TFP level of the economy through the malfunction of financial sector. Their results could be one illustration for TFP in the economy to be influenced through financial channel. We share the same view with these studies.

About the determinants of firm TFP, Syverson (2010) comprehensively surveys the recent empirical studies. He classifies six major internal drivers of firms TFP differences.[5] Those include (i) managerial practice and/or talent, (ii) higher-quality general labor and capital inputs, (iii) informational technology and R&D spending, (iv) learning-by-doing, (v) product innovation, and (vi) firm structure decision. While the tradition literature largely emphasizes the importance of R&D spending as a determinant of TFP, he points out "*the mechanisms the R&D literature highlights are likely to often overlap with the effects of unmeasured innovative spending*". He also states that "*understanding how such intangible capital stocks are built and sustained would shed light on many productivity-related issues for this reason.*" We consider the financially constrained firm cannot optimize the procurement of intermediate inputs, and presume that the accumulation of one type of intangible assets - the relation with

[4] Fukao et al. (2005) also check how the estimated fixed-effects on their first-stage panel estimation are correlated with bank characteristics in their second-stage estimation. We will leave the discussion for the applicability of this approach to our future research question.

[5] Productivity spillovers, intra-market competition and trade competition, deregulation or proper regulation, and flexible input markets are main external drivers of productivity differences.

efficient banks - could mitigate such a constraint. It is our main object in this paper to shed a new light on the role of the financial intermediation on firm TFP.

The importance of having a mainbank has been an issue in the extant banking study (Aoki and Patrick 1994; Aoki and Saxonhouse 2000). This strand of literature presumes that the existence of mainbank could potentially extend the firm's credit availability, which improves the firm's outcome. Alternatively, it is claimed that the existence of such a mainbank may send a good signal to other banks and this can also improve credit availability. Those studies, however, have not explicitly taken into account the heterogeneity of each mainbank. From the same reason as we are interested in the variation of firm performance, it would be natural to expect that the difference among banks exists. We take this point seriously and empirically study it. In this sense, it is our interest to follow and deepen the classic discussion associated with the role of mainbank.

3. Bank Output

Unlike the firms in manufacturing industries, measuring output for the business entities in service industries (e.g., banking) is not necessarily straightforward. As one example, Das and Ghosh (2006) categorizes the measurement of bank output into two groups. The first group characterizes banks as in the analogy of usual manufacturing companies. Such a "production approach" (e.g., Ferrier and Lovell 1990) considers, for example, the number of deposits and loans as output while the wage, rental price, and intermediation cost payments as input.[6] Those studies naively consider the size of bank's balance sheet as the measure of output. One criticism for

[6] Most of the studies in this group do not consider the interest payment to depositors as a cost.

this approach is on their ignorance about the specific characteristics of banks as financial intermediations, which uses the mismatch between lending and borrowing to generate its profit. The second group called "intermediation approach" responds to such criticism and intends to characterize explicitly banks as intermediaries between depositors and firms. This group is further categorized into two individual approaches based on their perspectives about intermediation.[7] First, the "asset approach" treats the liability and other physical resources as the input of bank's production process while the asset as output.[8] By putting a distinction between the two sides of bank's balance sheet, they intend to capture the role of banks as intermediaries. One shortcoming of this approach is the inability to analyze the productivity difference coming from the choice of capital structure (i.e., the composites of the liabilities and equities). Second, "user-cost approach" simply focuses on the return from the financial assets minus its reference rate, which corresponds to the opportunity cost of the funds. Whenever the net return is positive (negative), the bank's output is considered as positive (negative). This framework shares a view with the standard FISIM approach. One technical difficulty common both in the user-cost approach and FISIM approach is the difficulty to have the consensus on the measurement for reference rate, especially on how risk should be taken into account for this measurement.[9] FISIM is measuring bank's output by computing the net interest profit. Then, they split the output into the ones associated with lending and deposit services by using a reference rate. Notably, the recent FISIM literature further takes into account the risk adjustment since the user cost of money should be essentially adjusted for risk. For example, Basu et al. (2008), and Colangelo and

[7] See Berger and Humphrey (1992) for more detail.
[8] In this category, the service for depositors is not considered as output.
[9] As we will discuss later, challenging this technical difficulty is one contribution of this paper.

Inklaar (2008) uses various market rate data to construct an appropriate risk-adjusted reference rate. As another example, Guarda and Rouabah (2007) employs a simple micro-econometrics model to structurally estimate the shadow price of loans. Note that the instable nature of the estimated shadow price is criticized from the practical consideration.

In principle, FISIM interprets bank's net interest profit, which stands for the loan interest receipts minus the deposit interest payments, as its output. As widely pointed out in the literature (e.g., Basu et al. 2008), however, such a notion is somewhat problematic. In fact, the output associated with bank's lending service should be ideally computed as the loan interest receipts minus the required market return for the borrower's funding in the hypothetical situation where information asymmetry does not exist. This ideal reference rate for lending service is conceptualized in the center diagram in Figure-1.[10] Imagine the case where a firm is planning to finance its capital investment. If there is no information asymmetry between the firms and outside financiers, the firm can freely borrow from the market. Due to the existence of information problem, however, the firm needs to rely on banks, which could potentially mitigate the problem, and hence deserve rents. This is the reason why we need to measure the output associated with lending service by subtracting the required market return, which is computed in the hypothetical environment with no information asymmetry, from the loan interest receipts. Unless we take into account this adjustment, we inevitably over-estimate bank outputs by mistakenly subtracting risk-free interest, which is essentially lower than the hypothetical required market

[10] Figure-1(centre diagram) visualizes the idea for risk-adjustment proposed in Wang and Basu (2008).

return.[11]

Unfortunately, we could not generally observe the hypothetical required market return corresponding to the case without information problem. Corresponding to this concern, Basu et al. (2008) refers to the most plausible market indexes for the bank assets as possible. Those indexes containing the return of MBS, CMBS, or ABS, however, are not necessarily available. In this paper, we rely on the information on the allowance for loan losses, which we can observe in bank's balance sheet. In order to proxy the credit risk taken by banks in ex-ante perspective, we use the average of the changes in the allowance for loan losses over the next three years from a given period where we attempt to measure bank output. We use this information to quantify the average of the realized losses in banks' financial statement. Note that the allowance for loan losses is the estimated losses out of the loan outstanding at each point. Thus, the average change in the allowance for loan losses could summarize credit risk associated with the loan asset from the ex-post perspective. If the hypothetical financial market works well and the competition in the market is high enough, the credit risk observed ex-post could work as a good proxy for the credit risk estimated ex-ante (i.e., at the timing of loan provision). If this is the case, the hypothetical required market return for the loan asset could be set to the rate covering exactly such an ex-post observed credit risk. This is one justification for using the data on the allowance for loan losses in order to adjust the credit risk.[12] (Figure-1 right diagram)

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[11] Obviously, the output associated with deposit service could potentially suffer from the same problem. Ideally, we should construct the deposit output by subtracting the deposit interest payment from the depositor's required return for the bank in the case without the deposit insurance. In other words, the riskiness of each bank should be considered in the computation of the output. This idea is also capture in Figure-1. We believe, nonetheless, the possibility of bank failure is very low. Thus, we treat the risk-free rate and the required returns for banks in our sample are almost same.

[12] Of course, the risk which should be covered here is the non-systemic risk. It is our future task to disentangle the systemic and non-systemic risks in our analysis. As another remark, we have not adjusted the term-risk taken by banks, which corresponds to the duration gap between asset and liability held by banks. Since we do not have detailed information about

4. Data

We have two datasets, which store firm-level and bank-level data. First database is for bank characteristics provided by NEEDS Financial Quest. Second database is for the financial characteristics of firms, which is stored in Development Bank of Japan Corporate Financial Databank. After compiling the panel data for the efficiency of banks and its characteristics, we combine the data with the client firm's characteristics. For this purpose, we employ the loan relationship information between the listed firms and their lender banks over our sample period, which covers 1976 to 2005 fiscal years.[13] As a result of this operation, we end up with the large unbalanced panel data. Table-1 and Table-2 list the summary statistics and the correlation coefficients, respectively.[14]

4.1. Bank data

Our first dataset - NEEDS Financial Quest - stores bank's financial characteristics in the form of an unbalanced panel data. One remark is that the identification of each bank is based on the identity of each bank as of 2009 fiscal year. If a bank is merged with another bank before 2009, the recognized continuing bank at the timing of merger in the database is automatically treated as a survival one.[15]

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the durations of banks' asset and liability in our dataset, we could not exactly adjust this risk component. Potential alleviation for this problem is to use the information about the asset and liability volumes in several categories (e.g., (i) loan outstanding to mortgage, capital investment, and (ii) liability outstanding from short-term and long-term deposits). We will leave this issue to the future research question.

[13] We employ the loan share information of total loans (i.e., summation of the short-term and long-term loans) to determine the existence of the loan relationships. It would be interesting extension to focus on either one of those two loan share information.

[14] The tables are constructed from firm - top lender - year observations. This means that each number associated with firms is computed by picking up a firm only once in a year while a same bank could appear multiple times in a computation of the number associated with banks. We will detail this later.

[15] This means, for example, the financial data of Mizuho Bank is connected to that of Dai-ichi Kangyo Bank,

Before implementing the risk-adjustment to the original FISIM output briefed in the previous section, we process two steps. First, the gross output of bank j at the period t is measured by simply following FISIM concept (i.e., loan interest receipt minus deposit interest payment).

$$
\left\{
\begin{array}{l}
\text{Gross Output}_{j,t} = \text{Interest Receipt}_{j,t} - \text{Interest Payment}_{j,t} \ \cdots (1) \\
\text{where} \\
\text{Interest Receipt}_{j,t}\text{: Bank } j'\text{s Interest Receipt during the period } t \\
\text{Interest Payment}_{j,t}\text{: Bank } j'\text{s Interest Payment during the period } t
\end{array}
\right.
$$

This output measure in (1), however, are likely to be negative in many bank-year cases due to the mismatch of loan asset and deposit, which is a typical feature of Japanese banks. Corresponding to this problem, we adjust the deposit interest payment by multiplying the ratio of loan outstanding to deposit outstanding, and construct the so-called B/S Adjusted Output in (2).

$$
\left\{
\begin{array}{l}
\text{B/S Adjusted Output}_{j,t} = \text{Interest Receipt}_{j,t} - \text{Interest Payment}_{j,t} \times \dfrac{\text{Loan Outstanding}_{j,t-1}}{\text{Deposit Outstanding}_{j,t-1}} \ \cdots (2) \\
\text{where} \\
\text{Loan Outstanding}_{j,t-1}\text{: Bank } j'\text{s Loan Outstanding at the end of the period } t-1 \\
\text{Deposit Outstanding}_{j,t-1}\text{: Bank } j'\text{s Deposit Outstanding at the end of the period } t-1
\end{array}
\right.
$$

Mizuho-Corporate Bank is connected to the information of Fuji Bank, Mitsubishi-Tokyo-UFJ is connected to Mitsubishi-Tokyo, which is originally connected to Mitsubushi Bank, Risona Bank is connected to Daiwa Bank, and so on. Among those data connection, sometimes the continuation looks somewhat controversial (e.g., Mitsui-Sumitomo Bank follows the financial characteristics of Wakashio Bank, which is relatively small among the member of the merger).

Through this modification, we virtually compute a net interest profit for the bank, which finances all of the existing loan assets by deposit. Note that as a cost of this operation, we are inevitably forced to exclude the quality of asset-liability management in each bank from our analysis, which could be potentially an interesting research object.[16] Finally, we subtract the average of the changes in the allowance of loan losses over the following three years to each point as in (3).

$$\begin{cases} \text{Risk Adjusted Output}_{j,t} = \text{B/S Adjusted Output}_{j,t} \\ \qquad -\sum_{\tau=1}^{3} \frac{(\text{Allowance of Loan Losses}_{j,t+\tau} - \text{Allowance of Loan Losses}_{j,t+\tau-1})}{3} \cdots (3) \\ \text{where} \\ \text{Allowance of Loan Losses}_{j,t}\text{: Bank j's Allowance of Loan Losses at the end of the period t} \end{cases}$$

Then, our measure of bank efficiency is computed through dividing this final output measure by the operating cost as in (4). Figure-2 plots the panel data for the efficiency of banks in (4) over our sample period. We can immediately notice the large cross sectional dispersion and the seemingly structural change in time-series direction.

$$\begin{cases} \text{Bank Efficiency}_{j,t} = \frac{\text{Risk Adjusted Output}_{j,t}}{\text{Operationg Cost}_{j,t}} \cdots (4) \\ \text{where} \quad \text{Operating Cost}_{j,t}\text{: Bank j's Operation Cost over the period t} \end{cases}$$

4.2. Firm data

The firm characteristics are obtained from Development Bank of Japan

[16] Note that we also exclude bank's business fee revenue associated with, for example, business consulting, remittance, or loan guarantee etc.

Financial Data Bank, which stores the loan amounts from each bank to each firm and each firm's financial characteristics. Since the loan relation data stored in DBJ database, which is essential for our analysis, is available only for 1982 to 1999, we complement this data set with Nikkei Needs Financial Quest. We merge the firm and bank data by using these two databases, and construct the unbalanced panel data from 1976 to 2009 fiscal years. In our data, the list of firms is fixed to the one being alive in 2009 fiscal year. We do this to exclude the demographic effect associated with the entry and exit of firms. For bank's side, however, the list of banks vary over time due to the merger and acquisition among banks. The identification of each bank is based on the identity of each bank as of 2009 fiscal year. This means if a bank is merged with another bank before 2009, the recognized continuing bank at the timing of merger is automatically treated as a survival one. As a result, the data set consists of 3,197 firms and at most 164 banks. we use all the non-financial firms belonging to all the sectors.[17]

As the firm's ex-post efficiency measure for period $t+\tau$ ($\tau = 3$ and 5), we employ the TFP of each firm. We also implement the same exercise for τ= 1, 2, and 4. The obtained implication is almost same unless noted explicitly.[18] This is provided in East Asian Listed Companies Database (EALC) 2009 compiled by Japan Center for Economic Research (JCER), Center for Economic Institutions (IER, Hitotsubashi University), Center for China and Asian Studies (CCAS, Nihon University), and Center for National Competitiveness (Seoul University). As detailed in Fukao et al. (2011), the TFP level of firm f, industry j in year t, $TFP_{f,j,t}$ is calculated as follows in the case that

[17] It mainly covers manufacturing, utility (e.g., electricity and gas), transportation, retail and wholesale, construction and realty, finance, information, and other service industries.
[18] The results are provided upon request.

the data cover a period from $t = 0$ to T and t_0 $(0 < t < T)$ is the benchmark year. The estimation for each firm's TFP level is implemented as relative to the industry average TFP level. They use the multilateral TFP index method developed by Good et al. (1997).

$$LN(\mathrm{TFP}_{f,j,t}) = \left\{LN(Q_{f,j,t}) - \overline{LN(Q_{j,t})}\right\} - \sum_{i=1}^{n}(S_{f,i,j,t} + \overline{S_{i,j,t}})\left\{LN(X_{f,i,j,t}) - \overline{LN(X_{i,j,t})}\right\}$$

for $t = t_0$

$$LN(\mathrm{TFP}_{f,j,t}) = \left\{LN(Q_{f,j,t}) - \overline{LN(Q_{j,t})}\right\} - \frac{1}{2}\sum_{i=1}^{n}(S_{f,i,j,t} + \overline{S_{i,j,t}})\left\{LN(X_{f,i,j,t}) - \overline{LN(X_{i,j,t})}\right\}$$

$$+ \sum_{s=t_0+1}^{t}\left\{\overline{LN(Q_{j,s})} - \overline{LN(Q_{j,s-1})}\right\} - \sum_{s=t_0+1}^{t}\sum_{i=1}^{n}\frac{1}{2}(\overline{S_{i,j,s}} + \overline{S_{i,j,s-1}})\left\{\overline{LN(X_{i,j,s})} - \overline{LN(X_{i,j,s-1})}\right\}$$

for $t > t_0$

$$LN(\mathrm{TFP}_{f,j,t}) = \left\{LN(Q_{f,j,t}) - \overline{LN(Q_{j,t})}\right\} - \frac{1}{2}\sum_{i=1}^{n}(S_{f,i,j,t} + \overline{S_{i,j,t}})\left\{LN(X_{f,i,j,t}) - \overline{LN(X_{i,j,t})}\right\}$$

$$- \sum_{s=t+1}^{t_0}\left\{\overline{LN(Q_{j,s})} - \overline{LN(Q_{j,s-1})}\right\} + \sum_{s=t+1}^{t_0}\sum_{i=1}^{n}\frac{1}{2}(\overline{S_{i,j,s}} + \overline{S_{i,j,s-1}})\left\{\overline{LN(X_{i,j,s})} - \overline{LN(X_{i,j,s-1})}\right\}$$

for $t < t_0$

Here, $Q_{f,j,t}$ stands for the real output (real sales) of firm f in year t, $X_{f,i,j,t}$ represents the real input of production factor i of firm f in year t, and $S_{f,i,j,t}$ is the cost share of production factor i at firm f in year t. $\overline{LN(Q_{j,t})}$ denotes the arithmetic average of the log value of the output, in year t, of all firms in industry j to which firm f belongs, while $\overline{LN(X_{i,j,t})}$ stands for the arithmetic average of the log value of the input of production factor i, in year t, of all firms in industry j to which firm f belongs. Finally, $\overline{S_{i,j,t}}$ is the arithmetic average of the cost share of the input of production factor i, in year t, of all firms in industry j to which firm f belongs.

4.3. Matching data

As a result of the matching between firms and banks, we have a large size firm-bank match-level unbalanced panel data. By using the information about the short-term and long-term loan outstanding for each match, we also compute the loan share of each lender banks out of the total loan for each listed company. We use this variable to measure the strength or depth of loan relations. The share information is important to connect our study to the classic study on the value of mainbank.

5. Empirical Analysis

In this section, we empirically examine the quantitative impact of lender bank's efficiency at $t-1$ onto client firm's ex-post efficiency at $t+\tau$. Note that in order to see the correlation between lender bank's efficiency to client firm's TFP, we need to somehow summarize the potentially multiple lender banks' efficiency. For this purpose, we focus on the efficiency of top lenders. This reflects our consideration that the largest lender's characteristics exhibit the most important impact on its client firm's performance.[19] We also use a match between firm and its top lender as a group for our panel estimation. This means the group is changed when firms switch their top lender. This treatment allows us to partly control the endogeneity of matching between firms and their top lenders (see, for example, Fukao et al. 2005).[20]

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[19] As a robustness check for our empirical results, we also use the summary of all the lender banks' efficiency. This is computed as the weighted average of a given firm's lender banks' productivities with using each bank's total loan share (i.e., short-term and long-term) as the weight. The results are provided upon request.

[20] We use the firm's TFP at 3 or 5 periods after t in our panel estimation. This identification of our group variable implies that we focus on the long-standing loan relations between a firm and its top lender, which also justifies our empirical strategy featuring the performance of top lenders.

In the following subsection, we go over one theoretical illustration motivating our empirical study and construct our hypotheses. Note that no attempt is made to create any original theoretical model in this paper. We simply intend to set up a conceptual framework we refer to in our empirical study.

5.1. Theoretical underpinnings and hypothesis formulation

As pointed out in Chari et al. (2005), some sort of financial friction could be one candidate generating the correlation between external shocks to firms and the firms' productivity. As one illustration, Pratap and Urrutia (2010) constructs a theoretical model explicitly containing cash-in-advance constraint and demonstrate how firm's investment choice is distorted and its TFP deteriorates due to the internal allocative inefficiency.[21] By further considering the long-strand of literature about bank's role as motoring and/or screening, which essentially aim at mitigating the financial friction originated from information problem, we construct the following hypothesis.

***Hypothesis-1*: The ex-post increment in firm's TFP and the ex-post level of firm's TFP are positively correlated with the lagged efficiency of lender banks.**

For the test of this hypothesis, we consider the model (5).[22] Note that in order to quantify the marginal effect of bank efficiency to their client firms' productivity, we need to model the firm's hypothetical performance in the absence of the bank.[23] For this

[21] Miyakawa et al. (2011) empirically discusses the correlation between lender banks' productivity and their client firms' capital investment sensitivity with respect to the investment opportunity.

[22] All the estimation includes the time dummy. We also implement the estimation with the firm industry dummy. Those industry dummy has extremely high correlation with firm's fixed-effect since almost all the firms do not change their industrial categories. From this reason, we report the results based on the estimation with time dummy variables.

[23] In addition to this issue, we need to take into account for the possibility of reverse causality, or at least the amplifying

purpose, we simply add the factor accounting for bank efficiency to the otherwise basic formulation employed in the extant empirical literature. Except for a few recent studies (e.g., Fukao et al. 2005; Fukuda et al. 2009, Goto 2010; Amiti and Weinstein 2010), we know little about the quantitative impact of continuously measured bank efficiency/performance/soundness onto their client firms.

$$\begin{cases} Y_{i,t+\tau} = \beta_0 + \beta_1 \times \mathrm{BANKEFFIC}_{i,t-1} + \gamma \times X_{i,t-1} + \alpha_i + \epsilon_{i,t+\tau} \cdots (5) \\ \text{where} \\ Y_{i,t+\tau} = \Delta \mathrm{LN}(\mathrm{TFP}_{i,t+\tau}) \equiv \mathrm{LN}(\mathrm{TFP}_{i,t+\tau}) - \mathrm{LN}(\mathrm{TFP}_{i,t}) \quad \text{or} \quad \mathrm{LN}(\mathrm{TFP}_{i,t+\tau}) \\ X_{i,t-1}: \text{Firm's R\&D Intensity, Firm's Leverage, size, ROA, Bank Dependency, Bank'size, etc.} \end{cases}$$

The model we employ above is an extension of the model for TFP determination employed in a number of extant studies (e.g., Griliches 1998; Kwon 2007). We choose this to provide additional empirical findings directly comparable with the extant studies. In this equation, i, t, and τ denote the indexes for the pair of firm and its top lender, the current period, and how many periods we wait for setting the ex-post productivity measure (i.e., TFP), respectively. One crucial variable $\mathrm{BANKEFFIC}_{i,t-1}$ stores the efficiency of the top lender for firm i at the period $t-1$. $X_{i,t-1}$ stores the vector of the lagged control variables containing, for example, firm's R&D intensity (i.e., R&D expenditure divided by the total sales), leverage, ROA, and so on.[24] Finally, α_i and $\epsilon_{i,t+\tau}$ stand for the individual fixed-effect and the error term in our panel estimation.[25] Note that the individual effect α_i is measured for the pair of each firm and top lender

mechanism between the performances of banks and firms.

[24] The definitions of each variable are in Table-1.

[25] According to the standard model specification procedure, we choose the fixed-effect model.

since the group of our panel data is a match of a firm and its top lender. This means that the group for the panel estimation is changed when a firm switches its top lender.

The long strand of mainbank literature has been categorizing lender banks into two types (i.e., main or sub-main) in a discrete fashion by focusing on the tightness of relations. Then, they study the impact of the discrete characteristic onto firm performance, financial availability, and so on. It is our interest to follow this strand of classic literature on loan relationships as well as featuring the continuously measured bank efficiency. The second hypothesis we test aims at incorporating both the impact of bank efficiency and the depth of loan relations.

<u>Hypothesis-2</u>: The ex-post increment in firm's TFP and the ex-post level of firm's TFP are positively correlated with the lagged efficiency of lender banks when the loan share is high enough.

This hypothesis also corresponds to our conjecture that banks need high enough loan share to exhibit its efficiency. The necessity of the high loan share reflects, for example, the fixed cost associated with the monitoring/screening activities. In order to test this hypothesis, we consider the following model in (6).[26]

$$\begin{cases} Y_{i,t+\tau} = \beta_0 + \left(\beta_1 + \beta_2 \times \mathrm{LOANSHARE}_{i,t-1}\right) \times \mathrm{BANKEFFIC}_{i,t-1} + \gamma \times X_{i,t-1} + \alpha_i + \epsilon_{i,t+\tau} \quad \cdots (6) \\ \text{where} \\ Y_{i,t+\tau} = \Delta \mathrm{LN}\left(\mathrm{TFP}_{i,t+\tau}\right) \equiv \mathrm{LN}\left(\mathrm{TFP}_{i,t+\tau}\right) - \mathrm{LN}\left(\mathrm{TFP}_{i,t}\right) \quad \text{or} \quad \mathrm{LN}\left(\mathrm{TFP}_{i,t+\tau}\right) \\ X_{i,t-1}\text{: Firm's R\&D Intensity, Firm's Leverage, size, ROA, Bank Dependency, Bank'size, etc.} \end{cases}$$

[26] From the same reason as for (5), all the estimation includes the time dummy.

We check if $(\beta_1 + \beta_2 \times \text{LOANSHARE}_{i,t-1})$ jointly exhibits positive sign or not. We expect such a positive sign under the presumption that the efficient banks keeping high enough loan shares to firms could contribute to the improvement of firm's productivity.

5.2. Estimation results

The main estimation results are summarized in Table-3 and -4. In both tables, the first column shows the results of (5) and (6) for all samples and $Y_{i,t+\tau} = \Delta\text{LN}(\text{TFP}_{i,t+\tau})$. The second and third columns store the results for high leverage samples (i.e., higher than sample median) for $Y_{i,t+\tau} = \Delta\text{LN}(\text{TFP}_{i,t+\tau})$ and $Y_{i,t+\tau} = \text{LN}(\text{TFP}_{i,t+\tau})$. Considering the fact that our data store limited number of R&D intensity, the fourth column shows the results based on high leverage samples for $Y_{i,t+\tau} = \Delta\text{LN}(\text{TFP}_{i,t+\tau})$ with omitting the firm's R&D intensity from the covariates. Table-3 and -4 correspond to the estimations based on $\tau =$ 3 and 5, respectively.

First, we confirm that Hypothesis-1 is basically rejected for all the cases in Table-3. Although the second and third columns of Table-4, which are based on high leverage samples, provide the consistent results with the conjecture in Hypothesis-1 (i.e., positive coefficient), it is safe to conclude that Hypothesis-1 is not robustly supported when we alter τ. Second, on the other hand, Hypothesis-2 is largely supported for the samples with high leverage (i.e., second, third, and fourth columns in Table-3 and -4). A number of results provide $\beta_2 > 0$ and $\beta_1 < 0$, which implies that the bank efficiency leads to high firm TFP when the loan share is high enough. Some of the results also give $\beta_2 > 0$ with insignificant β_1, which means that the efficiency of banks works as a complement to the deep loan relations for improving client firm's productivity. The result supporting Hypothesis-2 are kept for the larger samples which omit firm's R&D intensity from the covariates. Such an empirical property is also found both for the cases of $Y_{i,t+\tau} = \Delta LN(TFP_{i,t+\tau})$ and $Y_{i,t+\tau} = LN(TFP_{i,t+\tau})$.

These results imply several important links between bank efficiency and firm performance. First, the contribution of banks to the improvement in firm TFP is somewhat conditional on the characteristics of firms. For the firms with low leverage, which generally means the larger room for borrowing, the efficiency of their lender banks do not matter. This is natural if we consider the potential channel determining firm TFP illustrated in Pratap and Urrutia (2010), which features the wedge originated from financial friction Those firms could easily fulfill their financial needs and do not necessarily encounter the allocative inefficiency. Second, the contribution of banks are also related to the characteristics of matches. Notably, the high efficiency of lender banks are not sufficient to improve the firm TFP. The deep relation represented by high loan share is sufficient to exhibit the value of their high efficiency. This is consistent with the views on the mainbank notion and/or the fixed cost story associated with screening/monitoring activities.

Table-5 shows the results of the same estimation with employing the bank efficiency measure based on the FISIM output without adjusting risk. Contrary to the results in Table-3 and -4, almost all the coefficients associated with bank efficiency or its interaction with the loan share do not exhibit significant signs. This implies that the credit risk adjustment we introduce plays a key role to establish the correlation hypothesized in this paper, which provides one justification to the criticism against the naïve FISIM concept without risk adjustment. This issue is discussed in a few recent studies, for example, Inklaar et al. (2008). As far as we know, this paper is the first one to study the quantitative meaning of the risk-adjustment through the correlation between the bank efficiency and client firm TFP.

5.3. Several omitted issues

The estimation results presented in the previous section potentially missed several important dimensions. First, we must have needed to focus not only on the whole risk-adjusted FISM but also the risk-adjusted FISIM associated with lending services. There are two technical issues toward this direction. On one hand, it is necessary to set the risk-free rate for each year to compute the FISIM output associated with deposit service. Since we do not have the exact information about the maturity of deposits, we need to rely on some proxy for this variable. Moreover, it is not easy to split the total operational cost into the ones associated with lending and deposit services. In order to focus on the risk-adjusted FISIM associated with lending services and go over the same empirical exercise in this paper, we need to overcome those technical difficulties. Second, the choice of our measure for bank efficiency is another point to be discussed. The current measure is a simple ratio of risk-adjusted bank profit to the operation cost. We could expect that the profits are affected, for example, by time-varying mark-up rates. Although we could potentially check if our results are robust to the variation in market-level mark-up by splitting the sample into the early and late periods, it could be insufficient. What we really need to measure is the one corresponding to TFP in the standard productivity literature. In this regard, we should consult on the recent studies about the TFP measurement in medical industry (e.g., Castelli et al. 2010). We leave the empirical investigation on this issue to our future research question.

As another important point, the fixed-effect model selected in this paper has a beneficial feature to partly control the endogeneity in the matching process between firms and top lenders. This reflects the presumption that the estimated fixed-effect parameters account for the unobservable match-specific heterogeneity, which is potentially correlated with the determinants of matching.[27] This issue also leads to the discussion about causality between bank efficiency and client firm's performance. The appropriate usage of instrument variables would be another possibility to tackle this problem. We leave these issues to our future research.

6. Concluding Remarks

This paper features one measure for bank efficiency and studies its impact on the ex-post TFP growth and level of their client firms. By using the panel-data for the bank efficiency with the wide varieties of bank and firm characteristics as well as the loan relationship information, we empirically establish that the bank efficiency measure has statistically significant interactions with the firm performance measure when the firms are highly levered and the top lender's loan share is high enough. The empirical results also imply the complementarity between bank efficiency and the depth of loan relationships for improving firms' TFP. These imply that it is necessary to expand the discussion for the determinants of firm performance to the characteristics of the parties having relationships with the firm. In this perspective, we believe this paper also

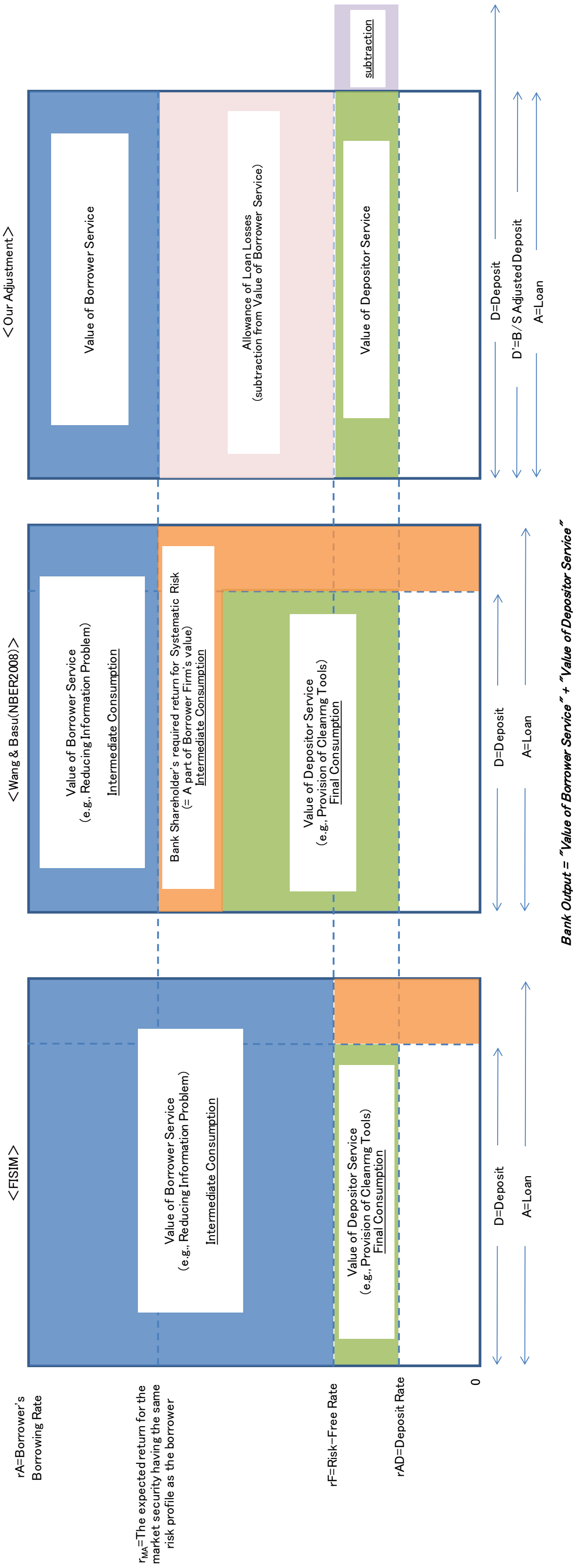
[27] The method proposed in Fox (2010) is another way to control this aspect.

contributes to the recently accumulated researches on the economics of relation.

To conclude, we list several future research questions. First, in order to establish the validity of our bank efficiency measure, we could implement the cross-county comparison of bank efficiency measure as well as the other efficiency measures of banks (e.g., based on DEA method). Second, the technical issues mentioned in the previous section need to be taken seriously (e.g., focusing on the lending FISIM output etc.). We believe all of these extensions provide further guides for better understanding of the bank efficiency as well as economic implication of firm-bank relations.

<Table and Figure>

Figure-1: FISIM Concept and Risk-Adjusted Bank Output



Note-1: The above figure conceptualizes the method we use in this paper. In this paper, we are not using the adjusted value of borrower service and value of depositor service separately. The sum of the two values is used as our output measure.

Note-2: The figure shows the case where D>A. We need to add some number to the deposit interest payments instead of subtracting.

Figure-2: Measured Bank Efficiency (Bank-Level)

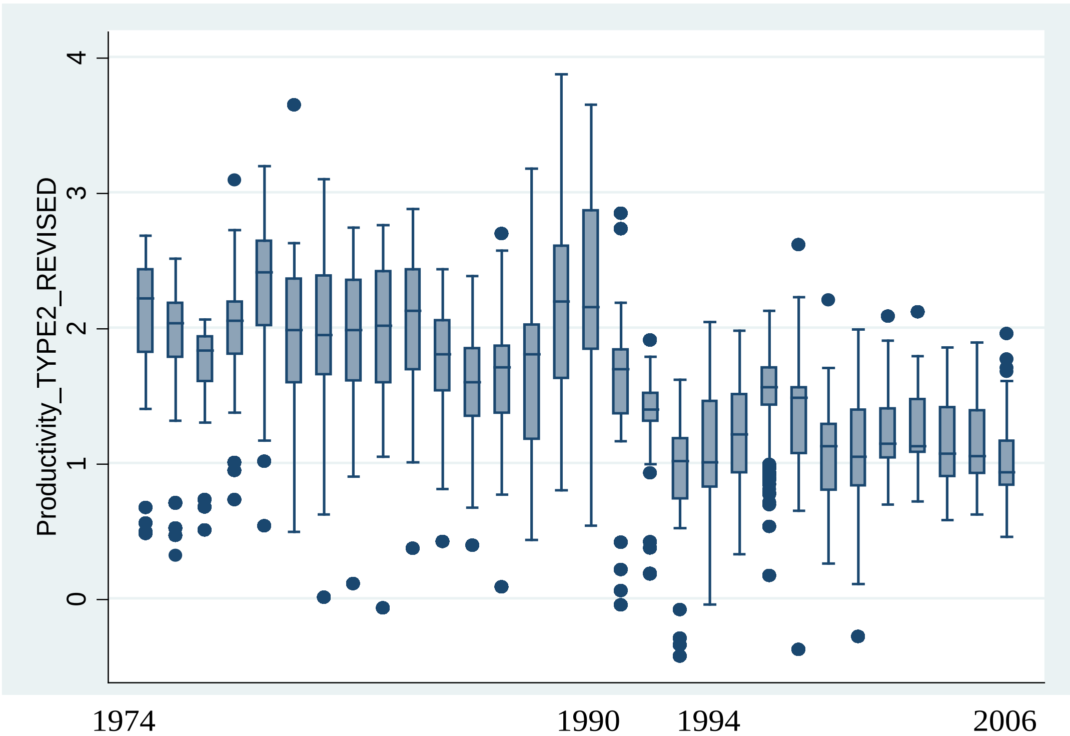


Table-1: Summary Statistics

Variable Name	Def	Obs	Mean	Std. Dev.	Min	Max
LN_TFP	Natural log of firm TFP measured by the deviation from the industry average	9642	-2.1401	0.7483	-4.2987	0.3254
LN_TFP (t+3) - LN_TFP (t)	Growth in firm TFP measured by the deviation from the industry average, in 3 periods from t	15156	0.0249	0.0832	-1.0579	1.1569
LN_TFP (t+5) - LN_TFP (t)	Growth in firm TFP measured by the deviation from the industry average, in 5 periods from t	12600	0.0357	0.0961	-0.8195	1.0410
c_LEVERAGE	Ratio of total liability to total asset	24804	0.6522	0.1883	0.0482	8.3381
c_LNSIZE	Natural log of total asset	24804	10.7030	1.3690	6.1759	16.2883
c_ROA	Ratio of EBITDA to total asset	24669	0.0865	0.0680	-1.0464	3.2691
c_BANK_DEPENDENCY	Ratio of bank borrowing (including short and total borrowing) to total liability	21698	0.3531	0.1818	0.0007	0.9693
c_LIQUIDITY_RATIO	Ratio of liquidity asset to liquidity liability	24804	1.4250	0.7596	0.0441	20.3485
c_INTANGIBLE_ASSET_RATIO	Ratio of intangible asset to total asset	24804	0.0063	0.0171	0.0000	0.4734
c_SHORTLOAN_RATIO	Ratio of short-term bank borrowing to total bank borrowing	21698	0.6619	0.2375	0.0010	1.0000
c_PBR	Price-to-Book Ratio	24691	7601	88366	13	5330745
c_R&D_INTENSITY	Ratio of R&D expenditure to total sales	4446	0.0244	0.0703	0.0000	2.4459
b_EFFIC	Credit risk-adjusted FISIM output of bank divided by its operational cost	24804	1.4993	0.7416	-1.9961	4.3007
b_EFFIC Pre-Risk Adjusted	"Pre" credit risk-adjusted FISIM output of bank divided by its operational cost	24804	1.5391	0.7460	-1.6286	3.8303
TOTAL_LOANSHARE	Share of top lender's total loan out of total loan outstanding	24804	0.3421	0.1733	0.0759	1.0000
b_EFFIC × TOTAL_LOANSHARE		24804	0.4999	0.3539	-1.9961	3.6454

Note: c_ and b_ denote the firm and bank variables, respectively.

Table-2: Correlation Table

(obs=487)

	LN_TFP	LN_TFP (t+3) - LN_TFP (t)	LN_TFP (t+5) - LN_TFP (t)	c_LEVERAGE	c_LNSIZE	c_ROA	c_BANK_DEPENDENCY	c_LIQUIDITY_RATIO	c_INTANGIBLE_ASSET_RATIO	c_SHORTLOAN_RATIO	c_PBR	c_R&D_INTENSITY	b_EFFIC	b_EFFIC Pre-Risk Adjusted	TOTAL_LOANSHARE	b_EFFIC × TOTAL_LOANSHARE
LN_TFP	1.00															
LN_TFP (t+3) - LN_TFP (t)	-0.02	1.00														
LN_TFP (t+5) - LN_TFP (t)	-0.04	0.66	1.00													
c_LEVERAGE	-0.20	0.09	0.06	1.00												
c_LNSIZE	-0.04	-0.08	-0.13	0.20	1.00											
c_ROA	0.26	-0.12	-0.13	-0.38	-0.02	1.00										
c_BANK_DEPENDENCY	-0.06	0.04	0.01	0.47	-0.05	-0.19	1.00									
c_LIQUIDITY_RATIO	0.15	-0.05	-0.01	-0.66	-0.10	0.18	-0.43	1.00								
c_INTANGIBLE_ASSET_RATIO	-0.13	0.00	0.01	0.01	0.19	0.03	-0.06	0.01	1.00							
c_SHORTLOAN_RATIO	0.02	-0.11	-0.09	0.00	0.06	-0.10	-0.12	-0.15	0.03	1.00						
c_PBR	0.15	-0.20	-0.10	-0.25	0.04	0.45	-0.13	0.20	0.16	0.01	1.00					
c_R&D_INTENSITY	0.19	0.02	0.02	-0.32	0.07	0.17	-0.21	0.50	0.13	-0.03	0.22	1.00				
b_EFFIC	0.04	-0.01	0.01	0.01	0.04	0.13	-0.03	0.02	0.01	0.10	0.00	0.08	1.00			
b_EFFIC Pre-Risk Adjusted	0.07	0.05	0.06	-0.06	-0.05	-0.03	-0.06	0.11	0.03	-0.03	0.10	0.02	0.13	1.00		
TOTAL_LOANSHARE	0.12	0.06	0.09	-0.16	-0.37	0.10	-0.06	0.16	-0.06	-0.05	0.11	0.03	0.04	0.14	1.00	
b_EFFIC × TOTAL_LOANSHARE	0.13	0.05	0.09	-0.11	-0.29	0.13	-0.07	0.14	-0.05	0.01	0.08	0.06	0.58	0.19	0.81	1.00

Table-3: Estimation Results (τ =3)

b_PROD = TOP LENDER's b_PROD	(i) DIF (τ=3) All c_LEVERAGE				(ii) DIF (τ=3) c_LEVERAGE > Median				(iii) LEVEL (τ=3) c_LEVERAGE > Median				(iv) DIF (τ=3, no R&D Intensity) c_LEVERAGE > Median			
Dependend Variable "DIF": LN_TFP (t+τ) - LN_TFP (t) "LEVEL": LN_TFP (t+τ)	Coef.	Robust Std.	Coef.	Robust Std.	Coef.	Robust Std.	Coef.	Robust Std.	Coef.	Robust Std.	Coef.	Robust Std.	Coef.	Robust Std.	Coef.	Robust Std.
c_LEVERAGE (t-1)	0.130	0.084	0.131	0.084	0.228	0.135 *	0.228	0.136 *	1.585	0.717 **	1.661	0.708 **	-0.053	0.037	-0.053	0.037
c_LNSIZE (t-1)	0.052	0.042	0.053	0.042	0.082	0.039 **	0.074	0.042 *	-0.149	0.181	-0.203	0.196	0.002	0.008	0.003	0.008
c_ROA (t-1)	0.046	0.062	0.047	0.062	0.097	0.097	0.096	0.098	0.037	0.521	0.028	0.511	-0.143	0.045 ***	-0.141	0.045 ***
c_BANK_DEPENDENCY (t-1)	-0.060	0.043	-0.061	0.043	-0.062	0.076	-0.058	0.077	0.208	0.299	0.249	0.299	0.044	0.021 **	0.045	0.021 **
c_LIQUIDITY_RATIO (t-1)	0.009	0.013	0.009	0.013	0.094	0.042 **	0.106	0.044 **	0.398	0.259	0.476	0.275 *	0.010	0.009	0.010	0.009
c_INTANGIBLE_ASSET_RATIO (t-1)	-0.010	0.598	-0.017	0.598	1.086	0.568 *	1.291	0.530 **	8.282	2.780 ***	9.259	2.783 ***	-0.315	0.363	-0.314	0.361
c_SHORTLOAN_RATIO (t-1)	-0.006	0.027	-0.007	0.027	0.073	0.046	0.087	0.049 *	0.154	0.308	0.242	0.316	0.017	0.012	0.017	0.012
c_PBR (t-1)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000 ***	0.000	0.000 ***
c_R&D_INTENSITY (t-1)	-1.149	0.497 **	-1.123	0.500 **	-0.148	0.433	-0.221	0.482	0.055	4.892	-0.235	4.754				
b_EFFIC (t-1)	0.005	0.009	0.012	0.017	0.001	0.012	-0.037	0.025	-0.018	0.058	-0.184	0.102 *	-0.003	0.002	-0.007	0.004 **
b_EFFIC (t-1) × TOTAL_LOANSHARE (t-1)			-0.020	0.040			0.123	0.069 *			0.566	0.259 **			0.015	0.009 *
_cons	-0.656	0.496	-0.660	0.495	-1.181	0.500 **	-1.121	0.516 **	-1.774	2.278	-1.417	2.358	0.028	0.086	0.017	0.085
# Obs	1223		1223		548		548		380		380		7100		7100	
# Groups	674		674		309		309		217		217		1204		1204	
Obs per group min	1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0	
Obs per group avg	1.8		1.8		1.8		1.8		1.8		1.8		5.9		5.9	
Obs per group max	5.0		5.0		5.0		5.0		5.0		5.0		18.0		18.0	
Prob > F	0.0000		0.0000		0.0029		0.0003		0.0000		0.0000		0.0000		0.0000	
R-sq (within)	0.1358		0.1364		0.2299		0.2490		0.3539		0.3689		0.1325		0.1331	

Note: All the estimation employ the fixed-effect model, which is selected through the standard model specification test (F-test to compare Fixed-effect and Pooling OLS, Hausman-test for comparing Fixed-effect and Random-effect models. ***:1%, **:5%, *:10%. Dependent variable is either (a) the growth in firm TFP, which is measure as the deviation from the industry average, in τ periods from t ("DIF"), or (b) the natural log of firm TFP at t+ τ ("LEVEL"). c_LEVERAGE is the ratio of total liability to total asset (c_ denotes firm variables), c_LNSIZE is the natural log of total asset, c_ROA is the ratio of EBITDA to total asset, c_BANK_DEPENDENCY is the ratio of bank borrowing (including short and total borrowing) to total liability, c_LIQUIDITY_RATIO is the ratio of liquidity asset to liquidity liability, c_INTANGIBLE_ASSET_RATIO is the ratio of intangible asset to total asset, c_SHORTLOAN_RATIO is the ratio of short-term bank borrowing to total bank borrowing, c_PBR is the Price-to-Book Ratio, and c_R&D_INTENSITY is the ratio of R&D expenditure to total sales. b_EFFIC is the credit risk-adjusted FISIM output of bank divided by its operational cost. TOTAL_LOANSHARE is the share of top lender's total loan out of total loan outstanding. The group for panel estimation is the match between a firm and its top lender. All the standard error is adjusted for clusters.

Table-4: Estimation Results (τ =5)

b_PROD = TOP LENDER's b_PROD	(v) DIF (τ=5) All c_LEVERAGE				(vi) DIF (τ=5) c_LEVERAGE > Median				(vii) LEVEL (τ=5) c_LEVERAGE > Median				(iix) DIF (τ=5, no R&D Intensity) c_LEVERAGE > Median			
Dependend Variable "DIF": LN_TFP (t+τ) - LN_TFP (t) "LEVEL": LN_TFP (t+τ)	Coef.	Robust Std.	Coef.	Robust Std.	Coef.	Robust Std.	Coef.	Robuar Std.	Coef.	Robust Std.	Coef.	Robust Std.	Coef.	Robust Std.	Coef.	Robust Std.
c_LEVERAGE (t-1)	0.019	0.132	0.017	0.134	-0.499	0.217 **	-0.554	0.192 ***	-1.744	0.772 **	-1.896	0.699 ***	-0.096	0.046 **	-0.095	0.046 **
c_LNSIZE (t-1)	0.009	0.080	0.009	0.081	0.015	0.139	0.017	0.136	0.101	0.422	0.055	0.371	0.014	0.011	0.015	0.011
c_ROA (t-1)	0.113	0.101	0.112	0.105	0.106	0.161	0.090	0.188	-0.501	0.480	-0.565	0.447	-0.197	0.054 ***	-0.197	0.054 ***
c_BANK_DEPENDENCY (t-1)	0.021	0.097	0.022	0.099	0.077	0.119	0.081	0.118	1.155	0.447 **	1.206	0.414 ***	0.029	0.025	0.031	0.025
c_LIQUIDITY_RATIO (t-1)	0.019	0.018	0.019	0.018	-0.132	0.072 *	-0.105	0.069	-0.778	0.393 *	-0.558	0.322 *	0.002	0.012	0.002	0.012
c_INTANGIBLE_ASSET_RATIO (t-1)	0.065	0.592	0.072	0.601	0.194	1.089	-0.216	1.249	0.983	3.129	-2.786	2.523	-0.620	0.571	-0.619	0.568
c_SHORTLOAN_RATIO (t-1)	0.113	0.048 **	0.113	0.048 **	-0.022	0.076	-0.020	0.076	-0.039	0.397	-0.038	0.351	-0.006	0.016	-0.005	0.016
c_PBR (t-1)	0.000	0.000 **	0.000	0.000 **	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
c_R&D_INTENSITY (t-1)	-0.435	0.800	-0.446	0.847	-0.152	0.714	-0.326	0.689	2.629	1.788	1.452	1.539				
b_EFFIC (t-1)	0.012	0.017	0.010	0.027	0.045	0.026 *	-0.011	0.029	0.371	0.114 ***	0.066	0.150	0.001	0.003	-0.005	0.005
b_EFFIC (t-1) × TOTAL_LOANSHARE (t-1)			0.007	0.062			0.194	0.110 *			1.043	0.452 **			0.020	0.011 *
_cons	-0.201	0.903	-0.206	0.911	0.365	1.575	0.345	1.561	-1.799	4.933	-1.450	4.430	-0.004	0.120	-0.017	0.119
# Obs	416		416		191		191		146		146		6111		6111	
# Groups	263		263		118		118		89		89		1047		1047	
Obs per group min	1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0	
Obs per group avg	1.6		1.6		1.6		1.6		1.6		1.6		5.8		5.8	
Obs per group max	3.0		3.0		3.0		3.0		3.0		3.0		16.0		16.0	
Prob > F	0.0124		0.0155		0.0061		0.0029		0.0000		0.0000		0.0000		0.0000	
R-sq (within)	0.0944		0.0945		0.2257		0.2690		0.3972		0.4559		0.1139		0.1148	

Note: All the estimation employ the fixed-effect model, which is selected through the standard model specification test (F-test to compare Fixed-effect and Pooling OLS, Hausman-test for comparing Fixed-effect and Random-effect models. ***:1%, **:5%, *:10%. Dependent variable is either (a) the growth in firm TFP, which is measure as the deviation from the industry average, in τ periods from t ("DIF"), or (b) the natural log of firm TFP at t+ τ ("LEVEL"). c_LEVERAGE is the ratio of total liability to total asset (c_ denotes firm variables), c_LNSIZE is the natural log of total asset, c_ROA is the ratio of EBITDA to total asset, c_BANK_DEPENDENCY is the ratio of bank borrowing (including short and total borrowing) to total liability, c_LIQUIDITY_RATIO is the ratio of liquidity asset to liquidity liability, c_INTANGIBLE_ASSET_RATIO is the ratio of intangible asset to total asset, c_SHORTLOAN_RATIO is the ratio of short-term bank borrowing to total bank borrowing, c_PBR is the Price-to-Book Ratio, and c_R&D_INTENSITY is the ratio of R&D expenditure to total sales. b_EFFIC is the credit risk-adjusted FISIM output of bank divided by its operational cost. TOTAL_LOANSHARE is the share of top lender's total loan out of total loan outstanding. The group for panel estimation is the match between a firm and its top lender. All the standard error is adjusted for clusters.

Table-5: Estimation Results (Pre Risk Adjusted b_PROD)

b_PROD = TOP LENDER's b_PROD	(ix) DIF (τ=3) c_LEVERAGE > Median				(x) LEVEL (τ=3) c_LEVERAGE > Median				(xi) DIF (τ=5) c_LEVERAGE > Median				(xii) LEVEL (τ=5) c_LEVERAGE > Median			
Dependend Variable "DIF": LN_TFP (t+τ) - LN_TFP (t) "LEVEL": LN_TFP (t+τ)	Coef.	Robust Std.	Coef.	Robust Std.	Coef.	Robust Std.	Coef.	Robust Std.	Coef.	Robust Std.	Coef.	Robust Std.	Coef.	Robust Std.	Coef.	Robust Std.
c_LEVERAGE (t-1)	0.222	0.132 *	0.224	0.133 *	1.582	0.800 **	1.671	0.815 **	-0.428	0.249 *	-0.423	0.248 *	-1.610	0.979	-1.801	0.898 **
c_LNSIZE (t-1)	0.083	0.038 **	0.082	0.039 **	-0.154	0.177	-0.183	0.185	0.015	0.143	0.013	0.141	0.183	0.466	0.246	0.476
c_ROA (t-1)	0.091	0.099	0.093	0.099	0.045	0.524	0.048	0.528	0.157	0.143	0.156	0.145	-0.450	0.684	-0.410	0.523
c_BANK_DEPENDENCY (t-1)	-0.063	0.076	-0.067	0.074	0.224	0.296	0.204	0.303	0.075	0.117	0.073	0.119	1.168	0.445 ***	1.295	0.432 ***
c_LIQUIDITY_RATIO (t-1)	0.092	0.042 **	0.095	0.043 **	0.388	0.265	0.428	0.271	-0.115	0.072	-0.118	0.075	-0.746	0.434 *	-0.567	0.414
c_INTANGIBLE_ASSET_RATIO (t-1)	1.103	0.590 *	1.188	0.576 **	8.363	2.779 ***	9.263	2.957 ***	-0.453	0.864	-0.422	0.871	-1.670	3.942	-3.764	3.130
c_SHORTLOAN_RATIO (t-1)	0.075	0.046	0.079	0.049	0.154	0.305	0.206	0.304	-0.026	0.082	-0.023	0.082	-0.256	0.426	-0.362	0.418
c_PBR (t-1)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
c_R&D_INTENSITY (t-1)	-0.185	0.452	-0.171	0.457	0.166	4.906	0.299	4.874	-0.454	0.510	-0.458	0.509	-0.963	1.788	-0.854	1.560
b_EFFIC (t-1) Pre-Risk Adjusted	-0.035	0.040	-0.050	0.048	0.015	0.284	-0.129	0.270	0.015	0.045	0.024	0.046	-0.163	0.241	-0.523	0.254 **
b_EFFIC (t-1) Pre-Risk Adjusted × TOTAL_LOANSHARE (t-1)			0.047	0.074			0.495	0.375			-0.029	0.112			1.210	0.546 **
_cons	-1.150	0.487 **	-1.142	0.493 **	-1.742	2.319	-1.600	2.355	0.335	1.574	0.354	1.564	-2.097	5.261	-2.905	5.357
# Obs	548		548		380		380		191		191		146		146	
# Groups	309		309		217		217		118		118		89		89	
Obs per group min	1.0		1.0		1.0		1.0		1.0		1.0		1.0		1.0	
Obs per group avg	1.8		1.8		1.8		1.8		1.6		1.6		1.6		1.6	
Obs per group max	5.0		5.0		5.0		5.0		3.0		3.0		3.0		3.0	
Prob > F	0.0065		0.0101		0.0000		0.0000		0.0154		0.0146		0.0008		0.0000	
R-sq (within)	0.2323		0.2335		0.3535		0.3597		0.1827		0.1833		0.2677		0.3197	

Note: All the estimation employ the fixed-effect model, which is selected through the standard model specification test (F-test to compare Fixed-effect and Pooling OLS, Hausman-test for comparing Fixed-effect and Random-effect models. ***:1%, **:5%, *:10%. Dependent variable is either (a) the growth in firm TFP, which is measure as the deviation from the industry average, in τ periods from t ("DIF"), or (b) the natural log of firm TFP at t+τ ("LEVEL"). c_LEVERAGE is the ratio of total liability to total asset (c_ denotes firm variables), c_LNSIZE is the natural log of total asset, c_ROA is the ratio of EBITDA to total asset, c_BANK_DEPENDENCY is the ratio of bank borrowing (including short and total borrowing) to total liability, c_LIQUIDITY_RATIO is the ratio of liquidity asset to liquidity liability, c_INTANGIBLE_ASSET_RATIO is the ratio of intangible asset to total asset, c_SHORTLOAN_RATIO is the ratio of short-term bank borrowing to total bank borrowing, c_PBR is the Price-to-Book Ratio, and c_R&D_INTENSITY is the ratio of R&D expenditure to total sales. b_EFFIC is the "pre" credit risk-adjusted FISIM output of bank divided by its operational cost. TOTAL_LOANSHARE is the share of top lender's total loan out of total loan outstanding. The group for panel estimation is the match between a firm and its top lender. All the standard error is adjusted for clusters.

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