AN EMPIRICAL ANALYSIS OF JAPANESE BANKING BEHAVIOR IN A PERIOD OF FINANCIAL INSTABILITY

BY

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1. Introduction

In this paper, we undertake to analyze the bank behavior in Japan during the recent period of financial instability. We focus attention on some aspects of the bank behavior which are viewed as significant in some quarters, but which have not yet received adequate attention in the literature.

We confine attention to primarily two aspects. First, there is the much speculated issue, often discussed in private circles, whether the banks behaved like profit-maximizers or share-maximizers over the instability period. In view of this, we work with a framework comprised of a structural loan supply function of individual banks, which incorporates a goal broad enough to include profit-maximization as a special case. In our formulation, the supply function permits one to test the profit-maximization hypothesis by testing for zero of the coefficient on some regressor in the function. This test differs in details from the one formulated in Noma (1986). Second, it is often contended, again in informal discussions among bankers and scholars, that the Japanese banks have long recognized -- certainly during the instability period --existence of interdependence(externalities) among themselves with reference to loan supply decisions. [The phenomenon is often called "Yokonarabi" in Japanese.] We propose to ascertain the validity of this contention more formally within our analytical framework. We accomplish this by allowing for regressor variables pertaining to rival banks in the loan supply function, and testing for significance of coefficients on such regressors. Presence of such regressors constitutes evidence of interdependence among banks.

The paper also makes a deliberate effort to quantify the effect of changes in the call lending rate (i.e. the short term interest rate) on the bank loans, an item of considerable interest to the Japanese Central Bank.

The behavior of the Japanese banks over the instability period has been the subject of analysis in several recent works; a select list includes Noma (1986), Ito and Sasaki (1998), Rhodes and Yoshino(1999), Horie(2001), and Hanazaki and Horiuchi (2002). The present study, however, differs from these works with respect to the issues we have delineated for examination here. Thus, virtually all these analyses assume that the banks engage in profit-maximization, unlike in our context where this assumption is a matter to be subjected to testing. An exception to this is Noma(1986) where profit-maximization or share-maximization is an item to be tested; the study, however, differs from our's in respect of
the approaches taken in testing the profit maximization hypothesis. Further, we offer a more detailed treatment of the effectiveness of the call rate as a monetary instrument than provided in these works, a possible exception to this being Rhodes and Yoshino (1999). Finally, none of these studies recognizes interdependence among rival banks, nor do they employ a more behaviorally oriented (Cournot-type) framework as done in the present paper.

The sample period we consider in this study runs from 1982 to 1995 inclusive. The choice of this period is influenced, in part, by the developments on both ends of the time span. First, the late 1970's were marked by strong government regulation of the banking industry, and the foreign capital controls were lifted in 1980. Also, with reference to the upper end of the chosen period, it was the case that 1997 and the period immediately thereafter witnessed a severe domestic financial crisis, and the accompanying currency crisis in South East Asia only made matters worse for the Japanese economy. Indeed, in 1997, some of the banks included in the present study filed for bankruptcy, and some others entered into mergers. This explains our choice of the sample period for consideration in this study. Furthermore, most experts agree that our chosen period consists of two sets of sub-periods marked by different sets of developments: 1982-1989 (Period I), and 1990-1995 (Period II). In Period I, for example, the land price and the Nikkei Stock price increased steadily -- the former from 29.4 in 1982 to 104.1 in 1990, and the latter from 7,531 Yen to 34,968 Yen. Concurrently also, loans expanded very rapidly over this period. This is because the banks used land as collateral whose value had increased sharply. By contrast, the stock price started to decline precipitously over Period II, indeed from 26,872 Yen to 19,868 Yen, when the Central Bank of Japan raised its call lending rate in December 1989. As a result, the growth of the bank loan supply began to decrease. Our empirical analysis will recognize this dichotomy, by allowing for different reaction coefficients over the two periods for select regressor variables in the loan supply function.

The supply function employed here is deduced from some underlying structure, treating banks as essentially monopolistic competitors of the Cournot type, each pursuing a goal which subsumes profit maximization as a special case. The more general goal can be consistent with profit-maximization subject to a profit-constraint, i.e., with the Baumol hypothesis, though the constraint does not explicitly enter in our analysis. The empirical counterpart of the loan supply function is a two-way random effects structural equation model, implemented here to the panel data on a
Among other things, we obtain strong evidence of the fact that the banks did not pursue profit maximization over the period under investigation. The two sub-periods are marked by different and significant coefficient estimates for some key variables such as the call lending rate. There is also evidence of strong externalities in the supply functions exerted by, for example, the rivals' previous period aggregate output (loans).

The plan of the paper is as follows. Section 2 formally develops the banks' loan supply function based on the aggregate loan demand function and individual cost functions. The precise formulation of the supply function is also of independent interest, as it suggests expedient ways of developing rich enough frameworks within which to test the profit-maximization hypothesis; see, in particular, footnote 3. Section 3 is empirical, which collects and discusses the empirical evidence relating to the bank behavior. Section 4 concludes the paper.

2. The Loan Supply Function.

We propose to carry out the analysis in the context of a bank's loan supply function, which we deduce from an underlying structure.

A. Formulation.

Suppose the aggregate demand function facing the N banks is given by

\[ r = d_0 + d_1 Y - d_2 Q \quad d_2 > 0 \tag{2.1} \]

where \( r \) = loan rate, \( Y \) = real GDP and \( Q \) = total loan demanded. Let \( q_i \) be the i-th bank's loan supply and \( Q_i = Q - q_i \) be the amount supplied by its rival banks; also assume that \( Y \) is exogenously given to each bank. Then, given \( Q_i \), the i-th bank's marginal revenue function is

\[
MR_i = \frac{d}{dq_i} \left[ q_i (d_0 + d_1 Y - d_2 q_i - d_2 Q_i) \right] \\
= d_0 + d_1 Y - d_2 Q_i - 2d_2 q_i \\
= r - d_2 q_i, \quad i = 1, \ldots N. \tag{2.2}^1
\]

1. The result in (2.2) assumes that banks correctly anticipate rival banks' loan supply amount \( Q_i \). This perfect foresight assumption, while not uncommon in microeconomic practice, is not entirely essential in our
Further, we assume that the total cost function of the $i$-th bank is given by

$$TC_i = c_{0i} + c_{1i}q_i + (1/2) c_2 q_i^2$$

so that its marginal cost function is

$$MC_i = c_{1i} + c_2 q_i.$$  \hfill (2.3)

We assume that the intercept term of the $MC$ function depends on some relevant variables other than $q_i$. In particular, since an important element of the marginal cost for a bank is the call rate ($CR$), we take the intercept as

$$c_{1i} = CR + f(Z_i)$$  \hfill (2.4)

where $f$ is a function of $Z_i$, the predetermined variables specific to the $i$-th bank. We spell out our choice of $Z_i$ shortly below.

Finally, we assume that the banks follow a goal which subsumes profit-maximization as a special case. Specifically, we assume that each operates by the rule: $MC = MR (1+\theta)$ where $\theta$ is a scalar; the rule signals profit-maximization when $\theta$ is zero. Under this rule, one can find from (2.3)-(2.4) that the loan supply function of the $i$-th bank is given by

$$q_i = \frac{1+\theta}{g}r - \frac{CR}{g} - \frac{f(Z_i)}{g}$$

$$= \frac{1+\theta}{g}(r - CR) + \frac{\theta}{g}CR - \frac{f(Z_i)}{g}$$  \hfill (2.5)

where $g = c_2 + d_2(1+\theta)$.

It is evident from (2.5) that the profit-maximization hypothesis ($\theta = 0$) is equivalent to

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2. Popularly known in the US as the federal funds rate.

3. As will become clearer later, the specification in (2.4) -- in particular, the dependence of $c_1$ on variables of the type $Z_i$ -- permits one to entertain a variety of patterns of interdependence/externalities among participating agents (banks) without unduly complicating the analysis. The device exemplified by (2.4) is reminiscent of the "tricks" used by Gorman (1976) in extending the consumer analysis through inclusion of variables other than commodities in the utility function.
Accordingly, we will test the hypothesis by testing whether the coefficient of $CR$ in (2.5) is zero.\textsuperscript{4}

**B. Stochastic Specification**

We implement the supply function as a two-way random effects error-component model with an additive disturbance term, which for the $i$-th bank at time $t$ is given by

$$u_{it} = \mu_i + \lambda_t + v_{it}, i = 1, \ldots, N; t = 1, \ldots, T,$$

where the $\mu$'s are bank-specific; the $\lambda$'s are time-specific; and the $v$'s are the white noise disturbances. Usual stochastic assumptions about the error components apply.

We take the function $f$ in (2.5) to be linear in $Z_i$, assumed to be predetermined variables. The explanatory variable $r$ is endogenous, assumed to be correlated with all the three error components. The supply function is thus treated as a structural error component model.

We estimate the model by generalized 2SLS method, which takes into account the structure of the variance-covariance matrix of the $u_{it}$'s. We use the TSP (version 4.5) for the purpose, taking the $NT$-rowed data matrix corresponding to the variables $\{Z_i, S, GDP\}$ as the IV set.

The elements of $Z_i$, specific to the $i$-th bank, are taken to be:

- $\text{DEP}_i$: deposits of the $i$-th bank
- $\text{MS}_i$: initial market share of the $i$-th bank (in 1981)
- $\text{DLRR}_i$: default loan risk reserve of the $i$-th bank
- $Q_{i,t-1}$: total loan of the $i$-th bank's rivals (t-1 period);

Note that the presence of the $Q_{i,t-1}$ variable in the loan supply function underscores interdependence among banks.\textsuperscript{5}

We also allow for the possibility that some of these variables may have different coefficients in Period I and Period II.

Specifically, we estimate the model in the form

$$q_{it} = a_0 + a_1 \text{DEP}_{it} + a_2 \text{MS}_i + a_3 \text{DLRR}_{it} + a_4 Q_{it-1} + a_5 CR_t + a_6 (r-CR)_t + u_{it} \quad (2.6a)$$

\textsuperscript{4} Strictly speaking, the profit-maximization hypothesis asserts that the net coefficient of $CR$ is the same as that of $r$.

\textsuperscript{5} Revankar and Rupert (1992) have previously considered interdependence of this sort in a “returns to schooling” regression model implemented in a panel data context.
in Period I, and

\[ q_{it} = a_0 + a_1 \text{DEP}_{it} + a_2 M_{it} + a_3 DLRR_{it} + b_4 Q_{it-1} + b_5 CR_t + b_6 (r-CR)_t + u_{it} \] \hspace{1cm} (2.6b)

in Period II, assuming different coefficients on \( Q_{it-1} \), \( CR_t \) and \( (r-CR)_t \) over the two periods. The subscripts ‘i’, ‘t’ and ‘it’ indicate that the variables in question vary over the corresponding domains. Thus the supply function \((2.6a-2.6b)\) we implement exhibits interdependence among the banks through inclusion of \( Q_{it-1} \) and also signals potential structural change from Period I to Period II. Note that --- see (2.5) --- the coefficients \( a_5 \) and \( b_5 \) are of the form: \( \theta/g \), and \( a_6 \) and \( b_6 \) are of the form: \( (1+\theta)/g \).

Finally, the estimates reported in section 3 make use of the data for the period 1981 through 1995. The data are drawn from several sources noted in Appendix A.


Table 1 presents estimates of the supply function \((2.6a - 2.6b)\). In discussing these results, we focus attention primarily on the issues of interdependence among banks, effectiveness of the call lending rate \( (CR) \) as a monetary policy instrument, and whether the banks pursued the goal of profit-maximization -- issues highlighted in Section 1.

<table>
<thead>
<tr>
<th></th>
<th></th>
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<tbody>
<tr>
<td>( \text{DEP}_{it} )</td>
<td>0.6072 (20.35)</td>
<td></td>
</tr>
<tr>
<td>( \text{MS}_{it} )</td>
<td>0.6532 (2.51)</td>
<td></td>
</tr>
<tr>
<td>( (r-CR)_t )</td>
<td>5.0051 (3.47)</td>
<td>11.1959 (5.27)</td>
</tr>
<tr>
<td>( CR_t )</td>
<td>2.6783 (3.31)</td>
<td>3.9103 (4.51)</td>
</tr>
<tr>
<td>( DLRR_{it} )</td>
<td>-40.7745 (-1.39)</td>
<td></td>
</tr>
<tr>
<td>( Q_{it-1} )</td>
<td>0.0530 (5.33)</td>
<td>0.0033 (0.68)</td>
</tr>
<tr>
<td>Constant</td>
<td>-28.2410</td>
<td></td>
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\[ \text{Table 1: Estimated Loan Supply Function}^* \]
We begin by first noting that the coefficient estimates are for the most part significant, and have expected signs. There is also evidence that the supply function underwent a structural change from Period I to Period II, in as much as $Q_t$, $CR_t$, and $(r-CR)_t$ have significantly different coefficients: We have in fact separately verified that the $t$-values for testing $a_4-b_4=0$, $a_5-b_5=0$ and $a_6-b_6=0$ are respectively: 5.6654, 5.4853, and 7.4, which are significant even at the 0.01 % level of significance.

(a) Interdependence

Possible existence of interdependence/externalities among banks is signaled by the relevance of the $Q_t$ variable, which is the rival banks' aggregate loan supply in the previous time period. The coefficient on this variable is significant and is also positive (0.0530) in period I. This indicates that the well-noted fact of aggregate loan expansion in period I is characterized by the fact that a bank's current year expansion has been fueled in good part by the previous period expansion by its rival banks. The phenomenon signals aggressiveness on the part of the banks in extending increased loan amounts, which is entirely consistent with the fact (documented shortly below) that the banks were not overly concerned with profit maximization over period I. By contrast, there is no evidence of any interdependence in Period II.

(b) Influence of the Call Lending Rate

In Period I, the coefficient of $(r-CR)$ is 5.0051 and that of $CR$ is 2.6783, so the net coefficient on $CR$ is -2.3267. Likewise we find the net coefficient of $CR$ in Period II to be -7.2856. And both coefficients are also significantly different from zero.\(^6\)

It is evident therefore that the $CR$ was available as an effective policy instrument over the two periods. The monetary authority indeed exploited this fact to control the loan supply. However, in order to encourage domestic demand, it is

\(^6\) We have separately verified that the $t$-values for testing whether net coefficients on $CR$ vanish are 3.5375 for Period I and 5.7600 for Period II, which readily confirms that the net coefficients are significant.
known that the monetary authority lowered the \( CR \) too much in Period I, which inevitably prompted the rapid growth of the loan supply over this period. On the other hand, the authority raised the \( CR \) considerably in the first part of Period II, which again explains why loan supply dried up rapidly over this period.

(c) Profit Maximization?

The issue of whether the banks in Japan pursued the goal of maximum profits over the two sub-periods in question has been debated frequently in some quarters, but has not been previously subjected to rigorous scrutiny through a quantitative analysis of pertinent data. We gather here some convincing evidence on the issue: Table 1 shows, in fact, that the banks did not pursue the maximum profit goal over either of the two subperiods. It is readily seen from the table that the coefficient of the \( CR \) variable, \( \theta /g \), is estimated as 2.6783 in Period I and 3.9103 in Period II, the respective t-values being 3.31 and 4.51. The estimates are significantly different from zero even at the 1% level of significance; the evidence therefore is overwhelmingly against the hypothesis of profit-maximization \((\theta = 0)\) in both periods. Furthermore, the coefficient on \((r-CR)\) is \((1+\theta ) /g\), and is estimated at 5.0151 and 11.1959 in Period I and Period II, respectively. Consequently, the respective \( \theta \) values are 1.15 and 0.54, -- both positive and significantly different from zero. Two implications of this: First, it follows from the general rule of \( MC=MR(1+\theta ) \) that the banks operated throughout the sample period at points where \( MC \) exceeded \( MR \), i.e., where the loan amounts supplied were well beyond the profit-maximizing levels. We do not compute the profit-maximizing loan amounts. But it is apparent from the \( \theta \) values that the loan amounts in Period I outstripped profit-maximizing levels by a much larger margin on average than in Period II, which seems eminently sensible-- Japanese banks expanded their loan supply much more aggressively in Period I than in Period II.

Figure 1 depicts the situation for a typical bank where \( q^* \) = profit-maximizing loan amount and \( q^a \) = actual loan amount supplied. Figure 2 is merely a restatement, in which a bank is seen to sacrifice maximum profits in favor of increased total revenue – the latter is obviously higher at \( q^a \) than at \( q^* \). One is reminded here of the Baumol hypothesis \((BH)\) which would posit that each bank maximizes total revenue subject to satisfactory profit-constraint \( \pi^a \); unlike in the BH, however, the constraint \( \pi^a \) is not imposed here extraneously but is determined in the system ex post.
Figure 1. Actual output \( q^a \) larger than profit-maximizing output \( q^* \).

Figure 2. Actual profits \( \pi_a \) lower than maximum profits \( \pi^* \).

4. Conclusion

The present paper analyzed the bank behavior in Japan over the financial instability period: 1982-1995. The
framework employed consists of a bank’s loan supply function, deduced from an underlying structure and implemented as an error component structural equation to a data set pertaining to a panel of N=14 banks. The loan supply function accommodates a goal which encompasses profit-maximization as a special case, and permits a simple test of the profit maximization hypothesis. The function also allows for potential existence of interdependence among banks by featuring rival banks’ total previous period loan amount as a regressor. Assessment of the effectiveness of the call lending rate in controlling the bank loan supply also receives its fair share of attention in the paper.

We documented evidence which strongly suggests that the banks did not pursue the goal of maximum profits in either of the two subperiods, but instead supplied loan amounts in excess of the profit maximizing level. The extent of this excess supply, moreover, is considerably larger in the first subperiod than in the second, which is consistent with the well-recognized fact that the former period was marked by aggressive expansion in total loan supply and the latter period witnessed contraction. A point of interest here is that, even in the face of contraction, actual loan supplies were above the profit-maximizing levels on average. In any event, the bank behavior throughout the sample period was very much in the spirit of the familiar Baumol hypothesis, according to which firms maximize revenues subject to a profits constraint. Further, we presented some evidence of interdependence / externalities among the banks, treating this phenomenon as signaled by the presence of a certain regressor in the supply function. The regressor in question is the total loan supply by the rivals in the previous year. In the first subperiod, the coefficient on the regressor is significant (even at the five percent level), which constitutes convincing evidence that the banks experienced strong interdependence. Furthermore, the fact that this coefficient is positive indicates that banks aggressively expanded the loan amounts in the current year in response to loan increases by rivals in the previous year, which is in agreement with the rapid rise in the total loan supply experienced in the first subperiod. Intriguingly, however, there is no evidence of such interdependence in the second subperiod. Finally, the net coefficient on the call lending rate is significant and negative in both subperiods, indicating that the variable was available as a powerful tool for the Central Bank of Japan in controlling the loan supply throughout the sample period. For some extraneous reasons, this policy variable was set at rather low levels, which obviously contributed to the large amounts of loans witnessed in the first subperiod. The Bank also raised the level of this variable in the early part of the second subperiod, which apparently has been a contributing factor in the rapid reduction of loans over the years in question.
Appendix A: Data source and Data description
(a) Financial Statement of All banks, Federation of Bankers Association of Japan (Zenkoku Ginko Zaimu Shohyo Bunseki), each fiscal year (1982-1995). The data used here is an annual data based on the fiscal year, namely from April 1982 to March 1996. 14 banks are Daiichi Kangyo Bank, Sakura Bank, Fuji Bank, Mitsubishi Bank, Asahi Bank, Sanwa Bank, Sumitomo Bank, Daiwa Bank, Tokai Bank, Hokkaido Takushoku Bank, Bank of Tokyo, Industrial Bank of Japan, Long term Credit Bank, Nippon Credit Bank. The analysis does not include trust banks which are included in all banks (Zenkoku Ginko) in Japan. Since their behavior were somewhat different from city banks and long term credit banks, we did not include trust banks in the analysis. Furthermore, there were bank mergers in the sample period. Such as Sakura bank (the merger of Taiyo bank, Kobe bank and Mitsui bank), and Asahi bank (the merger of Kyowa Bank and Saitama Bank). The data treats merged banks as if they were together in entire sample period by adding those banks together prior to their mergers.

References