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Effect of Branch Regulation in Japanese Banking*

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1. Introduction

Branching has been one of the most important strategy of banks, since deposit interest rates have been regulated[1]. It is alleged that the Ministry of Finance (MOF) has greatly restricted branches of private banks to suppress the competition in deposit market. MOF has discretionally decided the number of new branches for each private bank after hearing its desired number. In the period of high economic growth, banks in Japan tried enthusiastically to expand their branch networks, not only for the convenience of customers, but also for their own profits and growth. Once banks were able to increase the number of branches, their operating costs also increased. However, because of the regulation of deposit rates and cooperative market structure in the period, increases in deposits necessarily caused increases in profits.

The end of the high economic growth period induced changes in the Japanese financial system. Administrative directives gradually turned toward liberalization. Bank markets became more competitive. This situation called into question the basic philosophy of banks, particularly large banks, with regard to their branching policies. Many banks seem to have reconsidered their past policy and are asking whether more branches are needed to meet the needs of customers and to show good performance in an increasingly competitive market. In addition, the new technological progress in banking provided another cause for the reconsideration[2].

It is very interesting to see what does the change in bank branching policy suggest. Is it a long-term change or a temporary one? Does it mean that scale economies disappeared[3]? Does the branch regulation loose its power? The purpose of this paper is to answer these questions, especially the last one. Casual observation alone does not reveal whether the branch regulation is a binding condition to private banks, this can not be determined only by examining ex-post values. Whether the number of bank branches grows rapidly or remains constant, it is not known if the movement is resulted from government regulation or was voluntary choice of private banks.

I try to clarify whether branch regulation has been a binding condition to private banks by estimating bank cost functions. The idea is as follows: if the number of branches is actually limited by regulation, it is an exogenous variable for banks. Therefore, the cost function should include the number of branches in addition to output level and input prices. On the contrary, if the regulation is not binding condition to banks, the desired number of branches is achieved. Therefore the cost function needs not include the number of branches if the exogenous variables are properly included. Thus, it is possible to have some insight to the effect of branch regulation by examining whether or not the number of branches appears in the cost function.

It is the first time, to my best knowledge, that the effect of branch regulation is examined by inquiring whether or not the regulated variable is included in the bank cost function, although a similar approach was already taken by Cowing (1982) in the investigation of Averch-Jhonson effect in

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electric power industry in the U. S.. He examined whether the allowed rate of return is significant in the translog cost function and got the affirmative answer.

Upon testing the proposition with cross-sectional regression, I find that the regulation was binding for most periods, that the regulation on regional banks is more stringent than on mutual (Sogo) banks[4], and that the regulation has lost its power on mutual banks since 1973.

There are relatively fewer banks in Japan than in the U. S. because of the rigorous regulation on new entry. Instead, Japanese banks, on the average, have more branches than the U. S. banks. The regulation on branching in Japan, which is discussed in detail in the next section, seems to be more discretional than the U. S.: the principle by which new branches have been allocated to each bank is not clear. In view of this, it may be the case that the demand for branches of private banks was met by the regulatory authorities for a certain period in Japan.

Despite of this importance, a quite few studies have been done on bank branching in Japan[5]. Notable exceptions are Horike (1962), Horiuchi and Sasaki (1980), Horiuchi (1981), and Tatsumi (1985). Horike (1962) found a positive relation between increase of branches and the amount of deposits. Finding that the increase of branches of city and regional banks had been smaller than that of mutual banks and that the share of the former two had been decreasing for many years, Horiuchi examined whether or not the share of deposit and the number of branches are positively correlated. However, he did not find an unambiguous relation.

The rest of this paper is organized as follows: in the following section, I briefly survey the history of the branch regulation and make three conjectures which are examined in the subsequent sections. In section 3, a simple model of banks which focuses on the role of branch is developed and the regression equations for testing the effect of regulation are derived from it. The data are explained in section 4. Section 5 discusses the implication of the estimated results. The final section summarizes the conclusions and overviews possible areas of future research.

2. Regulation on Bank Branching in Japan : A Historical Survey

Banking laws including mutual bank law have prohibited the establishment of branches and conversion of their location without the permission of the Minister of Finance (Article 8). Under this article, MOF restricted the number of branches of banks after the Second World War. The alleged purpose was an attempt to avoid excess competition in the banking market. Detailed policies, however, have been frequently revised (see *Okurasho Ginkokyoku Kin'yu Nenpo*, MOF).

Examining branch regulation after 1950s, it is found that the attitude of MOF changed several times. To reflect these changes, the period since 1953 may be divided into six periods (See Table 1)[6]. In the period prior to 1953, which is not shown in Table 1, 1949 marks the turning point in bank branch regulation. Before 1949, new establishments of branches were necessary for the postwar recovery. The government and GHQ encouraged banks to expand their branch networks. However, after 1949 only conversion of branch location was allowed. The rationale was that only efficient branches should continue in operation.

From 1953 to 1962, which I named period I in Table 1, the conversion of branch location was suppressed along with new establishments, since MOF recognized that the ideal branch configuration had been successfully achieved.

The second period began with the so-called "liberalization notifications of administration" announced in April, 1963. The notifications proclaimed that the establishment of new branches would be considered if they contributed to rationalization of bank management as well as an improvement of service to depositors. Thus, the restriction on branching was considerably mitigated. In 1964, MOF announced that it would permit five (four regular and one small) branches per bank in principle. The regulation on location conversion was also relaxed. New branches were permitted if they were not expected to make trouble at new locations.

Meanwhile the movement of the actual number of branches can be summarized with

TABLE 1 CHRONOLOGY OF BRANCH REGULATION

PERIOD	YEARS	REGULATION ON		A	B
		NEW BRANCH	LOCATION CONVERSION		
I	1953-62	PROHIBITED IN PRINCIPLE	PROHIBITED IN PRINCIPLE	1.70	0.84
II	1963-65	RELATIVELY FREE: 5 BRANCHES A YEAR PER BANK IN 1964	RELATIVELY FREE	2.97	1.69
III	1966	COMPLETELY PROHIBITED	COMPLETELY PROHIBITED	0.70	0.44
	1967-68	1 BRANCH A YEAR PER BANK	2 BRANCHES A YEAR PER BANK		
IV	1969-72	1 BRANCH A YEAR PER BANK	RELATIVELY FREE	1.90	1.24
V	1973-78	73-74: 2, 75-76: 1, 77-78: 1.5 BRANCHES A YEAR PER BANK	PROHIBITED IN PRINCIPLE	2.74	1.51
VI	1979-83	SMALL & AUTOMATED BRANCH RECOMMENDED	FREE IN PRINCIPLE	3.29	2.65

1) A=Annual growth rate of the total number of branches
2) B=Averaged number of new branches per year per bank
SOURCE: calculated from ANNUAL REPORT OF BANKING BUREAU, MOF and ECONOMIC STATISTICS ANNUAL, BOJ

two indices, A and B, where A stands for the annual growth rate of the number of branches(%)and B the number of newly established branches per bank per year. They are presented in the final columns of Table 1. Their values were remarkably increased from 1.7% of period I to 2.97% of period II in A, and 0.84 to 1.69 in B.

In 1966, MOF "closed its branch administration", which meant MOF did not receive any application of both new establishments and conversion of location of branches. The reason taken by MOF was that branches had fully increased for the last four years. The restrictive policy continued in principle until 1973, though it was gradually lightened. The period 1966 to 1973 may be devided into two sub-periods according to the regulation of location conversion. While in period III from 1966 to 1968, the change in branch location was limited substantially as before, in period IV from 1969 to 1972, it was allowed to some degree.

Branch regulation was intensively modified in 1973. MOF stated that their aim of the regulation was not to suppress the number, but to realize an ideal configuration of branches. MOF doubled the ceiling of new establishments, continuing prohibition of the locations conversion. Meanwhile, indices A and B increased up to the level of period II (see Table 1). This comovement may be the significant consequences of the modification of the regulation.

MOF adopted a new directive system in 1979 with regard to small and automated branches and permitted each bank to introduce four branches in this category over in two years. Meanwhile, regular branches were restricted to the addition of two branches in the same period. MOF raised the ceiling of the number of new establishments of small and automated branches in the following years. In 1983, MOF deregulated the location conversions, and set the standard for new establishments per bank as follows: one regular branch, four small sub-branches and six automated branches within a two year period, and eight automated cash dispensers (CD)and ATM shops within a one year period.

Several conjectures on branch regulation can be made based on the foregoing survey. First, as indices A and B in Table 1 show, the actual change in the number of branches synchronized with the stringency of the regu-

TABLE 2 RATE OF INCREASE OF BRANCHES

PERIOD	YEARS	A CITY BANKS	A REGIONAL BANKS	A MUTUAL BANKS	B CITY BANKS	B REGIONAL BANKS	B MUTUAL BANKS
I	1953-62	1.82	1.16	2.55	2.63	0.64	0.74
II	1963-65	2.92	3.04	2.90	5.46	1.63	1.06
III	1966-67	0.19	0.95	0.35	0.31	0.65	0.14
	1968-69	n. a.	n. a.	n. a.	n. a.	n. a.	n. a.
IV	1969-72	0.50	2.17	1.99	0.92	1.50	1.06
V	1973-78	1.51	2.97	3.38	2.83	2.20	1.45
VI	1979-83	2.61	3.53	3.41	5.33	3.08	1.79
I-III	1953-67	2.06	1.64	2.63	3.07	0.86	0.76
IV-VI	1969-83	1.34	3.29	3.67	3.00	1.61	1.43
I-VI	1953-67 &1969-83	1.70	2.46	3.15	3.04	1.19	1.10
APPROVED NUMBER OF BRANCHES							
IV-VI	1968-84	1.67	2.92	3.40	3.36	2.49	1.62

1) A=Annual growth rate of the total number of branches
2) B=Averaged number of new branches a year per bank
SOURCE: calculated from ANNUAL REPORT OF BANKING BUREAU, MOF and ECONOMIC STATISTICS ANNUAL, BOJ

lation. This leads to the following conjecture:

Conjecture 1: The regulation has actually limited the number of branches of private banks for most periods.

However, it is important to note that the comovement of the regulation and the change of the number of branches is not the direct evidence of the causation. It may be the case that third factor caused the both phenomena.

Second, MOF set the standard of new establishment of branches on a *per bank basis* and did not proclaim that it considered the bank size when it allotted branches. If this is true, the number of new branches tended to be disproportionately larger for smaller banks. It is apparent, however, that MOF did not allot the standard number of branches automatically, but rather it examined the application of new branches one by one. In the consequence the permitted number of branches dispersed among banks in the wide range (e. g. from zero to six in 1965).

One way to examine whether the regulation favored to smaller banks is to compare the actual growth rates of the branches of city, regional, and mutual banks, since they differ in size. The smallest city bank is slightly larger than the largest regional bank measured in terms of outstanding loans and branches. The average size and number of branches of regional banks are nearly two times of mutual banks.

Indices A and B for each type of banks are shown in Table 2[7]. The movement of index B suggests that MOF did not apply the announced standard regardless of the bank size. It allotted more branches to larger banks than smaller ones. On the other hand, the index A shows that the growth rate of mutual banks is the highest and that of city banks is the lowest. In summary, it is probable that MOF took the size of a bank into consideration in their branch policy decisions but tended to give an advantage to smaller banks.

One might argue, however, that Table 2 only indicates that banks were unequally treated due to their types. To show that this is not the case, I examined whether smaller banks tend to achieve the higher growth rate of the number of branches than larger ones of the same type. Specifically, I estimated the following equation for each type of banks with OLS:

$$T_{1983,i}/T_{1975,i}=a+bT_{1975,i}+u_i,$$

where $T_{1975,i}$ and $T_{1983,i}$ are the number of branches of i-th bank in 1975 and 1983, respectively, so that the dependent variable represents the growth rate of the number of

branches of each bank. u_i stands for a disturbance term. If conjecture 2 is the case, the sign of b should be negative.

Estimates of b were significantly negative for city and regional banks, which implies that the number of outstanding branches is inversely proportional to their growth rate. On the other hand, when the equation was regressed over the mutual banks, b was not significant. Thus, I have,

Conjecture 2: New branches were granted in the manner that favored smaller banks.

Finally, observation of bank management in recent years and the liberalization policy adopted by MOF suggests the following conjecture.

Conjecture 3: The regulation is not binding in recent years.

However, we should note that these preliminary analyses can not clarify whether the observed phenomena were caused by the regulation. We need to consult the economic theory to find if the conjectures are valid.

3. Model

In this section, I specify a model which is utilized to test whether the regulation on bank branching has been binding or not.

Let us introduce the notation of variables:

C: the total operating cost of a bank
T: the number of branches of a bank
B: floor space of a bank
r: rental price of B
N: the number of employees of a bank
w: wage rate
Q: the amount of non-labor input other than building of a bank
p: price of Q
Y: real output of a bank

Since inputs of the bank production consist of labor N, building B, and other capital equipment Q, *the cost identity* is written as

$$C=rB+wN+pQ=T(rb+wn+pq), \quad (1)$$

where b, n and q stand for B/T, N/T, and Q/T, respectively. Note here that (1) is not cost function but merely an identity. (1) does *not* imply that the cost is proportional to the number of branches. As shown below, the cost function is not homogeneous of degree one with respect to the number of branches unless $t=f+g+h$.

I make two assumptions.

Assumption 1: Output of a bank depends on the number of branches as well as the amount of inputs b, n, and q. Thus, bank production function is described as

$$Y=Y(T, b, n, q). \quad (2)$$

The assumption that output is not necessarily proportional to the number of branches is essential to the analysis. The assumption is ad hoc and is desired to have "micro-micro economic foundation". Consider, however, theory of scale economies does not have "micro-micro economic foundation" either.

Assumption 2: A bank minimizes its cost subject to the regulation on the number of branches. Input prices and the level of output are given to the bank.

Under these assumptions, the bank behavior is formalized as

$$\underset{[T,b,n,q]}{\text{Min}}\ C=T(rb+wn+pq) \quad (3)$$

$$s.t.\ Y=Y(T, b, n, q) \quad (2)$$

and $$T\leq \bar{T}, \quad (4)$$

where $\bar{T}$ stands for the approved number of branches.

The first order conditions of the maximization are

$$Tr=z(\partial Y/\partial b), \quad (5)$$

$$Tw=z(\partial Y/\partial n), \quad (6)$$

$$Tp=z(\partial Y/\partial q), \quad (7)$$

$$rb+wn+pq+v=z(\partial Y/\partial T), \quad (8)$$

$$v(T-\bar{T})\leq 0 \text{ with complementary slackness,} \quad (9)$$

and $$Y=(T, b, n, q), \quad (2)$$

where z and v are the Lagrange multipliers corresponding to (2) and (4) respectively.

Binding regulation implies $T^*<\bar{T}$, where T^* stands for the number of branches which a bank desires to have. Then, from (9) it follows that $v=0$, so that optimal b^*, n^*, q^*, T^*, and z can be solved from (5)-(8) and (2) as the function of r, w, and p. Thus, the cost function can be written as:

$$\begin{aligned} C^* &= T^*(Y, r, w, p)[rb^*(Y, r, w, p) \\ &\quad + wn^*(Y, r, w, p) \\ &\quad + pq^*(Y, r, w, p)] \\ &= C(Y, r, w, p). \end{aligned} \quad (10)$$

On the other hand, that the regulation is binding implies $T^*\geq \bar{T}$, so that

$$T=\bar{T}. \quad (9)'$$

Thus, b^*, n^*, q^* and z are obtained by solving (5)-(7) and (2) as a function of r, w, p, Y and $\bar{T}$. The cost function is

$$\begin{aligned} C^* &= \bar{T}[rb^*(\bar{T}, Y, r, w, p) \\ &\quad + wn^*(\bar{T}, Y, r, w, p) \end{aligned}$$

$$+pq^*(\bar{T}, Y, r, w, p)]$$
$$=C(\bar{T}, Y, r, w, p). \quad (11)$$

Now, suppose that the regulation is binding in some year, and that we estimate both functions of (10) and (11). Then, (11) is the correct specification, while (10) is misspecified. Therefore, estimation of (11) should bring better results. On the other hand, if the regulation is not binding, the bank cost is well explained with Y, r, w, and p, so that the addition of branch data does not mean the addition of information. In sum, we can infer whether the regulation is binding or not by comparing the estimation performance of (10) and (11).

We must be careful, however, that the result that the number of branches has significant explanatory power in the regression merely implies that the private banks can not realize their desired number. It does not necessarily imply that the branch regulation causes it. On the contrary, if the coefficient of the number of branches is not significant, this unambiguously implies that the regulation is not binding.

In addition, the power of the test may be weakened if the function is not correctly specified. If some important exogenous variables are not included in the regression, the coefficient of the number of branches may be significant even when the regulation is not binding because it may pick up some explanatory power of hidden variables.

In view of these points, we may argue that the regulation is not binding when the number of branches does not have significant explanatory power, but the converse is not necessarily true. We will discuss the implication of our empirical results in the final section.

Two additional assumptions are made to execute the estimation.

Assumption 3: Real output Y is measured in terms of loans, hereafter denoted as L, which is exogenously determined.

This assumption justifies OLS estimation of the cost functions. The plausibility of the assumption have been disputed in the literature (see Benston (1972)).

The assumption that the loan is exogenously given seems questionable in the long-run. Note that, however, the existence of scale economies contradicts to the endogenous determination of output level. It is easily shown that the second order condition of the profit maximization is not satisfied when economies of scale exist, if markets of output and inputs are competitive (see Lau and Yotopoulos (1971; footnote 21)). Thus, the assumption is reasonable considering the observed scale economies in Japanese banking industry.

Assumption 4: Markets for equipments Q are so competitive that all the banks face the same price. Therefore, p may be excluded from the cross-sectional regressions.

On the contrary, I regard that banks face different rental prices of the land and building of branches. This supposition is reasonable for regional and mutual banks because they are not allowed in principle to build branches out of the prefectures where their main offices are located.

We should specify concrete functional form of the cost function to implement estimation. The following three specifications are adopted.

a) Translog Cost function:

$$\begin{aligned}\ln C = {} & a_0 + a_1 \ln L + a_2 \ln T + a_3 \ln r \\ & + a_4 \ln w + b_1 (\ln L)^2 + b_2 (\ln T)^2 \\ & + b_3 (\ln r)^2 + b_4 (\ln w)^2 \\ & + c_1 (\ln L)(\ln T) \\ & + c_2 (\ln T)(\ln r) \\ & + c_6 (\ln L)(\ln w) \\ & + c_7 (\ln T)(\ln w) \\ & + c_8 (\ln r)(\ln w) \\ & + c_{10} (\ln r)(\ln L) + u_1. \end{aligned} \quad (12)$$

Here u_1 stands for a disturbance term. If the regulation is not binding, then

$$a_2 = b_2 = c_1 = c_2 = c_7 = 0 \quad (13)$$

in (12). Although, translog function has desirable features theoretically, the estimation is seldom immune from multicollinear problem.

b) Cobb-Douglas Cost function:

$$\begin{aligned}\ln C = {} & a_0 + \underset{(+)}{a_1 \ln L} + \underset{(+)}{a_2 \ln T} + \underset{(+)}{a_3 \ln r} \\ & \qquad\qquad (0) \\ & + \underset{(+)}{a_4 \ln w} + u_2, \end{aligned} \quad (14)$$

where u_2 is a disturbance term. Expected signs are shown under each coefficient. If the regulation is not binding, then

$$a_2 = 0 \quad (15)$$

in (14).

Cobb-Douglas cost function suffers a serious problem in the present paper. Since the output elasticities of b, n, q, and T are

constant in Cobb-Douglas function, either of zero or infinite number of branches are optimal for banks depending on the relative intensity of elasticities. To be immune from this strange corner solutions, the following specification is adopted.

c) Modified Cobb-Douglas Cost function:

$$C = a_2 + \underset{(+)}{a_1 \ln Y} + \underset{\substack{(+)\\(0)}}{a_2 \ln T} + \underset{(+)}{a_3 \ln r} + \underset{(+)}{a_4 \ln w} + \underset{\substack{(?)\\(0)}}{a_6 (1/T^2)} + \underset{\substack{(?)\\(0)}}{a_7 (1/T^4)} + u_3, \quad (16)$$

where u_3 represents a disturbance term[8]. If the regulation is not binding, then

$$a_2 = a_6 = a_7 = 0 \quad (17)$$

in (16).

Likelihood ratio test (LR test hereafter) of the null hypotheses (13), (15), and (17) is done to see if the regulation was binding.

4. Data

All the data after 1974 except for some data for r are taken from *Nikkei Financial Data File of Banks*. The sample consists of twelve city banks, sixty-three regional banks, and seventy-one mutual banks[9]. Stock variables such as outstanding loans L, the number of branches T, floor space B, and the number of employees N are measured at the end of fiscal year, while flow variables, such as costs C (=personnel+non-personnel expenses), are annual data. Wage rate w is calculated as (personnel expenses)/(the number of employees).

Three different data are available for r. The first is the rent for private houses at the capital city of each prefecture (hereafter denoted as RP). This is the only data available for the whole period. The second one, PL, is the price of land at the business district by prefecture, which is announced by *Kokudo-Cho* (The National Land Agency) since 1975. The last data, DP, is the ratio of depreciation plus rent of land, building, and computers to area of building, which is calculated for each bank since 1974.

Neither set of data are ideal for the present purpose. As for the former two, it should be pointed out that banks have several branches outside their home prefecture. The discrepancy is fairly large for city banks which form nation-wide network of branches. The latter data also incur a problem: the amount of depreciation stated in the profit and loss table is almost determined by law and may not reflect its actual economic value. Considering these problems, all the equations are estimated with three sets of data as well as without them to check if the conclusions remain to hold.

Before 1974, all the data of mutual banks are taken from *Sogo Ginko Zaimu Shohyo Bunseki* (Analysis of Financial Statement of Mutual Banks), Data of w is not available for 1973 and 1958. Tax is not excluded from costs for 1973 and prior to 1963. The number of samples is 71 or 72.

As for city and regional banks before 1974, data of loans and personnel and non-personnel expenses are taken from *Okurasho Ginkokyoku Kin'yu Nenpo*. Data of the number of employees and branches are taken from *Zenkoku Ginko Zaimu Shohyo Bunseki* (Analysis of Financial Statement of All Banks). In 1973, data of w is not obtaind and tax is not excluded from costs. The number of samples is 13-15 and 61-63 respectively.

5. Results and Discussion

The pooling data method is not appropriate for the current purpose to find whether or not the effect of the regulation changed in any unknown period. Thus, OLS estimation is done biyearly from 1958 to 1962 and annually thereafter.

The estimates of Cobb-Douglas function are reasonable in general (see Table 3). The coefficients of $\ln L$ and $\ln T$ are around 0.6-0.8 and 0.1-0.3 respectively, if significant. The coefficients of $\ln w$ and $\ln r$ have positive signs for most cases. The estimates of modified Cobb-Douglas function are not very different from Cobb-Douglas function (see Table 4). The coefficient of $\ln L$ is also around 0.6-0.8 and those of $\ln w$ and $\ln r$ show positive signs. However, coefficients of $\ln T$ become less significant probably because of the effect of the terms of $1/T^2$ and $1/T^4$ added in this specification. The OLS estimates of translog cost functions seem to be suffered with multicollinear problem: many of estimates are not significant[10]. They are not shown in tables to save space.

The chi-squared values of the likelihood

TABLE 3 ESTIMATES OF COBB-DOUGLAS COST FUNCTION

FY	type of bank	CONST	ln L	ln T	ln w	ln r	$\bar{R}^2$
		?	+	?	+	+	df
1980	city	−1.403	0.609	0.327	1.015	0.011	0.914
		−0.80	6.87	1.87	1.81	0.11	7
	regional	−2.250	0.663	0.265	0.850	0.0773	0.986
		−2.25	15.84	3.97	6.91	1.58	58
	mutual	−3.139	0.787	0.0996	0.493	0.144	0.970
		−6.62	14.90	1.15	2.95	2.39	65
1975	city	−1.160	0.719	0.185	0.129	0.056	0.946
		−1.23	8.63	1.32	0.37	0.81	7
	regional	−3.120	0.735	0.124	1.044	0.145	0.981
		−7.14	18.64	1.97	7.93	3.24	58
	mutual	−3.924	0.878	0.0435	0.542	0.157	0.988
		−14.1	28.48	0.89	4.95	4.65	65
1970	city	−1.500	0.767	0.135	0.0834	0.0135	0.976
		−1.97	11.23	0.87	0.20	0.18	9
	regional	−1.752	0.651	0.275	0.767	0.103	0.973
		−4.48	13.64	3.86	4.15	2.35	56
	mutual	−1.872	0.634	0.343	0.661	0.129	0.978
		−5.98	19.27	6.65	4.88	3.27	67
1965	city	−3.091	0.828	0.0518	−0.743	0.146	0.938
		−0.94	6.58	0.32	−0.85	0.50	7
	regional	−1.499	0.683	0.168	0.969	0.137	0.983
		−3.86	17.05	2.92	6.04	3.83	58
	mutual	−0.843	0.738	0.127	0.820	−0.012	0.982
		−2.28	22.58	2.62	6.84	−0.30	67
1960	city	−0.601	0.622	0.381	0.308	−0.005	0.939
		−0.42	8.35	3.50	0.55	−0.51	7
	regional	−0.458	0.636	0.172	1.027	0.120	0.978
		−1.09	15.71	2.94	7.43	2.94	59
	mutual	−1.005	0.823	0.0531	0.741	−0.047	0.972
		−2.08	21.08	1.05	6.09	−1.09	67

1) t-values are shown under coefficients.
2) r stands for rent of private house(RP)
3) df and $\bar{R}^2$ stand for degrees of freedom and adjusted muliple correlation coefficient, respectively.

ratio test(LR test) are presented in Tables 5-7, where RP is used as the data of r. The values vary with the period as well as the type of banks, which suggests that the effect of the branch regulation varies as well.

According to the result based on Cobb-Douglas function which is shown in Table 5, the null hypothesis that the regulation is not binding is not rejected for mutual banks from 1958 to 1964 and after 1974. It is not rejected for regional banks for 1966-67 and ambiguous for 1973-75. As for city banks, it is not rejected for 1962-73 and ambiguous thereafter. "Ambiguous" here means that it is rejected at 5% significance level for LR test and not rejected at 1% significance level.

Estimation of modified Cobb-Douglas cost function gives similar results in general except that the null hypothesis is rejected after 1972 for city banks and after 1968 for regional banks at 1% significant level(see Table 6).

Results of translog cost function are quite similar to those of Cobb-Douglas function for regional and mutual banks[11]. Only the difference is that the null hypothesis (13) becomes rejected in 1963 and 64 for mutual banks(see Table 7)[12]. City banks are not estimated because of the lack of degree of freedom.

Considering the defects of the data r, I estimated the equations excluding the variable r. The results are quite similar to those in Tables 5-7. Only the notable difference is that the null hypothesis is not rejected in the case of translog cost function for mutual banks after 1979. I also implemented the estimations with DP and PL as the data of r

TABLE 4 ESTIMATES OF MODIFIED COBB-DOUGLAS COST FUNCTION

FY	type of bank	CONST	ln L	ln T	ln w	$1/T^2$	$1/T^4$	ln r	$\bar{R}^2$
		?	+	?	+	?	?	+	df
1980	city	35.482	0.881	−6.01	0.672	-3.6×10^5	4.8×10^9	−0.753	0.975
		3.77	11.20	−3.62	1.43	−4.12	4.29	−1.22	5
	regional	−2.348	0.652	0.316	0.824	320.8	-3.3×10^5	0.0802	0.986
		−3.79	15.97	2.75	6.36	0.86	−1.44	1.66	56
	mutual	−3.936	0.774	0.351	0.492	317.7	−53700.	0.121	0.972
		−6.62	15.01	2.49	3.03	1.84	−1.45	2.03	63
1975	city	5.618	0.799	−1.13	0.411	−79713	9.6×10^8	0.053	0.975
		−0.56	12.89	−0.65	1.07	−1.03	1.27	1.13	5
	regional	−2.687	0.718	0.119	0.959	120.2	-1.8×10^5	0.140	0.984
		−3.98	19.26	1.08	6.92	0.42	−1.34	3.35	56
	mutual	−4.043	0.877	0.0802	0.533	37.55	−4739.	0.154	0.986
		−10.8	27.92	0.89	4.43	0.48	−0.46	4.37	63
1970	city	−44.01	0.822	7.326	0.151	1.9×10^5	-1.2×10^9	−0.053	0.978
		−1.57	11.41	1.54	0.38	1.45	−1.37	−0.62	7
	regional	−1.027	0.623	0.178	0.616	−147.9	−29677	0.121	0.975
		−1.61	13.06	1.33	3.21	−0.51	−0.26	2.72	54
	mutual	−1.615	0.641	0.262	0.686	−28.18	896.	0.127	0.978
		−3.57	18.81	2.61	4.93	−0.48	0.20	3.11	65
1965	city	−22.62	0.884	3.251	−0.929	74946	-3.9×10^8	0.167	0.926
		−0.45	4.52	0.41	−0.88	0.35	−0.30	0.52	5
	regional	−1.224	0.680	0.106	0.914	−119.6	22974	0.144	0.982
		−2.53	16.70	1.20	5.34	−0.97	0.91	3.85	56
	mutual	−0.288	0.741	−0.0358	0.868	−75.49	2976	0.004	0.984
		−0.74	23.7	−0.51	7.60	−3.15	2.89	0.11	65
1960	city	−9.072	0.651	1.770	0.309	32343	-1.6×10^8	−0.047	0.923
		−0.66	6.96	0.76	0.43	0.65	−0.68	−0.38	5
	regional	−0.55	0.656	0.135	1.069	13.18	−1647.	0.135	0.978
		−1.16	15.50	1.57	7.40	0.25	−0.58	3.20	57
	mutual	−0.484	0.813	−0.056	0.813	−46.12	1220.	−0.02	0.978
		−1.03	22.91	−0.78	7.38	−3.46	4.08	−0.56	65

1) t-values are shown under coefficients.
2) r stands for rent of private house (RP)
3) df and $\bar{R}^2$ stand for degrees of freedom and adjusted multiple correlation coefficient, respectively.

since 1974 and 1975 respectively. The results are in concord with those presented above. In sum, the results are not very sensitive to the specification and the choice of the data of the rental price of the floor space.

How these LR test results can be related to the attitude of MOF? Tables 5-7 show that the null hypothesis is rejected in period II for regional banks and accepted in period III for city and regional banks. At a glance, these results seem to contradict to the fact that MOF slackened the rein in period II and tightened it in period III. However, if we consider that MOF adopted the policy in which it changed the situation gradually in a couple of years to avoid possible disorder, it is not difficult to interpret the test results with the change of the branch regulation.

Index A in Table 2 suggests that regional and city banks were strictly restricted in period I while mutual banks had already been considerably liberalized. Therefore it is not surprising that the null hypothesis is not rejected for mutual banks in period I. The liberalization in period II probably aimed regional and city banks because index A jumped up sharply for them from period I to II but not for mutual banks. Noting that the liberalization was not full-deregulation but the relaxation of the ceiling of the regulation, it is not sensible to suppose that MOF accepted whatever private banks wanted to build. Thus, it is natural that it took two years for regional banks to achieve their desired number of branches so that the null hypothesis is rejected in period II for regional banks.

Some of the newly admitted branches in

TABLE 5 LIKELIHOOD RATIO TEST OF EQ.(15) : COBB-DOUGLAS COST FUNCTION

FY	PERIOD	CITY BANKS	REGIONAL BANKS	MUTUAL BANKS	TOTAL
1958	53-62 I	11.550**	6.680**	2.388	
1960	(restricted	12.121**	8.738**	1.180	
1962	period)	2.882	21.576**	0.175	
1963	63-65 II	15.655**	11.599**	1.305	
1964	(free	3.864*	14.954**	2.371	
1965	period)	0.173	8.651**	7.005**	
1966	66-68 III	0.606	3.556	12.177**	
1967	(prohibited	0.532	2.427	9.562	
1968	period)	2.089	6.483*	15.769**	
1969	69-72 IV	0.407	14.371**	26.072**	
1970		1.134	14.380**	36.482**	
1971		1.721	11.366**	20.989**	
1972		1.711	10.130**	15.622**	
1973	73-78 V	3.771	4.700*	4.882	
1974		4.701*	3.871*	3.280	
1975		2.663	4.102*	0.849	
1976		3.183	8.154**	0.217	
1977		4.317*	9.560**	0.923	
1978		6.347*	11.211**	1.201	
1979	79- VI	7.114**	17.141**	1.121	
1980		4.876*	15.115**	1.424	
1981		4.241*	17.974**	3.264	
1982		3.550	21.711**	4.194*	
1983		4.277*	30.183**	8.263**	
1984		4.689*	27.981**	18.612**	
Rejection Rate		11/24=46%	22/24=92%	12/24=50%	45/72=62%

1) ** denotes the null hypothesis is rejected at 1% level
   * denotes the null hypothesis is rejected at 5% level
2) rent of private house(RP) is used as the data of r
3) $\chi^2(1)=3.842(5\%), 6.635(1\%)$

period II were built in the subsequent years in period III. In view of this, the result that the null hypothesis is not rejected in period III for regional banks seems reasonable[13]. Since MOF regulates the number of new establishment, not the outstanding number of branches, and it has never assigned the reduction of branches, this interpretation is convincing.

In a word, it makes sense to think that the statistical results that the null hypotheses (13),(15), and (17) are not rejected in mid-1960s and strongly rejected around 1970 related to the change of the regulation by MOF. "The liberalization of administration" in the second period brought about the desired number of branches in 1966-67 and restrictive regulation in period III recovered the effect of regulation in 1968.

How can I derive some insights to the conjectures presented in section 2? LR test shows that the number of branches has significant explanatory power in many cases. The null hypothesis that the number of branches has no explanatory power was rejected at 5% level in 45 cases out of total 72 regressions(62%) in the case of Cobb-Douglas cost function, 56 out of 72(78%) for modified Cobb-Douglas, and 34 out of 48(70%) for translog cost function. For regional banks, among others, the hypothesis has been rejected except for 1966 and 1967. Thus, conjecture 1 is confirmed in general.

As for conjecture 2, it is apparent that the results of LR test differ among banks. Specifically, the pattern of the LR test results for mutual banks is considerably different from regional and city banks. While the null hypothesis is rejected for 1965-72 and accepted for other periods for mutual banks, the opposite results are obtained for city and regional banks(see Table 5). On the other

TABLE 6 LIKELIHOOD RATIO TEST OF EQ.(17) : MODIFIED COBB-DOUGLAS COST FUNCTION

FY	PERIOD	CITY BAKS	REGIONAL BAKS	MUTUAL BANKS	TOTAL
1958	53-62 I	12.996**	8.416*	4.686	
1960	(restricted	13.298**	11.336*	19.372**	
1962	period)	3.905	22.041**	0.543	
1963	63-65 II	18.911**	12.452**	5.643	
1964	(free	7.483	15.679**	7.969*	
1965	period)	2.078	9.708*	17.502**	
1966	66-68 III	2.485	6.200	18.830**	
1967	(prohibited	4.090	6.150	13.514**	
1968	period)	21.805**	18.338**	21.421**	
1969	69-72 IV	8.104*	18.523**	29.048**	
1970		6.162	20.564**	38.471**	
1971		8.102*	18.843**	22.085**	
1972		20.418**	17.667**	17.515**	
1973	73-78 V	13.457**	16.163**	6.248	
1974		14.540**	22.512**	3.748	
1975		16.120**	15.820**	1.118	
1976		15.021**	23.042**	1.406	
1977		19.098**	22.695**	4.079	
1978		23.662**	21.275**	6.405	
1979	79- VI	20.817**	22.244**	9.330*	
1980		23.702**	21.420**	7.668	
1981		14.268**	28.302**	8.517*	
1982		17.300**	33.043**	10.096*	
1983		20.717**	35.869**	14.595**	
1984		28.012**	32.216**	22.686**	
Rejection Rate		18/24=75%	22/24=92%	15/24=63%	56/72=78%

1) ** denotes the null hypothesis is rejected at 1% level
   * denotes the null hypothesis is rejected at 5% level
2) rent of private houst(PR) is used as the data of r
3) $\chi^2(3)=7.815(5\%), 11.345(1\%)$

hand, if I focus on the rejection rate of the null hypothesis, mutual and city banks are similar each other. The rate is around 90% for regional banks while 50-60% for city and mutual banks(see Tables 5 and 6)[14]. Thus, comparing the rejection rates of mutual and regional banks, I may conclude that the regional banks have been regulated more strictly, which implies smaller banks have been treated more generously. However, it is not certain that the same statement is confirmed comparing mutual and city banks.

As for conjecture 3, the regulation is shown to be less restrictive to mutual banks for periods V and VI. This is consistent with conjecture 3 that the regulation became less binding in recent years. However, the regulation to regional and city banks is still binding for the recent period. Some results, e. g. those with DP as the data of r, indicate that it becomes binding again for mutual banks in period VI.

Two interpretations are possible for this result. One is that it actually shows that the regulation becomes restrictive again in period VI. The new regulation tries to distort the branching policy of private banks so as to increase small or automated branches and restrict ordinary ones. Indeed, ceiling on ordinary branches is quite low : only one new establishment is allowed per two years. Thus, although it is commonly believed that the branch regulation has been drastically liberalized since 1979, it might contradict to what private banks desire.

The other interpretation is that the result in period VI is biased and unreliable. Three reasoning are possible for this interpretation. First, as noted in section 3, the rejection of the null hypothesis does not necessarily imply

TABLE 7 LIKELIHOOD RATIO TEST OF EQ.(13) : TRANSLOG COST FUNCTION

FY	PERIOD	REGIONAL	MUTUAL	TOTAL
1958	53-62 I	19.024**	9.926	
1960	(restricted	13.423*	9.701	
1962	period)	38.530**	5.641	
1963	63-65 II	25.962**	15.467**	
1964	(free	28.559**	12.047*	
1965	period)	17.869**	15.516**	
1966	66-68 III	9.069	25.193**	
1967	(prohibited	9.886	19.253**	
1968	period)	8.088	21.645**	
1969	69-72 IV	15.938**	33.776**	
1970		13.632*	57.261**	
1971		13.810*	39.137**	
1972		9.454	27.183**	
1973	73-78 V	13.840*	3.787	
1974		8.883	11.343*	
1975		15.301**	10.360	
1976		6.880	7.087	
1977		16.008**	5.515	
1978		18.826**	5.833	
1979	79- VI	20.239**	12.387*	
1980		15.885**	19.370**	
1981		21.344**	11.885*	
1982		24.991**	13.017*	
1983		28.126**	20.606**	
1984		20.597**	28.641**	
Rejection Rate		18/24=75%	16/24=67%	34/48=71%

1) ** denotes the null hypothesis is rejected at 1% level
   * denotes the null hypothesis is rejected at 5% level
2) RENT OF PRIVATE HOUSE(RP) is used as the data of r
3) $\chi^2(5)=11.07(5\%), 15.09(1\%)$

binding regulation. Second, since banks, especially larger banks, diversify their assets as well as the source of funds in 1980s, the outstanding loan might fail to represent the output of banks very well. Some variables which measure the foreign exchange activity and operation of fund in money markets might be necessary. Third, biases may also be created by the use of the total number of branches and sub-branches. Although the present paper assumes that branches are homogeneous, the types of branches are quite diversified in period VI. Furthermore, the installment of CD and ATM outside branches was deregulated in 1983. Since our data of T does not include them, the results after 1983 may be biased.

In sum, it is not safe to derive the definite conclusion that the regulation is still valid for city and regional banks without examining these elements.

6. Concluding Remarks

I examined the effect of branch regulation by means of the estimation of bank cost function. Our main conclusions may be summarized as follows:

(1) The number of branches has been controlled by MOF for the most of the periods. For example, regional banks could not realize their desired number of branches except for mid-1960s.

(2) The regulation has been carried out discretionary among different types of banks. Mutual banks have been treated more generously than regional banks except for 1965-72.

(3) The branch regulation has less restrictive since 1973 for mutual banks. It still restricts, however, regional banks and probably city banks.

One might argue that the results of the LR test merely indicate whether land and buildings are fixed factors for banks, but tell nothing about regulation. I do not agree with this opinion by the following reasons. First, I found that the null hypothesis is not rejected in some cases. As I mentioned in section 3, this result does imply that the regulation was not binding in that year, although the converse is not necessarily true.

Second, I found that the results of the statistical tests differ systematically depending on type of banks and the estimation periods. The pattern of the test outcome is generally in agreement with the change of the branch regulation.

Third, while the number of branches was shown to be fixed input for regional and city banks since 1979, the floor space of branch was turn out not to be fixed input for any type of banks since 1974[15]. If we adopted the view that the rejection of the null hypothesis is not caused by binding regulation but by incomplete adjustment of construction of branches, we should have concluded that the adjustment of the floor space was completed while that of the number was not. This is an awkward conclusion. On the other hand, it is reasonable to interpret the result that the number was controlled by MOF but the floor space was not.

There remain a number of problems in this paper. As for the theoretical framework, dynamic feature of the investment decision is desired to be embedded in the model. Such an extension may help distinguishing the effect of the regulation from incomplete adjustment of fixed inputs.

The present paper focuses on analyzing the domestic branches. Since overseas businesses become more important in recent years, the analysis of overseas branches is interesting. The regulation on them might be more rigid than before. I did not investigate whether location conversion of bank branches has been effectively regulated. I hope that these problems will be solved in future works.

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Footnotes

1) Temporary Interest Rate Adjustment Law puts the ceiling of deposit interest rates since 1947. BOJ sets the effective guideline below the ceiling rates.

2) In 1985, the media reported that Kyowa Bank, a smaller city bank, decided to reduce its number of branches by twentyfive in a three year period. This was equivalent to 10% reduction of all its branches. Probably, Kyowa Bank voluntarily chose to reduce its branch network. The decision is attributable, in part, to its many branches relative to its size, and the fact that its profit rate and efficiency is lower than other city banks. The drastic change could also reflect a general transition of branch management undergone secretly.

3) Japanese banking industry is regarded as having scale economies to some degree. See Nishikawa(1972), Royama and Iwane(1973), Kuroda and Kaneko(1986), Noma and Tsutsui(1987 a, b), and Yoshioka and Nakajima(1987).

4) Most of mutual banks have been transformed into so-called second regional banks since 1988.

5) Asking the effect of branching on the efficiency of banks is a conventional question in the U. S.. As is well known, the regulation on the branching differs among states: about 1/3 of the states adopt the unit banking, the others allow multiple branches. The diversity of the branch regulation naturally causes the question "which organizational form, unit or branch, for the banking industry best serves the public welfare"(Benston(1965)). However, they have never inquired whether or not the regulations were binding. In the most cases, the efficiency of branches has been investigated through the estimation of cost function. For example, Benston(1965) used dummy variables representing the number of branches in the cost functions. Powers(1969) estimated cost functions over the samples stratified into branch-and unit-banks and compared the results. Benston et al. (1983) adopted the number of offices as an independent variable in the translog cost function and estimates it over branch- and unit- state banks. See also Greenbaum(1967), Benston(1972), Longbrake and Haslem(1975), Sherman and Gold(1985), and Nelson(1985). Their main findings were 1) unit bank of a given size is more efficient than a branch bank of the same size, *ceteris paribus*, and 2) merging several unit banks into one branch bank results in lower operating costs because of the scale economies. However, some studies do not support them: e. g. Benston et al.(1983) finds that "the cost structures between branch and unit state banks are very similar".

6) The following paragraphs are mainly based on Kobayashi(1973).

7) We should be very careful in interpreting the figures in Table 2, because they are marred with the following two problems. First, mergers among different types of banks and conversions from one type to another make it difficult to find the appropriate measure of the growth rate of each type of banks. Secondly, figures in Table 2 represent the actual increase of branches and are not necessarily in agreement with the approved number. Data of the approved number of new establishments, which are immune to the defects, are available to us only for 1968-84(the periods IV-VI). A and B with the approved number are shown at the last row in Table 2, which show the same tendency as the realized number.

8) Modified Cobb-Douglas cost function is derived from the production function:

$$Y=a(T+\frac{\alpha}{T})^{t}b^{f}n^{g}q^{h},$$

where α represents some constant.

9) Bank of Tokyo is excluded from samples, since it is specialized in foreign exchange.

10) There is no restriction on translog cost function since the price of capital is assumed to be constant. I also perform the FIML estimation of translog cost function and share equations of the personnel expenses and expenses of building for the period of 1974-84. See footnote 11.

11) According to the FIML estimation, the regulation is shown to be binding for all cases. I suspect that the supposed share equation of the expenses for land and buildings is unreliable.

12) We should note that the results may be unreliable because of the multicollinearity.

13) The situation can not be analyzed with the model of the present paper because it assumes that the optimal number is always realized if the regulation is not binding. We need to allow lags in MOF's reaction as well as time to build the branches. However, the nature of the problem seems more complex. For example, suppose that branches of the whole banking become excessive because of exogenous decline of the loan demand. Then, individual bank does not want to reduce its branches which results in the decrease of the share and therefore not profitable, unless MOF assigns the reduction quota to each bank evenly. In order to analyze this situation fully, it seems necessary to consider non-cooperative game among private banks and show the possibility of "prisoner's dilemma" where private banks have relatively excess branches compared with the Pareto optimum equilibrium. The restrictive branch regulation plays the role of helping the banks to move to a Pareto superior equilibrium.

14) The difference between regional and mutual banks is narrowed in the estimation of translog cost function: 75% of regional banks vs. 70% of mutual banks.

15) In the case that the floor space is regulated as well as the number of branches, the cost function becomes

$$\ln C_v=d_0+\underset{(+)}{d_1}\ln L+\underset{(?)}{d_2}\ln T+\underset{(+)}{d_3}\ln w+\underset{(0)}{d_4}\ln r+\underset{(-)}{d_5}\ln b+u_4,$$

where $C_v=wn+pq$.

If d_4 is zero and d_5 is negative, it may be concluded that the regulation on the floor space is binding. Estimating the equation for each type of banks since 1974, the coefficients of $\ln r$ and $\ln b$ were turned out to be significantly positive in most cases. This contradicts to the hypothesis that floor space of branches is also regulated.

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