1. Introduction

The purpose of this paper is to analyze the relation between market structure and performance in Japanese banking. Specifically, we investigate 1) whether higher concentration ratio implies less competition and therefore higher loan interest rates and profits and 2) whether higher concentration ratio tends to result in wasteful expenditures. Such an analysis is necessary for appraisal of the regulations on the new entry and branching which limit the competition among banks.

The former topic is most popular in the industrial organization literatures (see Heggestad (1979) and Gilbert (1984)). As for the Japanese bank market, however, there have been no studies to date, to the best of our knowledge. The present paper tries to fill the gap.

Most of the previous studies on this topic adopted explanatory variables without sufficient theoretical reasoning so that their empirical specifications were more or less ad hoc. In contrast, the present paper chooses explanatory variables as theoretically as possible. Giving a rigorous representation to the market structure-performance hypothesis, we test the hypothesis using the profit function and the reduced form of the market interest rates.

It is likely that Japanese banks are too extravagant for the following reasons. First, it is often pointed out that banks pay relatively higher wages to their employees and have much more lavish buildings than other industries. Second, Japanese banks are manager-controlled. Third, Japanese bank markets are not competitive, but highly regulated.1) Banks in a competitive markets must seek profits in order to survive, even if they are controlled by managers. Thus, it is interesting to see whether the higher concentration ratio and higher loan interest rates result in higher profits or wasteful expenditures.

* The earlier version of this paper was presented at the Western Local Meeting of the Japan Economic and Econometric Society in 1987, a seminar at the Bank of Japan, and MEW (Monetary Economics Workshop) in Osaka. We would like to thank Noriyuki Doi, Hideo Hayakawa, Yuzo Honda and a referee of this Journal for their helpful comments. We are also indebted to Tony Suraci and Robert Dekle for editing the manuscript.

1) New entry into banking has been prohibited by the Ministry of Finance (hereafter MoF). Deposit interest rates have been completely regulated by MoF and the Bank of Japan. The upper and lower bound of loan interest rates have been linked to the official discount rate so that they are not determined freely in the loan markets (see Tsutsui (1982) and Asako and Uchino (1987)). Non-price competition has also been fairly limited: e.g., the number of new branches has been effectively regulated by MoF until very recently (see Tsutsui (1986)). These regulations by the authorities help private banks to maintain their cooperation in their conduct (See Tsutsui and Royama (1987)).
Articles concerning wasteful expenditures may be classified into two groups: one is the so-called expense preference hypothesis (see Edwards (1977), Hannan (1979), Hannan and Mavinga (1980), Smirlock and Marshall (1983), and Rhoades (1980)), and the other is an analysis of economic inefficiency (Richard and Villanueva (1980) and Mullineaux (1978)). The present paper follows the second approach and tests the hypothesis that the higher concentration results in the less technical efficiency by means of estimation of the cost function. To the best of our knowledge, this is the first attempt to investigate the relation between technical inefficiency and the concentration index.

In view of this technical inefficiency, structure-performance hypothesis does not necessarily imply that the interest rate and profits are higher in the more concentrated market simultaneously. If the monopoly achieves the very high technical efficiency, it is possible that the interest rate in the monopolistic market is as low as that of the competitive market. On the contrary, if the monopoly is technically inefficient, it is probable that the profits of the monopoly is almost the same as that of the competitive bank. Therefore, the previous studies which investigate whether the interest rate and the profits correlate with the concentration ratio should be criticized. They should have investigated whether the performance of the more concentrated market is closer to that of the monopoly. This is done in this paper.

In the next section, we construct a model of the oligopolistic bank based on the structure-performance hypothesis. Reduced forms of the market interest rate, profit function and cost function of the bank and the market are developed for the testing. In Section 3, we explain the estimation methods and the data. In Section 4, we present our estimation results and discuss them. The final section is devoted to a view of possible future research.

2. Theoretical Framework

2.1 Model

The operation of an oligopoly is not fully clear when compared with that of competitive and monopolistic markets except for very simple cases. Although remarkable progress is being made in this field, we believe that the structure-performance hypothesis is still a practical and fruitful way to investigate the oligopolistic operation.

Let us consider how to formulate the traditional market structure-performance hypothesis. The hypothesis is that the performance of the oligopolistic market is in the middle of those of monopoly and perfect competition because the market structure of oligopoly stands in the middle of them. In view of this, we formalize the structure-performance hypothesis more explicitly than the usual way as follows:

2) These two approaches differ in their implications and methods. According to the first approach, even if wasteful conduct is recognized in some banks, they operate efficiently from the manager's view point by definition. The second approach may be formulated that the bank adopts an inferior technology (Leibenstein (1966), Forsund, et al. (1980)). While it is possible to derive the cost function dual to the inefficient production function in the second approach, cost function is generally meaningless in the first approach except for the simple case of linear utility function (see Appendix B). Therefore, while the estimation of cost function of the bank is a useful method for the second approach, input demand function has been utilized for testing the first approach.
Hypothesis 1

The market performance of loan interest rates and profits is between the two extremes of perfect competition and monopoly: the higher the degree of market concentration, the closer the performances to those of monopoly. In mathematical form,

\[ R_{obs} = R_c + E(R_m - R_c)HI \]

\[ P_{obs} = P_c + E(P_m - P_c)HI, \]

where \( E = 1 \) or at least \( E > 0 \).

Here subscripts \( obs, m, \) and \( c \) stand for the observed, monopolistic, and competitive respectively, \( R \) stands for loan interest rate, and \( P \) denotes profits. \( HI \) means Hirfindahl index of the market concentration, which is zero for the perfect competition, and 1 for the monopoly. The hypothesis is tested by examining whether or not \( E = 1 \).

If hypothesis 1 is valid, banks in the higher concentrated markets earn larger revenues. In the traditional literature, this implies higher profits. Recently, however, it has been often pointed out that the larger revenues will result in wasteful expenditure or inefficient production instead of an increase in profits. The present paper investigates whether the higher market concentration correlates with a technical inefficiency.

Hypothesis 2

The higher the market concentration is, the less the technical efficiency. In mathematical representation,

\[ Q = Af(K, L), \]

\[ A = A' \exp (-BHI), \]

with \( A' > 0 \) and \( B > 0 \).

Here, \( Q \) is output, which is assumed to be loans, \( K \) and \( L \) denote two inputs, capital and labor, so that \( Af \) is a production function.\(^3\)

We specify a simple model in order to examine these hypotheses more closely and use the following assumptions.

Assumption 1

Regional banks, mutual banks, and credit associations within each prefecture form a bank market segmented and isolated from other prefectures.

Assumption 2

Given the input prices, the bank maximizes its profits.

Assumption 3

The bank raises its funds from deposits at exogenous interest rates \( r_D \), then holding required reserves, the bank invests them into loans. Thus, the budget of the bank is described as

\[ Q + Z = D, \]

where \( Q, D, \) and \( Z \) stand for loans, deposits, and the required reserves respectively. The deposits is determined by the behavior of non-bank private sector and is given to the bank.

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\(^3\) What is the output of the bank has been disputed in the literature (see Benston (1972), Royama and Iwane (1973)). However, the agreement has not been reached. Several measures have been proposed and used in the empirical studies including the outstanding loans, deposits, or total assets, the number of loans or deposits, Devisia index of total assets, gross income of the bank, and interest revenue. Whether or not we should include the interest payment in the cost is also unclear. Although we adopt the outstanding loans as the bank output and operational expenses as the bank cost in the present paper, we do not claim that these measures are superior to the others. A possible justification of this choice is given in Kuroda and Kaneko (1986).
Assumption 4

Production function of the bank is of Cobb-Douglas form:

\[ Q = AK^bL^c. \]

All the banks have the same technology except for the difference in possible technical inefficiency stated in Hypothesis 2.

Assumption 5

Inverse demand function for loans is of the Cobb-Douglas form:

\[ R = j_0Q^{j_1}Y^{j_2}, \quad j_0 > 0, -1 < j_1 < 0, 4) j_2 > 0, \]

where \( R \) is loan interest rate. \( Y \) is a scale variable such as income of demanders for loans.

Assumption 6

The share of \( i \)-th bank in the market, \( s_i = Q_i/Q \), is an exogenous variable at each point of time.

Assumptions 3–5 are adopted for computational convenience. Assumption 6 together with the latter part of Assumption 4 are necessary to bridge the behavior of individual bank and the market equilibrium (see Edwards (1977)).

It is interesting to generalize Assumption 2 to the manager's utility maximizing behavior. However, consider that the conclusions of the present paper hold as far as the manager's utility function is linear (see Appendix B), and that the linear utility function has been assumed in the previous articles on the expense-preference behavior.

The industrial organization articles disputed the exogeneity of the wage rate stated in Assumption 2. Since banks and their trade unions bargain on the wage rate taking into account the bank profits, the wage rate should be an endogenous variable. However, the exogenous wage rate in our analysis is fairly reasonable because most trade unions of Japanese large banks have negotiated the same wage growth rate every year. Therefore, although the growth rate itself may depend on the average performance of banks, the difference of wage rate among banks does not. The difference may come from the districts where banks operate.

Assumption 1 may be most controversial. The assumption itself could be an interesting hypothesis to be tested. In this article, however, we just presume it based on the following observation. The Ministry of Finance (hereafter MoF) restricts regional and mutual banks to build their branches within prefectures where their head offices locate or adjacent to them. It also restricts most credit associations to operate within a prefecture. Of course, the bank market of each prefecture may interact with adjacent markets through the operation of branches locating outside of their home-prefecture and through that of city banks which have country-wide branch networks. We suppose, however, that such interaction is so weak that we may disregard it. We also ignore the effect of credit cooperatives and agricultural credit unions. This might be justified since those institutions are very small so that they play merely a role as fringe firms in the

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4) \( 1 + j_1 > 0 \) is the condition for the marginal revenue, which is \( R(1 + j_1) \), to be positive.
5) As for the estimation of the full translog cost function of the Japanese bank, refer to Noma and Tsutsui (1987a, b).
6) In 1985, Sumitomo bank negotiated with its trade union higher wage rate than the other city banks. The media reported it as a remarkable affair.
bank markets.

2.2 Long-run Functions for Testing

Given those assumptions in the previous section, we can derive testable equations for bank behavior, such as the loan interest rates, cost, and profit functions.

With some calculation, we get the reduced form of the market loan interest rates. The derivation procedure is shown in Appendix A.

\[
\ln R_{obs} = e_0 + e_1 \ln Y + e_2 \ln w + e_3 \ln r + e_4 HI + u_R,
\]

where \( e_1 = (1 - b - c)j_2/(1 - b_1) > 0 \), \( e_2 = -cj_1/(1 - b_1) > 0 \), \( e_3 = -bj_1/(1 - b_1) > 0 \), \( e_4 = [e^{-Bj_1/(1-b_1)(1+j_1)} - 1]E \), and \( b_1 = (b + c)(1 + j_1) \). We assume \( 0 < b_1 < 1 \), which is necessary to determine the signs of most coefficients of interest rate equation and profit function. \( u_R \) is a random disturbance term.

The term in the square brackets of \( e_4 \) is positive as far as interest rate in competitive market is lower than that of monopolist \((R_c < R_m)\). However, this does not necessarily hold because the monopoly might be far more technically efficient than the competitive banks. Put it differently, if Hypothesis 2 is rejected and \( B \) takes very big negative value, the term in the brackets may be negative. We cannot infer the sign of \( E \) from the sign of \( e_4 \) in this case. On the contrary, if Hypothesis 2 is supported, we are certain that \( e_4 > 0 \) implies the validity of Hypothesis 1. Actually, we can show that conditions of \( 0 < 1 + j_1 < 1, 1 - b_1 > 0 \), and \( B > 0 \) assure that the term in the brackets is positive.

The profit function is given by

\[
\ln P = d_0 + d_1 \ln Y + d_2 \ln w + d_3 \ln r + d_4 HI + u_P,
\]

where \( d_1 = j_2/(1 - b_1) > 0 \), \( d_2 = -c(1 + j_1)/(1 - b_1) < 0 \), \( d_3 = -b(1 + j_1)/(1 - b_1) < 0 \), and \( d_4 = [(1 - b_1)(1 + j_1)e^{-B(1+j_1)/(1-b_1)} - 1]E \). \( u_P \) is a random disturbance term. The derivation is shown in Appendix A. The sign of \( d_4 \) is the same as that of \( P_m - P \), which depends on the value of \( B \) in the short-run. If Hypothesis 2 is rejected, which means \( B \) is negative, the term in the brackets of \( d_4 \) is positive, and therefore \( d_4 > 0 \) implies \( E > 0 \). On the contrary, when Hypothesis 2 is accepted, the sign of the term in the brackets is ambiguous. In this case, we cannot answer whether the Hypothesis 1 is valid based on the sign of \( d_4 \). In the long-run, \( P \) vanishes by definition, so that we are certain that the term in the brackets is positive regardless of the value of \( B \).

The cost function dual to the Cobb-Douglas production function is well-known (see (A-6) in Appendix A):

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7) Usually, a profit function is described as the function of input and output prices provided that the products market is competitive. In the present paper, however, the output price is endogenous so that we substitute it with the exogenous variables.

8) Unfortunately, the assumption of Cobb-Douglas production function does not provide a good circumstances for analyzing the long-run situation because the AC curve is always below and does not intersect with the MC curve as far as \( b + c < 1 \). Thus, when the long-run equilibrium is reached, the MC is identical to the AC, which means \( b + c = 1 \).
In \( C = C_0 + a_1 \ln Q + a_2 \ln \omega + a_3 \ln r + a_4 HI + u_C \).

Here, \( a_1 = \frac{1}{b+c} > 0, a_2 = \frac{c}{b+c} > 0, a_3 = \frac{b}{b+c} > 0, \) and \( a_4 = \frac{B}{b+c} \). \( u_C \) is a random disturbance term. It is clear that \( a_4 > 0 \) implies that Hypothesis 2 is valid and vice versa.

### 2.3 The Short-run Behavior

Most studies on the cost structure of the Japanese bank found scale economies even if small (See Yoshioka and Nakajima (1987), Noma and Tsutsui (1987a, b), Kuroda and Kaneko (1986), Royama and Iwane (1973), and Nishikawa (1972)). This implies that the second order condition of the profit maximization is not satisfied, to say the least, for the perfect competition. This fact recommends us analyzing the “short-run” behavior of the bank.

Then, what is the fixed inputs? This is not an easy question, although standard textbooks tell us that the variable input is labor and the fixed input is capital. It is alleged that the employment is the most important investment for Japanese banks. If this is the case, it is not appropriate to regard the number of employees as a variable input.

However, it may be reasonable to consider that overtime work is adjustable to the fluctuation of the demand for outputs even if the number of employees is not. In this case, the total man-hour labor represents the variable input and other non-personnel expenses may be regarded as the fixed inputs.

Following this view, regression equations (6), (7), and (8) are modified to:

\[(6)' \ln R_{obs} = e_0' + e_1' \ln Y + e_2' \ln \omega + e_4' HI + e_5' \ln K + u_R' \]

where \( e_1' = (1 - c)j_2/(1 - b_2'), \ e_2' = -c j_1/(1 - b_1'), \ e_4' = b j_1/(1 - b_1'), \ e_5' = [((1 + j_1) c j_1/(1 - b_1') \exp(-B j_1/(1 - b_1')) - 1]E, \ b_1' = c (1 + j_1) \).

\[(7)' \ln (P + rK) = d_0' + d_1' \ln Y + d_2' \ln \omega + d_4' HI + d_5' \ln K + u_P', \]

\[(8)' \ln (C - rK) = a_0' + a_1' \ln Q + \ln \omega + a_4' HI + a_5' \ln K + u_C', \]

where \( a_1' = 1/c, \ a_5' = -b/c, \ a_4' = B/c. \) 

Derivation is similar to that in the long-run case. These short-run functions are tested as well as the long-run functions.\(^9\)

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\(^9\) We also estimated the short-run functions assuming that the floor space of a bank is a fixed factor. In most cases, the sign of \( HI \) confirmed our conclusions that Hypothesis 1 is accepted and Hypothesis 2 is rejected. However, the estimation does not seem satisfactory enough: the coefficient of the floor space does not satisfy the expected sign in the cost function, and the coefficient of the output is smaller than that of the long-run cost function. Moreover, the coefficient of the wage rate sometimes violates the expected sign. These suggest that something is wrong with the assumption of this short-run cost function.
2.3 Individual and Market Functions

Which one should we use for the estimations, per bank basis samples or per market basis samples? As for the cost function, it is demonstrated in Appendix A that under the Assumptions 6 and 4 the individual and the market cost functions have the same form except for the constant term. Thus, we estimate the cost function over both samples.

Our profit functions (7) and (7)' are derived with $P_c$ being the total profits of the competitive market. Therefore they are the market profit functions and we must use the prefecture samples. How can we derive the individual profit functions? To see this, let us rewrite the market loan demand function of (5) as

$$R = j_0(Q_i/s_i)^{1/2}Y^{1/2} = j_0Q_iY^{1/2},$$

where $Y_i = Y/s_i^{1/2}$. We may interpret (5)' as the loan demand function for the $i$-th bank, being $Y_i$ the scale factor of demanders. With this analogy, let us assume that the profit function for the $i$-th bank is written as

$$P_i = e^{dY_i^a}w^{d_2}r^{d_3}e^{d_4HI},$$

where $Y_i$ is given by (5)'. Then the total profit function is derived by summing up (9) over banks in a prefecture, that is

$$P = \sum P_i = e^{dY_i^a}w^{d_2}r^{d_3}e^{d_4HI} \sum s_i^{-j_1/(1-b_1)}.$$  

(10) becomes identical to (7) by defining $d$ so as to hold $e^{d_0} = e^d \sum s_i^{-j_1/(1-b_1)}$. Thus, (9) is consistent with the market profit function (7). Taking log of (9), we get the individual profit function:

$$ln P_i = d + d_1 \ln Y + d_2 \ln w + d_3 \ln r + d_4 HI + d_6 \ln s_i + u_i^P,$$

where $d_6 = -j_1/(1 - b_1) > 0$. Market share of each bank is added in the individual profit function.

Similarly, we can show that the following individual short-run profit function is consistent with (7)'

$$ln (P_i + rK_i) = d' + d_1' \ln Y + d_2' \ln w + d_4' HI + d_6' \ln K + d_6' \ln s_i + u_i^P.$$

Thus we will regress (9)' and (9)'' over individual bank samples.

Individual interest rate function does not exist in our framework because the interest rate is determined in the market. The same interest rate must hold for every bank. In reality, however, interest rates differ among banks. The deviations from the average interest rate should be explained by an additional reasoning which our model overlooked. For example, we assume that there is only one kind of loan, although in the real world loans are not homogeneous. Different interest rates are applied to loans depending on their quality, such as terms of loans, collateral, and the default risk of borrowers. Thus, we must add a variable representing the quality of loans, when we regress the interest rate functions over the individual bank samples. In Japan, larger banks tend to have better customers so that their interest rate can be lower. Thus, the average quality of loans of the bank might be well summarized in the bank size.

3. Estimating Procedure and Data

3.1 Additional Assumptions

In order to implement the estimation of our equations, we adopt the following additional
Assumption 7
The demand function for loans are identical over the prefectures, so that the variables of $j_0, j_1,$ and $j_2$ may be regarded as constant.

Assumption 8
Markets of capital equipments are so perfect that all the banks face the same price. Therefore, the term $\ln r$ may be included in the constant term of cross-sectional regression equations.

Assumption 7 is essential to our analysis. Since the every coefficient of interest rate and profit functions is a function of $j_0, j_1,$ and $j_2,$ we cannot estimate them without this assumption. Assumption 8 is often adopted for convenience because reliable data of rental price of capital is hard to obtain.

3.2 Estimation Procedure
We estimate the equations derived in the previous sections in two ways. First we estimate each equation separately by OLS so that we get the estimates of the coefficients of each equation such as $a_0, a_1, a_2, \ldots$. Since the profit and interest rate functions are in reduced form, the OLS estimates of them have the desirable properties.

On the other hand, OLS estimates of the cost function may be marred with the simultaneous equation biases because output $Q$ is endogenous in the present paper. To get rid of the biases, we ought to use an instrumental variable of the output. Assuming that the demand is satisfied at $Q_{obs}$, output of an oligopoly is easily calculated from (6)' and (5):

$$(11)' \ln Q_{obs} = (e_0' - \ln j_0)/j_1 + cj_2/(1 - b_1') \ln Y + e_2'/j_1 \ln w + e_4'/j_1 HI + e_5'/j_1 \ln K + uQ',$$

We must also be aware that the disturbance terms of (6)' and (11)' may be correlated. The maximum likelihood estimations of the simultaneous equation system of (6)' and (11)' give unbiased estimates provided that $C$ and $Q$ are endogenous variables.

Second, we estimate the original parameters such as $j_1, j_2, b, c, E,$ and $B$ by expressing the coefficients with them and estimating cost, profit, interest rate, and output functions simultaneously. This procedure may serve for identification since it puts a priori restrictions on the coefficients in the “reduced form” equations.

3.3 Data
The number of market samples is 46 because we delete Shizuoka prefecture. The market sample is constructed as sum or average over regional and mutual banks and credit associations in a prefecture. The individual bank samples consist of regional and mutual banks and credit associations. The number of the sample is 469.

The definitions of data are given here.

$HI$: Hirfindahl index which is calculated for each prefecture based on the outstanding deposits of regional banks, mutual banks, and credit associations.

10) This is because some data are not reported for Shizuoka Sogo Bank.
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\textbf{R}: Loan interest rate which is calculated by (interest rate revenues from loans in 1982)/(outstanding loans at the end of 1982).

\textbf{C}: Cost which is the sum of personnel and non-personnel expenditures, measured in one million yen.

\textbf{Y}: Prefectural Income taken from \textit{Todofukenbetsu Keizai Tokei (Economic Statistics by Prefectures)} issued by Bank of Japan.

\textbf{w}: Wage rate which is calculated by (salary paid)/(the number of employees) for regional and mutual banks and (personnel expenses)/(the number of employees) for credit associations. Data of the number of employees of credit associations are taken from “Kaisha Sokan” issued by Nippon Keizai Shinbun. The data is available only 354 of 470 credit associations.

\textbf{P}: Current profits before tax measured in one million yen.

\textbf{Q}: The outstanding loans at the end of 1982 fiscal year, measured in one million yen.

\textbf{D}: The outstanding deposits at the end of 1982 fiscal year, measured in one million yen.

\textbf{rK}: Non-personnel expenses.

All the data of regional and mutual banks are taken from Nikkei Needs Data File (bank), and those on credit associations are from “Zenkoku Sin-yokinko Zaimu Shohyo” issued by Kin-yu Tosho Shuppan Sha, otherwise mentioned.

4. Results and Discussion

4.1 Results of Separate Estimations

Let us examine the results of cost function first because Hypothesis 2 can be elucidated by them alone. They are presented in Table 1.\textsuperscript{11}) In most estimations, the coefficients of the concentration index show the negative sign. This implies the rejection of Hypothesis 2.

The first two rows show the estimates of the long-run cost function of (8) with market and individual samples respectively. Both estimations are similar each other. The coefficients of the output and wage rate satisfy the expected signs. The coefficient of the Hirfindahl index has a significant negative sign. The coefficient of the output is smaller than unity, implying scale economies. The bank does not choose the output level in the long-run and we had better investigate the short-run behavior of the bank.

The results of the short-run cost function are presented in the next rows. Again the coefficient of the Hirfindahl index shows the negative sign, even if less significant. This rejects Hypothesis 2. However, the results are not satisfactory enough. The coefficient of the fixed input does not show the correct sign. Moreover, the coefficient of the output is smaller than that of the long-run cost function.

Next, let us proceed to the results of the profit function because Hypothesis 2 has been rejected. They are presented in Table 2. In most cases, the coefficients of \textit{HI} are significantly positive. This implies that Hypothesis 1 is accepted.

Let us inspect the table a little bit carefully to see if the estimation results are reliable. The first

\textsuperscript{11}) As was mentioned in the former section, the OLS estimates may be biased. 3SLS and FIML estimation of cost and output functions are tried. However, the results are not remarkably improved. We do not show the results to save space, since we report the FIML estimates of the entire system below.
two rows present the results of the long-run profit function with the market and individual samples respectively. Following the argument in the previous section, the market share of each bank is added to the explanatory variables in the individual sample estimation. The coefficient of \( \ln Y \) shows the correct sign but that of the wage rate does not. The coefficient of the Hirfindahl index is positive in both cases, which is consistent with Hypothesis 1.

In the short-run profit function with the market sample, all the coefficient are consistent with
the signs expected from the theory: the coefficient of the wage rate turns into negative. The coefficient of $HI$ becomes highly significant. These results support Hypothesis 1. With the individual samples, the market share of each bank is highly significant. Only a flaw of the results is that the wage rate shows positive sign.

In sum, all the estimations of the profit function strongly support Hypothesis 1.

Table 3 Estimation Results of Interest Rate Equation

<table>
<thead>
<tr>
<th># of Eq.</th>
<th>Const.</th>
<th>ln $Y$</th>
<th>ln $w$</th>
<th>$HI$</th>
<th>ln $K$</th>
<th>ln $D$</th>
<th>$\bar{R}^2$</th>
<th># of Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$e_1(\cdot)$</td>
<td>$e_2(\cdot)$</td>
<td>$e_3$</td>
<td>$e_4(\cdot)$</td>
<td>$e_5(\cdot)$</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>long-run</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>(6)</td>
<td>$-2.590$</td>
<td>$0.0010$</td>
<td>$-0.0277$</td>
<td>$-0.0813$</td>
<td>0.064</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ln $R$</td>
<td>$-19.7**$</td>
<td>0.12</td>
<td>$-0.40$</td>
<td>$-1.79$</td>
<td>46</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(6)</td>
<td>$-2.557$</td>
<td>$0.0191$</td>
<td>$-0.154$</td>
<td>0.011</td>
<td>0.045</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ln $R$</td>
<td>$-24.72**$</td>
<td>2.55</td>
<td>$-4.14**$</td>
<td>0.25</td>
<td></td>
<td>469</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>short-run</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>(6)'</td>
<td>$-2.506$</td>
<td>0.0322</td>
<td>0.0462</td>
<td>$-0.121$</td>
<td>$-0.0526$</td>
<td>0.143</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ln $R$</td>
<td>$-19.06**$</td>
<td>1.99</td>
<td>0.62</td>
<td>$-2.57*$</td>
<td>$-2.20*$</td>
<td>46</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(6)'</td>
<td>$-2.559$</td>
<td>0.0214</td>
<td>0.0484</td>
<td>0.0339</td>
<td>$-0.0483$</td>
<td>0.264</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ln $R$</td>
<td>$-28.2**$</td>
<td>3.26</td>
<td>$-4.14**$</td>
<td>0.85</td>
<td>$-11.83**$</td>
<td>469</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Estimates with Adjusting The Quality of Loan (with individual samples only)

**long-run**

| (13)    | $-2.345$ | 0.0206 | 0.0585 | 0.0433 | $-0.0472$ | 0.282  |        |              |
| ln $R$  | $-25.69**$ | 3.18 | 1.60 | 1.09 | $-12.45**$ | 469    |        |              |

**short-run**

| (13)'   | $-2.099$ | 0.0196 | 0.0582 | 0.0528 | 0.0580 | $-0.101$ | 0.288  |              |
| ln $R$  | $-14.53**$ | 3.03 | 1.60 | 1.33 | $2.19*$ | $-4.05**$ | 469    |              |

Estimation with Variables Not in Log

<table>
<thead>
<tr>
<th>Const.</th>
<th>$Y$</th>
<th>$w$</th>
<th>$HI$</th>
<th>$K$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\times 10^{-7}$</td>
<td>$\times 10^{-3}$</td>
<td>$\times 10^{-5}$</td>
<td></td>
</tr>
<tr>
<td><strong>long-run</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(14)</td>
<td>0.0744</td>
<td>0.159</td>
<td>$-0.784$</td>
<td>$-0.0024$</td>
</tr>
<tr>
<td>$R$</td>
<td>15.1**</td>
<td>2.06*</td>
<td>$-0.72$</td>
<td>$-0.80$</td>
</tr>
<tr>
<td>(14)'</td>
<td>0.086</td>
<td>0.197</td>
<td>$-2.80$</td>
<td>0.0029</td>
</tr>
<tr>
<td>$R$</td>
<td>35.25**</td>
<td>4.67**</td>
<td>$-5.55**$</td>
<td>1.15</td>
</tr>
</tbody>
</table>

**short-run**

| (14)'   | 0.072  | 0.62  | 0.349 | $-0.00549$ | $-0.0207$ | 0.247  |        |
| $R$     | 15.13** | 3.14** | 0.31 | $-1.77$ | $-2.52*$ | 46     |        |
| (14)'   | 0.0754 | 0.18  | 0.149 | 0.00516 | $-0.140$ | 0.317  |        |
| $R$     | 32.81** | 4.93** | 0.30 | $2.35*$ | $-12.38**$ | 469    |        |

Estimation with Effective Interest Rates (with market samples only)

**long-run**

| (6)      | $-3.142**$ | 0.104** | $-0.186$ | $-0.344$ | 0.400  |        |        |
| ln $R$   | $-6.54**$ | 3.05** | $-0.76$ | $-1.82$ | 46     |        |        |

**short-run**

| (6)'     | $-3.311$ | 0.0699 | $-0.202$ | $-0.309$ | 0.0551 | 0.391  |        |
| ln $R$   | $-5.90**$ | 1.06  | $-0.81$ | $-1.55$ | 0.60  | 46     |        |

Note: See Table 1.
The results of the interest rate equations are presented in Table 3. In the long-run estimations, the fit is very poor. Only the coefficients of $\ln Y$ with individual bank samples show the correct sign. Hirfindahl index is not significant. We are not very satisfied with the results.

The short-run results are much better. The fit is improved and the most coefficients show the correct signs. However, the effect of Hirfindahl index is ambiguous.

As was argued in the last section, we ought to have added the bank scale to the regressions with the bank samples. The unsatisfactory results may be due to the lack of this variable. Adopting deposits as the bank scale, the regression equation now becomes:

\[
\ln R = e_0 + e_1 \ln Y + e_2 \ln w + e_4 HI + e_6 \ln D + u
\]

\[
\ln R = e_0' + e_1' \ln Y + e_2' \ln w + e_4' HI + e_6' \ln K + e_6' \ln D + u.
\]

Their estimation results are shown in the next two rows. The fit is improved and the coefficient of $HI$ shows a positive sign even if insignificant. In the short-run, however, the coefficient of the fixed inputs does not show the appropriate sign.

The nonpositive coefficient of $HI$ does not contradict the acceptance of Hypothesis 1 when Hypothesis 2 has been already rejected (see the argument in Section 2). The monopolistic bank can offer the interest rate as low as that of the competitive bank because of its high technical efficiency. Nevertheless, it is interesting to see whether or not the traditional structure-performance hypothesis is supported by data. Let us search intensively for a result which is consistent with it.

The first modification is the use of the level instead of variable in logs:\footnote{\cite{12}}

\[
R = e_0 + e_1 Y + e_2 w + e_4 HI + u
\]

\[
R = e_0' + e_1' Y + e_2' w + e_4' HI + e_5' K + u,
\]

although these specifications are not compatible with the Cobb-Douglas production function. The estimates are reasonable in general except that the coefficient of the wage rate often takes the wrong sign. However, the coefficient of $HI$ takes positive and negative signs depending on the individual and market samples.

The final test is the examination of the effective loan interest rates.\footnote{\cite{13}} It is often alleged that

\footnotetext{12}{We also tried the use of the unlogged interest rate leaving other variables in logged values. This specification can be derived by rewriting the demand function for loan (5) and Hypothesis 1 by replacing $R$ with $e^R$. The estimation results are not remarkably changed from those of (13), so that we do not present them in the Table.}

\footnotetext{13}{We also examined the inclusion of the one-period-lagged interest rate into the explanatory variables. Thus, the specifications are

\[
\ln R = e_0 + e_1 \ln Y + e_2 \ln w + e_4 HI + e_6 \ln R(-1) + u,
\]

where $R(-1)$ indicates one-period lagged variable of $R$. This modification seems reasonable, since the loan interest rate is calculated as (interests paid in 1982 fiscal year)/(outstanding loans at the end of 1982 fiscal year) which may reflect the loan interest rate contracted in the former periods. Moreover the lagged dependent variable may capture the slow adjustment or the disequilibrium phenomena of loan markets (see Tsutsui (1982)).

The estimates of (15) type equations are not reasonable. The interest rate is almost explained with its own lagged variable and all the other variables are not significant. The results are not shown in the table to save space.
the quoted loan interest rate is almost institutionally fixed\(^{14}\) and that the bank and the firm negotiate effective rate by arranging the compensating balances. If this is the case, we must use effective loan interest rates in the analysis and the poor fit of the foregoing regressions is not surprising.

The effective rate \(R^e\) is defined as,

\[
R^e = \frac{RQ - RT}{(Q - T)}
\]

where \(T\) represents the compensating balances, and \(RT\) is the interest rate of \(T\). It is hard to get an appropriate data of \(T\) and \(RT\) for the individual bank. What is available for \(T\) is merely deposits by corporations by prefecture. We adopt the one year deposit interest rate as the data of \(RT\). Since the corporate deposits consist of various terms of deposits, this data is not perfect.

The estimates of the effective loan interest rate equation are presented in the last two rows in Table 3. The fit is much improved compared with the corresponding results using the quoted interest rate. See the first and the third rows of the table. This suggests that the analysis of the effective rate is promising. However, the results are not satisfactory enough: the fixed inputs and wage rate are not significant. The coefficient of \(HI\) shows negative sign although it is not highly significant. This means higher concentration tends to make interest rate lower.

In sum, notwithstanding our intensive search for the appropriate specification, the results of the interest rate function are rather mixed. We can not deduce definite conclusion from them. One interesting feature of the results is that the coefficients of Hirschman index always show the positive sign when bank samples are used and the negative sign with market samples. However, we do not know how to interpret this.

4.2 Results of Simultaneous Estimations

The results of the separate estimation have some problems aside from the discouraging outcomes of the interest rate function. Specifically, the coefficients of the fixed input in the cost function and the coefficient of the wage rate in the profit function seldom satisfy the expected signs. This implies that some a priori conditions presumed in our model are not supported with the observations. Such inconvenient outcomes might come from that we do not appropriately consider a set of restrictions on the coefficients cross equations.

In order to put the restrictions, we express each coefficient with the original parameters and estimate cost, output, and profit functions simultaneously. We do not include the interest rate equation to avoid the unfavorable effect of the possible misspecification of the interest rate equation.\(^{15}\)

The results are gathered in Tables 4 and 5. There, estimates of the original parameters are shown first, then the coefficients of each function calculated from them follow.

---

\(^{14}\) The upper and lower bounds of the quoted interest rate have been linked to the official discount rate.

\(^{15}\) We also estimate the system which includes the interest rate equation. The fit of the interest rate equation is very poor. However, the estimates of other functions are not very different from those presented in Tables 4 and 5.
\[ \text{N. Mori and Y. Tsutsui: Bank Market Structure and Performance: Evidence from Japan} \]

<table>
<thead>
<tr>
<th>Table 4 Simultaneous Estimations: Long-run</th>
</tr>
</thead>
</table>

**Market Samples**

Estimates of the Original Parameters

<table>
<thead>
<tr>
<th>$j_1$</th>
<th>$j_2$</th>
<th>$b$</th>
<th>$c$</th>
<th>$B$</th>
<th>$E$</th>
<th>likelihood</th>
</tr>
</thead>
<tbody>
<tr>
<td>$-$</td>
<td>$+$</td>
<td>$+$</td>
<td>$+$</td>
<td>$?$</td>
<td>$?$</td>
<td># of samples</td>
</tr>
</tbody>
</table>

-0.157 0.055 1.223 -0.143 -0.431 -0.012 74.46

-1.31 0.66 4.89** -0.56 -4.27** -0.27 46

Estimates of the Cost Function

<table>
<thead>
<tr>
<th>Const.</th>
<th>$\ln Q$</th>
<th>$\ln w$</th>
<th>$H1$</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$a_0$</td>
<td>$a_1(+)</td>
<td>$a_2(+)</td>
<td>$a_4</td>
<td></td>
</tr>
<tr>
<td>-2.190</td>
<td>0.926</td>
<td>-0.133</td>
<td>-0.399</td>
<td>0.983</td>
</tr>
</tbody>
</table>

-5.62** 50.93** -0.56 -4.47**

Estimates of Profit Function

<table>
<thead>
<tr>
<th>Const.</th>
<th>$\ln Y$</th>
<th>$\ln W$</th>
<th>$H1$</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$d_0$</td>
<td>$d_1(+)</td>
<td>$d_2(-)</td>
<td>$d_4</td>
<td></td>
</tr>
<tr>
<td>1.295</td>
<td>0.614</td>
<td>1.351</td>
<td>0.151</td>
<td>0.811</td>
</tr>
</tbody>
</table>

1.49 16.43** 3.08** 0.81

Estimates of Output Function

<table>
<thead>
<tr>
<th>Const.</th>
<th>$\ln Y$</th>
<th>$\ln w$</th>
<th>$H1$</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$e_0$</td>
<td>$e_1(+)</td>
<td>$e_2(-)</td>
<td>$e_4</td>
<td></td>
</tr>
<tr>
<td>5.097</td>
<td>0.664</td>
<td>1.602</td>
<td>-0.0273</td>
<td>0.824</td>
</tr>
</tbody>
</table>

4.15** 14.40** 2.50* -0.50

**Individual Samples**

Estimates of the Original Parameters

<table>
<thead>
<tr>
<th>$j_1$</th>
<th>$j_2$</th>
<th>$b$</th>
<th>$c$</th>
<th>$B$</th>
<th>$E$</th>
<th>likelihood</th>
</tr>
</thead>
<tbody>
<tr>
<td>$-$</td>
<td>$+$</td>
<td>$+$</td>
<td>$+$</td>
<td>$+$</td>
<td>$?$</td>
<td># of samples</td>
</tr>
</tbody>
</table>

-0.0011 0.0223 0.575 0.590 -0.163 -0.384 2.12* 469

-0.48 2.06* 13.81** 13.17** -3.84** 1.84 -690.42

Estimates of the Cost Function

<table>
<thead>
<tr>
<th>Const.</th>
<th>$\ln Q$</th>
<th>$\ln w$</th>
<th>$H1$</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$a_0$</td>
<td>$a_1(+)</td>
<td>$a_2(+)</td>
<td>$a_4</td>
<td></td>
</tr>
<tr>
<td>-2.532</td>
<td>0.858</td>
<td>0.507</td>
<td>-0.140</td>
<td>0.987</td>
</tr>
</tbody>
</table>

-40.27** 157.8** 13.71** -3.84

Estimates of Profit Function

<table>
<thead>
<tr>
<th>Const.</th>
<th>$\ln Y$</th>
<th>$\ln w$</th>
<th>$H1$</th>
<th>$\ln s$</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$d_0$</td>
<td>$d_1(+)</td>
<td>$d_2(-)</td>
<td>$d_4</td>
<td>$d_4(+)</td>
<td></td>
</tr>
<tr>
<td>3.261</td>
<td>-0.136</td>
<td>3.599</td>
<td>-0.746</td>
<td>-0.0067</td>
<td>0.194</td>
</tr>
</tbody>
</table>

4.28** -2.07* 14.92** -2.70** -0.48

Estimates of Output Function

<table>
<thead>
<tr>
<th>Const.</th>
<th>$\ln Y$</th>
<th>$\ln w$</th>
<th>$H1$</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$e_0$</td>
<td>$e_1(+)</td>
<td>$e_2(-)</td>
<td>$e_4</td>
<td></td>
</tr>
<tr>
<td>8.159</td>
<td>-0.159</td>
<td>3.603</td>
<td>-1.169</td>
<td>0.197</td>
</tr>
</tbody>
</table>

9.14** -2.07* 14.82** -3.11**

**Note:** See Table 1.
### Table 5  Simultaneous Estimations: Short-run

**Market Samples**

<table>
<thead>
<tr>
<th>Estimates of the Original Parameters</th>
<th>$J_1$</th>
<th>$J_2$</th>
<th>$b$</th>
<th>$c$</th>
<th>$B$</th>
<th>$E$</th>
<th>likelihood</th>
<th># of samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>-0.113</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>?</td>
<td>?</td>
<td>-0.349</td>
<td>135.06</td>
</tr>
<tr>
<td>-2.93**</td>
<td>1.46</td>
<td>23.61**</td>
<td>29.44**</td>
<td>-4.36**</td>
<td>11.80**</td>
<td>46</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Estimates of the Cost Function**

<table>
<thead>
<tr>
<th>Const.</th>
<th>$\ln Q$</th>
<th>$HI$</th>
<th>$\ln K$</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$a_0'$</td>
<td>$a_1'(+) + a_2'(-)$</td>
<td>$d_0'$</td>
<td>$d_1'(+) + d_2'(-)$</td>
<td>$e_0'j_1 - e_1'j_2 + e_2'j_3(-)$</td>
</tr>
<tr>
<td>-12.90</td>
<td>3.144</td>
<td>-1.099</td>
<td>-2.404</td>
<td>0.708</td>
</tr>
<tr>
<td>-10.81**</td>
<td>29.44**</td>
<td>-4.24**</td>
<td>-17.55**</td>
<td></td>
</tr>
</tbody>
</table>

**Estimates of Profit Function**

<table>
<thead>
<tr>
<th>Const.</th>
<th>$\ln Y$</th>
<th>$\ln w$</th>
<th>$HI$</th>
<th>$\ln K$</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$d_0'$</td>
<td>$d_1'(+) + d_2'(-)$</td>
<td>$d_3'(+) + d_4'(-)$</td>
<td>$d_5'(+) + d_6'(-)$</td>
<td>$d_7'(+) + d_8'(-)$</td>
<td>$d_9'(+) + d_{10}'(-)$</td>
</tr>
<tr>
<td>1.170</td>
<td>0.0552</td>
<td>-0.393</td>
<td>0.223</td>
<td>0.945</td>
<td>0.977</td>
</tr>
<tr>
<td>4.23**</td>
<td>1.49</td>
<td>-14.25**</td>
<td>3.04**</td>
<td>17.86**</td>
<td></td>
</tr>
</tbody>
</table>

**Estimates of Output Function**

<table>
<thead>
<tr>
<th>Const.</th>
<th>$\ln Y$</th>
<th>$\ln w$</th>
<th>$HI$</th>
<th>$\ln K$</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>(+) $e_0'j_1 - e_1'j_2 + e_2'j_3(-)$</td>
<td>$e_3'j_4(-)$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.535</td>
<td>0.0176</td>
<td>-0.443</td>
<td>0.386</td>
<td>1.065</td>
<td>0.961</td>
</tr>
<tr>
<td>11.49**</td>
<td>1.48</td>
<td>-21.08**</td>
<td>4.11**</td>
<td>26.08**</td>
<td></td>
</tr>
</tbody>
</table>

**Individual Samples**

<table>
<thead>
<tr>
<th>Estimates of the Original Parameters</th>
<th>$J_1$</th>
<th>$J_2$</th>
<th>$b$</th>
<th>$c$</th>
<th>$B$</th>
<th>$E$</th>
<th>likelihood</th>
<th># of samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>-0.0732</td>
<td>0.0322</td>
<td>0.861</td>
<td>0.188</td>
<td>?</td>
<td>-0.0737</td>
<td>1.197</td>
<td>352.45</td>
<td></td>
</tr>
<tr>
<td>-12.02**</td>
<td>4.24**</td>
<td>141.4**</td>
<td>169.1**</td>
<td>-1.57</td>
<td>3.98**</td>
<td>469</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Estimates of the Cost Function**

<table>
<thead>
<tr>
<th>Const.</th>
<th>$\ln Q$</th>
<th>$HI$</th>
<th>$\ln K$</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$a_0'$</td>
<td>$a_1'(+) + a_2'(-)$</td>
<td>$d_0'$</td>
<td>$d_1'(+) + d_2'(-)$</td>
<td>$e_0'j_1 - e_1'j_2 + e_2'j_3(-)$</td>
</tr>
<tr>
<td>-23.32</td>
<td>5.309</td>
<td>-0.391</td>
<td>-4.570</td>
<td>0.376</td>
</tr>
<tr>
<td>-93.41**</td>
<td>169.1**</td>
<td>-1.57</td>
<td>-98.26**</td>
<td></td>
</tr>
</tbody>
</table>

**Estimates of Profit Function**

<table>
<thead>
<tr>
<th>Const.</th>
<th>$\ln Y$</th>
<th>$\ln w$</th>
<th>$HI$</th>
<th>$\ln K$</th>
<th>$\ln s$</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$d_0'$</td>
<td>$d_1'(+) + d_2'(-)$</td>
<td>$d_3'(+) + d_4'(-)$</td>
<td>$d_5'(+) + d_6'(-)$</td>
<td>$d_7'(+) + d_8'(-)$</td>
<td>$d_9'(+) + d_{10}'(-)$</td>
<td>$d_{11}'(-)$</td>
</tr>
<tr>
<td>1.164</td>
<td>0.0390</td>
<td>-0.211</td>
<td>0.115</td>
<td>0.966</td>
<td>0.0887</td>
<td>0.960</td>
</tr>
<tr>
<td>11.62**</td>
<td>4.26**</td>
<td>-81.49**</td>
<td>4.04**</td>
<td>140.2**</td>
<td>12.28**</td>
<td></td>
</tr>
</tbody>
</table>

**Estimates of Output Function**

<table>
<thead>
<tr>
<th>Const.</th>
<th>$\ln Y$</th>
<th>$\ln w$</th>
<th>$HI$</th>
<th>$\ln K$</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>(+) $e_0'j_1 - e_1'j_2 + e_2'j_3(-)$</td>
<td>$e_3'j_4(-)$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.564</td>
<td>0.0073</td>
<td>-0.228</td>
<td>0.086</td>
<td>1.043</td>
<td>0.977</td>
</tr>
<tr>
<td>87.69**</td>
<td>4.27**</td>
<td>-129.6**</td>
<td>1.64</td>
<td>159.9**</td>
<td></td>
</tr>
</tbody>
</table>

*Note: See Table 1.*
Table 4 presents the long-run estimation. As we mentioned in the last section, the existence of the scale economies ($b + c > 1$) contradicts the long-run profit maximization. This contradiction appears in strange values of some parameters. For example, in the market sample estimation, the parameters of loan demand function $j_1$ and $j_2$ are not significant, and those of production function, $b$ and $c$, take absurd values. The estimates of the coefficient of the wage rate is negative, which means the increase in the wage rate decreases the costs, other things being equal.

The estimates of the original parameters with individual samples show less problems: all the parameters satisfy the requirements except that $b + c$ exceeds unity. This violation of the condition of long-run profit maximization, however, results in strange values of coefficients of $\ln w$ and $\ln Y$ in the profit and output functions. Those results suggest that long-run profit maximization models do not explain the behavior of the Japanese bank because there exists scale economies.

Short-run estimations are presented in Table 5. Most of the estimates of the original parameters as well as the coefficients calculated from them are significant and consistent with the theory. The assumption that the non-personnel expenses are fixed inputs and labor hours are adjusted to maximize profits in the short-run seems reasonable.

A merit of the simultaneous estimation is to give direct estimates of $B$ and $E$. Significantly positive $E$ both with market and individual samples clearly accepts Hypothesis 1. Moreover, the estimate of $E$ is very close to unity, which is consistent with the theory. $B$ shows negative sign both in market and bank samples. This implies the rejection of Hypothesis 2. Closer inspection reveals that $B$ is significant with the market samples but insignificant with bank samples.

We should be careful that implication of the negative sign of $B$ differs with which sample is used. The negative sign of $B$ with the market sample implies that the larger bank is more technologically efficient because what is controlled in the regression in this case is the sum of the output of the prefecture. The same level of the prefectural output cum higher concentration means that the average scale of bank is larger.

On the other hand, if we find the negative $B$ with the individual samples, the same interpretation cannot be applied because the individual bank scale is controlled in the regression. In this case the negative $B$ implies that the bank of the same size in the higher concentrated market spends less. A possible interpretation is as follows:

Since the deposit interest rate is regulated, the bank must use the non-price measures such as customer-services-outside-branches and gifts to depositors to get more deposits. On the other hand, the total supply of deposits has been inelastic to "the effective deposit interest rate" including all the advantages for depositors. The reason for this is that deposits have been the only way for personal saving. Thus, the bank in more competitive markets needs to expend more for non-price competition for the same deposits. If the foregoing situation prevails, the cost function estimation looks as if the bank adopted the inferior technology in competitive markets.

We must be aware that in competitive markets the technical inefficiency does not imply social inefficiency under the foregoing interpretation. The depositors are better off in the bank losses when the markets are in lower concentration. Thus, it is hard to say whether the total surplus decreases when the market becomes more competitive.

The fact that $B$ is significant with the market sample and insignificant with bank sample sug-
suggests that efficiency of oligopoly mainly comes from the scale economy of individual bank.

Other parameters also take the reasonable values: \( j_1 \) and \( j_2 \) are \(-0.11\) and \(0.04\) respectively which means if the outstanding loans (the income, respectively) of one prefecture are twice as much as that of the some other prefecture, its interest rate is lower (higher) around 11% (4%) of the prevailing level. The interest rate is not very sensitive to the market condition of the prefecture. The capital and labor elasticity of output are around 0.8 and 0.3 respectively. The coefficients of each function calculated from the original parameters are also reasonable.

5. Concluding Remarks
In this paper we have examined whether the market structure-performance hypothesis is valid in the Japanese bank markets through the estimation of the loan interest rate, cost, and profit functions. The value of this paper is that the explanatory variables are chosen as theoretically as possible.

The results of the simultaneous estimation of the whole system suggest that:
1) the higher the market concentration, the closer the performances of that market to those of monopoly, and
2) the higher the market concentration, the higher the technical efficiency.

The separate estimation of the profit function also confirms the conclusion of 1), that is, the higher concentration ratio tends to produce the higher profits.

The conclusion of 2) also has the basis on the finding by the OLS estimation of the cost function, that is, the degree of market concentration has a negative effect on the bank costs.

What is the policy implication of these conclusions? The conclusion of the higher efficiency of the larger bank suggests that a policy which limits the bank scale is inappropriate and unnecessary. On the other hand, the positive correlation between the concentration ratio and the profits suggests that the regulations on the new entry, branching, and operation area cause income distribution problem. These regulations should be relaxed.

Our analysis is limited in many aspects. As noted in Section 2, that some assumptions may be restrictive and that the conclusions might critically depend on them. We have disregarded the effect of credit cooperatives and city banks and we did not adjust the effect of the branches which are located outside of their home-prefectures.

We have focused on technical inefficiency and assumed that banks are price efficient. Although we have pointed out that banking is highly regulated, we did not explicitly embed that into the analysis. Regulation on loan interest rates may be the cause of the ambiguous estimates of the interest rate function. We did not consider the appropriate ad hoc variables to explain the bank performances either. Although we do not deny the importance of such investigations, it is impossible to consider all the aspects in the study. The aim of this paper is to know how far we can go by the simple theoretical approach, and we hope that the outcome is quite satisfactory.

Appendix A
In this appendix, we will show the derivation of the testable equations.

A.1 Derivation of the Reduced Form of Interest Rate (6)

\( Q_m \) is derived from the maximization of monopoly profits:

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\[ \text{(A-1)} \quad \text{Max} \ P_m = RQ_m - r_D D - rK_m - wL_m \]
\[ \text{st. (3), (4), and (5).} \]

Since \( D \) is assumed to be fixed, (A-1) is tantamount to
\[ \text{(A-1)' Max} \ RQ - rK - wL, \]
\[ \text{st. (4) and (5).} \]

From Assumption 4,
\[ \text{(A-2)} \quad Q_m = A_m K_m^b L_m^c, \]
\[ \text{(A-2)' Q}_c = A_c K_c^b L_c^c, \]
where \( A_m = A'e^{-B} \) and \( A_c = A' \).

\( L_m \) can be calculated as (see Edwards (1977; p. 159))
\[ \text{(A-3)} \quad L_m = l w^b r^d b^e c^f, \]
where \( b_1 = (b + c)(1 + j_1) \), \( b_2 = [b(1 + j_1) - 1]/(1 - b_1) \), \( b_3 = -b(1 + j_1)/(1 - b_1) \), \( b_4 = j_2/(1 - b_1) \), and \( l = [A'_{c+j_1} b^{(1 + j_1) c^1 - b(1 + j_1) j_0(1 + j_1)}]^{1/(1 - b_1)}. \)

\( K_m \) is similarly shown to be
\[ \text{(A-4)} \quad K_m = k w^d r^d b^e c^f, \]
where \( d_2 = -c(1 + j_1)/(1 - b_1) \), \( d_3 = [c(1 + j_1) - 1]/(1 - b_1) \), and \( k = [A'_{c+j_1} b^{(1 + j_1) c^1 - b(1 + j_1) j_0(1 + j_1)}]^{1/(1 - b_1)}. \)

Substituting (A-3) and (A-4) into (A-2), we get
\[ \text{(A-5)} \quad Q_m = \left[ A_m b^{(b + c)} c^{(1 + j_1)} w^{-c} r^{-b} Y^{(b + c) j_2} \right]^{1/(1 - b_1)}. \]

Note that we should use the same market demand function and the same market marginal cost curves to calculate \( Q_c \) and \( Q_m \), since \( R_c \) and \( R_m \) are the imaginary interest rates provided that the market in question are monopolistic or competitive. \( Q_c \) is calculated from solving the market equilibrium, viz, the total marginal cost \( MC = \text{market demand} \). The cost function dual to the Cobb-Douglas production function is well known:
\[ \text{(A-6)} \quad C_i(Q; w, r) = \left[ (c/b)^{b/(b + c)} + (b/c)^{c/(b + c)} \right] A^{-1/(b + c)} Q^{1/(b + c)} w^{c/r} r^{b/(b + c)}, \]
where subscript \( i \) denotes the \( i \)-th bank. Due to the Assumption 6, the total cost function has the same form as (A-6) except for the constant term, since
\[ C = \sum C_i = \left[ (c/b)^{b/(b + c)} + (b/c)^{c/(b + c)} \right] A^{-1/(b + c)} Q^{1/(b + c)} w^{c/r} r^{b/(b + c)} \sum Q^{1/(b + c)}. \]

Substituting \( Q_i = s_i Q \), we get
\[ \text{(A-6)' C} = \left[ (c/b)^{b/(b + c)} + (b/c)^{c/(b + c)} \right] A^{-1/(b + c)} Q^{1/(b + c)} w^{c/r} r^{b/(b + c)}, \]
where \( A = A \sum s_i^{1/(b + c)}. \)

Thus, solving \( MC = dC(Q)/dQ = P_c = j_0 Q_c Y^{j_2} \) for \( Q_c \), we obtain,
\[ \text{(A-7)} \quad Q_c = \left[ A c_j^{(b + c)} b^{c} c^{(1 + j_1)} w^{c} r^{-b} Y^{(b + c) j_2} \right]^{1/(1 - b_1)}. \]

Comparing (A-7) with (A-5) reveals
\[ \text{(A-8)} \quad Q_m = (1 + j_1)^{(b + c)/(1 - b_1)} e^{-B(1 - b_1)} Q_c. \]

From (A-8) and (5), (1) in the text can be rewritten as
\[ \text{(A-9)} \quad R_{obs} = p_c \left[ E \left( e^{-B(j_1/(1 - b_1)) (1 + j_1)^{(b + c)/(1 - b_1)} - 1} \right) HI + 1 \right]. \]

Taking logs of (A-9), the interest rate function is
\[(A-10) \quad \ln R_{obs} = e_0 + e_1 \ln Y + e_2 \ln w + e_3 \ln r + \ln \left[ E \left[ e^{-B j Y (1-b)} (1 + j_1) b \right] - 1 \right] HI + 1 \]

By expanding logarithm of the last term, we obtain

\[(6) \quad \ln R_{obs} = e_0 + e_1 \ln Y + e_2 \ln w + e_3 \ln r + e_4 HI.\]

The sign of \(e_4\) depends on \(b + c < 1\), which is necessary for the second order condition of the profit maximization in the competitive market.

\[A.2 \quad \text{Derivation of the Profit Function (7)}\]

Next, let us derive the profit function (7). The profits of monopoly and competitive banks are

\[(A-11) \quad P_m = Q_m (R_m - AC(Q_m)) \quad \text{and} \quad (A-11)' P_c = Q_c (R_c - AC(Q_c)).\]

Thus,

\[(A-12) \quad P_m - P_c = [R_m Q_m - R_c Q_c] + [C(Q_c) - C(Q_m)] = 0 \quad Y^{j_2} Q_m^{j_1} - w_c/(b+c) - b/(b+c) c/(b+c) A' - [e^{B Y^{j_2} Q_m^{j_1}} - Q_c^{j_1}].\]

On the other hand, from (A-5) and (A-7),

\[(A-13) \quad Q_m^{i} - Q_c^{i} = (w - c r - b Y^{j_2} Y^{j_2} A' j_1/(1-b) - [e^{B Y^{j_2} Q_m^{j_1}} (1 + j_1)^{j_1} (1-b) - 1],\]

for any \(i\).

Thus, we get

\[(A-12)' \quad P_m - P_c = [A' j_1 (1+j_1) b^{j_1} c^{j_1} Q_m^{j_1} - w_c^{j_1} Y^{j_1} Q_m^{j_1}] - [1 - (b+c)].\]

Therefore,

\[(A-14) \quad P_{obs} = [A' j_1 (1+j_1) b^{j_1} c^{j_1} Q_m^{j_1} - w_c^{j_1} Y^{j_1} Q_m^{j_1}] - [1 - (b+c)] + E \left[ e^{-B Y^{j_1} Q_m^{j_1}} (1 + j_1)^{j_1} (1-b) \right] HI + 1\]

Taking logarithm and expanding the last term, we obtain

\[(7) \quad \ln P = d_0 + d_1 \ln Y + d_2 \ln w + d_3 \ln r + d_4 HI\]

in the text.

\[\text{Appendix B}\]

In this appendix, it is shown that incorporating the expense-preference hypothesis into our models does not change our regression equations (6), (7), and (8) except the constant terms, if utility function is linear.

Let us assume that the utility of a manager is linear to profits, and non-personnel and personnel expenses:

\[(A-15) \quad U(P, E, F) = xP + yE + zF, \quad \text{where} \quad E = wL, \quad F = rK, \quad \text{and} \quad x, y, \quad \text{and} \quad z \quad \text{are constants.} \]

In view of \(P = RQ - (rK + wL)\), utility function is rewritten as

\[(A-16) \quad U = xRQ - [(x - y)rK + (x - z)wL].\]

Thus, the utility maximizing problem can be divided into two stages: first minimizing cost of \((x - y)rK + (x - z)wL\) to find the cost function \(C(Q)\), then finding the utility maximizing \(Q\) based on the cost function. It is clear that the cost function is the same as (8) if we replace
r and w with \((x - y)r \) and \((x - z)w\). The only difference is that the constant term is larger than that of (8) by \(c/(b + c) \ln (x - y) + b/(b + c) \ln (x - z)\).

How should the interest rate and profit functions be modified? Consider that the first order conditions of the maximization of the general utility function are

\[
\begin{align*}
(A-17) & \quad bRQ(j_1+1) - rK(1 - U_F/U_P) = 0, \\
(A-18) & \quad cRQ(j_1+1) - wL(1 - U_E/U_P) = 0.
\end{align*}
\]

On the other hand, the corresponding conditions of the profit maximization are obtained by setting \(U_F = U_E = 0\) in (A-17) and (A-18). Thus, the necessary modification for the manager's utility maximization is only replacing \(w\) and \(r\) with \(w(1 - U_E/U_P)\) and \(r(1 - U_F/U_P)\) respectively. Therefore, (6) and (7) are not changed except for the constant terms as far as \(U_E/U_P\) and \(U_F/U_P\) are constants. The linear utility function satisfies this condition.

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First draft received August 17, 1987; final draft accepted June 30, 1988.

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