Efficiency in the Japanese trust banking industry: A stochastic distance function approach

Yamori, Nobuyoshi and Harimaya, Kozo

Nagoya University

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Nobuyoshi Yamori[a,*] and Kozo Harimaya[b]

[a] Nagoya University, Furo-cho Chikusaku Nagoya Aichi 464-8601, Japan

[b] Sapporo Gakuin University, Bunkyo-dai Ebetsu Hokkaido 069-8555, Japan

Abstract

This paper aims to assess the technical efficiency of Japanese trust banks by using the stochastic distance function approach, which is suitable for analyzing complex trust banks but has never applied for Japanese trust banks. Although the trust banking industry has been one of the most restricted financial sectors in Japan, it has recently been deregulated, particularly in terms of entry restrictions. Most noteworthy was the approval of the entry of the foreign-owned trust banks that represented the financial liberalization at that time. The traditional theory expects that allowing new entry makes market more competitive and therefore players become more efficient to survive. Therefore, it is interesting to investigate whether the liberalization made Japanese banks more efficient. The results indicate that the traditional domestic trust banks possess a technical efficiency superior to new entrants (i.e., foreign-owned trust banks). However, we failed to find an apparent tendency for trust banks to be more efficient now than in the pre-liberalization period.

Keywords: Japanese trust banking industry; Deregulation; Foreign-owned banks; Technical efficiency

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* *Corresponding author*. E-mail: *yamori@soec.nagoya-u.ac.jp*

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１． Introduction

As is generally known, the Japanese financial market was a highly regulated one. In order to promote financial market reforms, the Hashimoto Cabinet initiated the Japanese version of the Financial Big Bang in 1996. However, since the 1980s, financial deregulation and liberalization have been gradually implemented. The first event in this trend was that entry barriers into the trust banking industry were relaxed in the mid-1980s. Until then, only seven domestic trust banks had chiefly dominated the trust banking business in Japan. However, in May 1984, due to pressures from other countries towards liberalization, foreign banks were granted permission to enter the trust banking business through establishing a locally incorporated firm; thereafter, nine foreign-owned trust banks were incorporated upon meeting the standards of approval. Furthermore, following the passing of the Financial Systems Reform Law in 1992, other financial institutions were allowed to set up trust subsidiaries. Almost all large securities companies and city banks incorporated trust subsidiaries successively; the number of trust subsidiaries reached 18 at the peak.

Among the Japanese financial institutions, trust banks are unique in the specialty business; in addition to the conventional commercial banking services, many asset management services, which include both trust businesses and real estate operations (e.g. brokerage or appraisal services), are permitted. This led the other Japanese financial institutions, such as city banks, insurance companies, and securities companies, to consider the trust banking business as being very lucrative. In particular, at that time, the corporate pension markets were expected to expand; therefore, it is possible that the prime motivation for the new entrants into the trust banking business was to manage a lucrative business[1].

However, due to the recent wave of financial consolidation, there has been a decrease in the number of trust banks. The 'traditional' domestic trust banks have been consolidated into four banks, and most of them are now allied with major bank groups. In addition, it is noteworthy that there are some foreign-owned trust banks that have withdrawn operations in Japan; the number of foreign-owned trust banks has decreased by four as of March 2007.

The study aims to empirically investigate whether the liberalization in trust banking markets made trust banks more efficient. For the estimation of the efficiency measures, the stochastic frontier cost functions have been widely used in the recently published literature on banking, However, this approach has a disadvantage: the mandatory requirement of obtaining the data set pertaining to total costs, outputs, and input prices. This is because detailed financial statements for each foreign-owned trust bank and trust subsidiaries are very difficult to acquire, particularly the data pertaining to segment expenses, which are required to calculate input prices. In order to overcome the aforementioned difficulties, this study employs the stochastic distance function approach[2]. Since this approach is expressed as a function of outputs and inputs, the efficiency measures estimated from this procedure can be held as being convenient and functioning relative indexes, thereby indicating technical efficiency. In the duality theory, under certain conditions, an input distance function is dual to a cost frontier and an output distance function is dual to a revenue frontier. In the majority of empirical distance function analyses, it is common to select either output or input orientation ex ante. Since there are very few studies investigating the efficiency of trust banks in Japan, there is no definite choice of an appropriate orientation. To deal with the above-mentioned limitation, this study employs an approach that estimates both output and input distance functions and compares the results with each other.

The remainder of this study is organized as follows. Section 2 presents the methodology adopted in this study for the measurement of the efficiency levels; section 3 describes the data; section 4 discusses the empirical results; and section 5 summarises and concludes the study.

2. Methodology

With regard to the efficiency measures, it would be very difficult to choose an appropriate measurement methodology, particularly for describing a production technology. The advantages of output and input distance functions, which are employed in this study, include permitting the modelling of a multi-input, multi-output production process without price information. Therefore, when the standard assumption of firms operating in a perfectly competitive market is considered to be unrealistic, it is appropriate to employ these distance functions.

As noted by Fare and Primont (1995), the output distance function is generally based on the following definition of the production technology of the firm: the output set expressed as $P(x)$ represents the set of all output vectors $y \in R_+^M$ that can be produced using the input vector $x \in R_+^K$. The production technology is assumed to satisfy the standard axioms, such as convexity and disposability. The output distance function $D_o(x, y)$ is then defined as follows:

$$D_O(x, y) = \min\{\theta > 0; \frac{y}{\theta} \in P(x)\}, \tag{1}$$

where y and x are M outputs and K inputs, respectively. The output distance function is non-decreasing, positively linearly homogeneous, and convex in outputs; however, in inputs, it is decreasing. Thus, this function can be interpreted as the maximum radial expansion of outputs, holding the inputs constant[3]. The output distinction function $D_o(x, y)$ will take a value that is less than or equal to one if each output is an element of the feasible production set, expressed as $P(x)$; thus, if all output vectors are located on the upper boundary of the production set, it will have a value of unity. Therefore, the magnitude of $1/\theta$ in (1) represents a radial expansion of outputs that is required to attain the production frontier.

For the functional form of the distance function, the popular translog form is employed in this study. Further, just as in Lovell *et al.* (1994), a restriction of linear homogeneity in outputs is imposed on the function. Homogeneity implies that $D_o(x, \mu y) = \mu D_o(x, y)$, where $\mu > 0$; thus, if one of the outputs, for example, the qth output, is arbitrarily selected, μ can be set as $1/y_q$. Accordingly, the translog output distance function can be expressed as follows:

$$\ln(D_{Oi} / y_{qi}) = \alpha_0 + \sum_{j=1}^{K} \alpha_j \ln x_{ji} + \sum_{l=1}^{M-1} \beta_l \ln y_{li}^* + \frac{1}{2} \sum_{j=1}^{K} \sum_{k=1}^{K} \alpha_{jk} \ln x_{ji} \ln x_{ki}$$

$$+\frac{1}{2}\sum_{l=1}^{M-1}\sum_{h=1}^{M-1}\beta_{lh}\ln y_{li}^{*}\ln y_{hi}^{*}+\sum_{j=1}^{K}\sum_{l=1}^{M-1}\rho_{jl}\ln x_{ji}\ln y_{li}^{*},$$

$$i=1,2,\ldots,N, \tag{2}$$

where $y_l^* = y_l/y_q$, and α, β, and ρ are the coefficients to be estimated. By the restriction of linear homogeneity in outputs, the summations of all the terms involving the qth output become zero; thus, the summations involving the qth output in the above-mentioned expression are over M–1, not over M. Based on Young's theorem, the symmetry conditions are also imposed on the second-order parameters in (2), that is, $\alpha_{jk} = \alpha_{kj}$ for all j and k and $\beta_{lh} = \beta_{hl}$ for all l and h.

By using TL (.) to represent the translog function, this equation may be more concisely expressed as

$$\ln D_{Oi}-\ln(y_{qi})=TL(x_i, y_i / y_{qi}, \alpha, \beta, \rho),$$

$$i=1,2,\ldots,N, \tag{3}$$

and hence,

$$-\ln(y_{qi})=TL(x_i, y_i / y_{qi}, \alpha, \beta, \rho)-\ln D_{Oi},$$

$$i=1,2,\ldots,N, \tag{4}$$

Furthermore, by appending a symmetric error term v_i to account for statistical noise, and rewriting ln D_{oi} as u_i, the stochastic output distance function can be obtained.

$$\ln(y_{qi})=-TL(x_i, y_i / y_{qi}, \alpha, \beta, \rho)+v_i-u_i,$$

$$i=1,2,\ldots,N, \tag{5}$$

where v_i is the normally distributed error term and u_i is the one-sided inefficiency term that assume take one of several distributional forms. Following previous studies on banking that employ the stochastic cost function, Altunbas *et al*. (2000), the distribution of inefficiency is specified to be half-normal in this study.

Following the stochastic frontier approach, the estimation of this model is carried out through the maximum likelihood procedure. The predicted value of the output distance function for each efficiency is estimated as the exponent of the negative of the error term (i.e. exp($-u_i$)), which is not directly observable. However, as proposed by Jondrow *et al*. (1982), it is taken as the conditional mean or mode of the distribution of the inefficiency term on the composed error term (i.e. v_i-u_i in Eq. (5)).

The input distance function is defined similarly. However, in contrast to the output distance function with the input vector held fixed, it considers by how much the input vector may be proportionally decreased holding the output vector constant. By using the input set expressed as $L(y)$, the input distance function can be expressed as follows:

$$D_I(x, y) = \max\{\rho > 0; \frac{x}{\pi} \in L(y)\}, \tag{6}$$

where the input set $L(y)$ represents the set of all input vectors $x \in R_+^K$, which can produce the output vector $y \in R_+^M$. The input distance function is non-decreasing, positively linearly homogeneous, and convex in inputs; however, it is increasing in outputs. Thus, this function can be interpreted as the minimum radial reduction of inputs with the outputs held constant. The distinction function $D_I(x, y)$ will take a value that is greater than or equal to one if each input is an element of the feasible input set, expressed as $L(y)$. The magnitude of $1/\pi$ in (6) represents a radial reduction of inputs, which is required to reach the inner boundary of the input set.

After imposing linear homogeneity in inputs, which implies that $D_I(\omega x, y) = \omega D_I(x, y)$, where $\omega >$ 0, the translog input distance function can be expressed in a similar manner.

$$\ln(D_{Ii} / x_{qi}) = \alpha_0 + \sum_{j=1}^{K-1} \alpha_j \ln x_{ji}^* + \sum_{l=1}^{M} \beta_l \ln y_{li} + \frac{1}{2}\sum_{j=1}^{K-1}\sum_{k=1}^{K-1} \alpha_{jk} \ln x_{ji}^* \ln x_{ki}^*$$

$$+ \frac{1}{2}\sum_{l=1}^{M}\sum_{h=1}^{M} \beta_{lh} \ln y_{li} \ln y_{hi} + \sum_{j=1}^{K-1}\sum_{l=1}^{M} \rho_{jl} \ln x_{ji}^* \ln y_{li},$$

(7)

where $x_j^* = x_j/x_q$. By the restriction of linear homogeneity in inputs, the summations of all the terms involving the qth input become zero. Following steps similar to those explained previously, this equation may be more concisely expressed as:

$$\ln D_{Ii} - \ln(x_{qi}) = TL(x_i / x_{qi}, y_i, \alpha, \beta, \rho), \quad i = 1, 2, \ldots, N, \qquad (8)$$

and hence,

$$-\ln(x_{qi}) = TL(x_i / x_{qi}, y_i, \alpha, \beta, \rho) - \ln D_{Ii}, \quad i = 1, 2, \ldots, N. \qquad (9)$$

Furthermore, similar to the stochastic output distance function in (5), the stochastic input distance function can be described as follows:

$$\ln(x_{qi}) = -TL(x_i / x_{qi}, y_i, \alpha, \beta, \rho) + v_i + u_i, \quad i = 1, 2, \ldots, N. \qquad (10)$$

Now, the inefficiency term has changed from $-u_i$ to $+ u_i$ due to the difference in the definitions of each distance function. This model is also estimated through the maximum likelihood procedure by specifying the distribution of inefficiency as half-normal. The observation-specific estimates of the inefficiency are also calculated in a similar manner.

Since both inputs and outputs appear as regressors in the distance functions, there remains the possibility of a simultaneous equation bias. In other words, with regard to the output (input) distance functions, the inputs (outputs) should be treated as exogenous and the outputs (inputs) would be endogenous. However, as noted in Cuesta and Orea (2002), by using the normalization with one of the outputs (inputs), output (input) ratios appear as regressors and these ratios may be assumed to be exogenous.

3. The data and specification of inputs and outputs

In the previous studies on Japanese banks, the domestic trust banks were conveniently included in the sample (see, e.g. Tachibanaki *et al.*, 1991; Fukuyama, 1995; Drake and Hall, 2003; and Solomon, 2006) [4]. However, it should be noted that the inclusion of trust banks in the complete data set causes a grave problem. The reason lies in the segregation of duties due to which a trust bank (inclusive of foreign-owned trust banks) is obliged to isolate trust property from the bank-owned assets, thereby creating a necessity of setting up a trust account apart from a banking account. Nevertheless, the previous literature has not sufficiently considered the trust bank behaviour reflected in such trust accounts[5]. As a result, this study is focuses only on financial institutions that are engaged in the trust banking business. Therefore, the sample in this study comprises traditional domestic trust banks, foreign-owned trust banks, trust subsidiaries, and a few other financial institutions; it excludes commercial banks[6].

As regards the specification of the inputs and outputs, this paper comprehensively assumes that trust banks behave solely for the purpose of earning profit[7]. Thus, based on the trust banks' twofold balance sheet pertaining to the trust and banking accounts, the trust banks are treated as firms that employ each account's liabilities and labour to produce different types of profits. Thus, three outputs can be defined from the component of ordinary profit: (1) commissions on trust account (y_1), (2) interest income (y_2), and (3) other operating income (y_3)[8]. In addition, the three inputs are defined as follows: (1) total liabilities in the trust account (x_1), (2) total liabilities in the banking account (x_2), and (3) the number of employees (x_3). In order to compensate for any overlaps, the magnitude of loans to the banking account is subtracted from the total liabilities in the banking account[9]. Among the three outputs, the revenues derived from trust businesses are reflected in y_1 and are generally proportional to the magnitude of x_1. However, in contrast, the revenues derived from ordinal banking businesses are reflected in y_2 and y_3.

In this study, the data are mainly drawn from the financial statements of trust banks in Japan over the period from 1994 to 2005. These data are obtained from '*Shintaku'* (which means trust), which is published by the Trust Companies Association of Japan[10]. The pooled cross-sectional time series data used for the estimation comprises of 339 usable data points. Since the entry, exit, and consolidations processes were parallel during the sample period from 1994 to 2005, the number of samples included in each year is inconsistent.

A description of the relevant data for fiscal 1994 and fiscal 2005 are presented in Table 1. In addition to the summary statistics of all the samples, those of domestic trust banks, foreign-owned banks, and trust subsidiaries are also described. It should be noted that, as displayed in the table, the mean value of the total liabilities in the trust account (x_1) increased during the period from 1994 to 2005, indicating that the trust bank market expanded following the financial deregulation and liberalization in recent years. In addition, it must be particularly noted that the former profit structure of domestic trust banks appears to be heavily dependent on the banking business on average; this is revealed by the fact that at the mean level, interest income (y_2) is approximately four times greater than commissions on trust account (y_1) in 1994. On the contrary, the mean value of commissions on trust accounts (y_1) for foreign-owned trust banks is greater than the two other outputs in both years and is increased to approximately triple the amount from 1,429 million yen in 1994 to 4,155 million yen in 2005. Besides, the mean value of the other operating income (y_3) for trust subsidiaries is larger than the other two outputs in both years.

(insert Table 1 here)

4. Empirical results

4.1 Results of the distance function

The empirical results for the estimated model are presented in Table 2. Prior to estimation, all monetary variables, except input x_3, have been deflated by the GDP deflator index. Further, in keeping with the characteristics of the translog functional form, each variable has been divided by its mean value. The results in Table 2 pertain to the case when the restrictions of linear homogeneity are imposed using output y_1 and input x_1 as a numeraire[11].

With regard to the results of the output distance function model, the terms σ^2 and γ are positive and statistically significant at the 1% level. In addition, the one-sided generalized likelihood ratio test rejects the null hypothesis of $\gamma = 0$ at 1% level (a statistic of 15.4750 exceeds the 1% critical value of 5.4119), indicating that the output-oriented stochastic frontier approach is adequate for the examination of the technical efficiency for the Japanese trust banking industry. The estimated value of γ indicates that approximately 82% of the difference between the actual and potential output arises from the technical inefficiency of each trust bank. Moreover, as revealed, the *t*-ratios on all first-order coefficients and approximately half second-order coefficients indicate statistically significant. This suggests that the estimated model is a good fit to the observed data. In addition, all the elasticities possess the expected signs at the geometric mean. Therefore, at this point, the estimated output distance function fulfils the property of monotonicity (i.e. non-decreasing in outputs and decreasing in inputs).

By calculating the negative sum of the input elasticities, the scale elasticity measure can be defined; In other words, increasing scale economies are indicated by a value of the measure greater than one. In this study, the scale elasticity at the approximation point—that is, evaluated at the points of the overall mean—is 1.1532 and is significantly different from zero. Similar results can also be observed in the case of the estimated values for each year. Therefore, the findings indicate the presence of increasing returns to scale and are exceedingly similar to the findings of most empirical studies on Japanese banking[12].

The results of the input distance function model are similar. The terms σ^2 and γ are also positive and statistically significant at the 1% level, although the estimated value of γ decreases relative to the results for the output distance function model. The one-sided generalized likelihood ratio test rejects the null hypothesis of $\gamma = 0$ at the 10% level (a statistic of 1.8996 exceeds the 10% critical value of 1.6424). However, in sharp contrast to the output distance function model, the property of monotonicity, that is, non-decreasing in inputs and decreasing in outputs, in this case, of the estimated input distance function model is not completely satisfied at the geometric mean. Therefore, it should be noted that the input-oriented stochastic frontier approach is not very appropriate to examine the technical efficiency for Japanese trust banking industry; rather, the output-oriented stochastic frontier approach is more suitable for this purpose.

(insert Table 2 around here)

4.2 Technical efficiency changes

Table 3 summarizes the results of the output distance function model. The estimated mean technical efficiency is found to be 0.7068 during the period 1994–2005. The results reveal that the domestic trust banks are on average (0.7507) more efficient than the foreign-owned trust banks (0.7308) and trust subsidiaries (0.6794). The ANOVA (*F*) test indicates that mean differences of efficiencies in different groups are statistically significant at the 1% level (the *F* value is 8.1335). In addition, the Kruskal Wallis test also indicates that there is significant difference in variances at the 1% level (the χ^2 value is 12.8149).

With regard to the temporal variation in the mean technical efficiency, although the pattern is non-monotonic, it increases from 0.7094 in 1994 to 0.7971 in 2005 for the domestic trust banks; in particular, the incremental tendency is observed after 2001. The reason behind the decline in the incremental tendency of the mean efficiency value of domestic trust banks from 2000 to 2001 is the lower efficiency of the new entrant in 2001[13]. In contrast, the mean technical efficiency decreases from 0.8157 in 1944 to 0.6810 in 2005 for the foreign-owned trust banks. However, as revealed by the standard deviation, which is higher than those for the domestic trust banks, the efficiency differences among the foreign-owned trust banks are quite large in each year. Although the number of foreign-owned trust banks remains unchanged up to 2003, there has been one foreign-owned trust bank that changed its designation and management characteristics entirely and has been excluded from the classification of foreign-owned trust banks. Besides, a new entrant has also emerged in 2000[14]. Excluding this, there are some other instances of designation change during the sample period due to merger and consolidation. The decrease in the number of foreign-owned trust banks in recent years is particularly significant; in addition to merger and consolidation, a few foreign-owned trust banks have also evacuated. On the other hand, the annual mean technical efficiency for trust subsidiaries is relatively low, despite the increase from 0.4814 in 1994 to 0.6769 in 2005. It is noteworthy that a number of trust subsidiaries shown in Table 3 indicate the recent radical movement of consolidation; undoubtedly, only four trust subsidiaries can be observed during the entire period from 1994 to 2005. Therefore, it should be noted that the lower technical efficiency for trust subsidiaries might be attributed to the short time that elapsed since each foundation[15].

(insert Table 3 around here)

Table 4 summarizes the results of the input distance function model. The estimated mean technical efficiency is found to be 0.7844 for the period 1994–2005, which is considerably higher than that of the previous results shown in Table 3. One of the most interesting results is that foreign-owned trust banks are on average (0.7985) more efficient than domestic trust banks (0.7916) and trust subsidiaries (0.7841). However, as shown, there are slight differences among each mean technical efficiency value as both the ANOVA (F) and the Kruskal Wallis tests do not indicate statistically significant differences of the mean and variance in each group.

With regard to the temporal variation in the mean technical efficiency, the pattern of tendency of each group is quite similar to the results in Table 3. Instead, there is no consistent evidence of mean technical efficiency differences in each year. Interestingly, the trust subsidiaries are on average more efficient than the domestic trust banks and foreign-owned trust banks in the four-yearly estimates (1998, 1999, 2001, and 2002). Following these inconsistent results, the Mann-Whitney U test is performed to examine if the distributions of the two efficiency values could be identical. Consequently, the test statistic suggests that the null hypothesis—that each distribution of technical efficiency values is identical—was not rejected at the 1% level. However, taking into consideration the sufficiency result of the monotonicity condition, it is noteworthy that employing the stochastic input distance function is not strongly supported in this case. In other words, the managerial characteristics of different groups are demonstrated in the revenue-based efficiency differences for Japanese trust banking industry; an output distance function is dual to a revenue frontier, while an input distance function is dual to a cost frontier.

(insert Table 4 around here)

In conclusion, based on the results in Table 3, it should be observed that the traditional domestic trust banks have experienced superior technical efficiency as compared with other foreign-owned trust banks and trust subsidiaries. This is consistent with the results of other studies pertaining to the efficiency advantage of U.S. domestic banks; therefore, the home field advantage hypothesis of Berger *et al*. (2000) hold for the Japanese trust banking industry[16]. In this sense, it may be considered that managerial problems, such as the differences in business practices, and customs, and language barrier become costs that have been borne by the foreign-owned trust banks and reflect in the efficiency results.

However, as mentioned previously, the mean efficiency value of traditional domestic trust banks also tends to decrease just after consolidation. Table 5 shows the mean efficiency values for each group with the comparison between non-merged and merged banks by using the results in Table 3. The instances of change in designation, mainly due to the merger among some parent companies of foreign-owned trust banks or trust subsidiaries, are included in the merged banks. As shown in Table 5, as compared with regard to the domestic trust banks, merged banks are on average (0.7515) more efficient than non-merged banks (0.7251). However, it must be observed that, while there is only one non-merged bank after 2002; this is the new entrant that was founded in 2001 after the division of a trust bank. Thus, all the traditional domestic trust banks have ultimately undergone consolidation until 2001. As the results in the first two years for merged banks (0.7438 in 1999 and 0.7058 in 2000) indicate, the significant characteristics of that the immediate effect of the mergers is a decrease in technical efficiency. This finding is quite similar to the ones obtained by Cuesta and Orea (2002) for Spanish savings banks[17]. They claim that although the starting point of the merged banks is almost the same as that of the non-merged banks, there is an initial decrease followed by an increase in technical efficiency indexes, suggesting that mergers have some impact on technical efficiency.

In contrast to the traditional domestic trust banks, the non-merged banks are on average more efficient than merged banks for both of foreign-owned trust banks and trust subsidiaries. The

Mann-Whitney U test also indicates that the distribution of non-merged banks is statistically different from that of the merged banks at the 5% level for foreign-owned trust banks. Although there have been no mergers among foreign-owned trust banks previously, the results indicate that mergers among parent companies also have a negative effect on the efficiency changes of their subordinates. In comparison with trust subsidiaries, the non-merged banks are also on average more efficient than the merged banks. However, the Mann-Whitney U test statistic does not reject the null hypothesis that populations are identical at the 10% level. Interestingly, in sharp great contrast to the traditional domestic trust banks, the efficiency of trust subsidiaries improved insignificantly after a certain period of time has elapsed. Overall, for both the foreign-owned trust banks and trust subsidiaries, of particular significance is the exit of quite a few merged banks in recent years. Therefore, although the explicit relationship between the lower efficiency of a bank and its exit has not been sufficiently explored in previous researches, the results suggest a possible cause for the recent realignment of the foreign-owned trust banks and trust subsidiaries.

(insert Table 5 around here)

5. Conclusion

This paper examines the technical efficiency of Japanese trust banks in three representative groups during the period 1994–2005 by using a stochastic distance function approach. The distance function is advantageous in that it does not require information about prices, permitting the modelling of a multi-input, multi-output production process. Since there are very few previous studies investigating the efficiency of trust banks in Japan, both output and input distance functions have been employed in this study to avoid the choice of the specific orientation ex ante.

The main conclusion of this study is that according to the theoretical sufficiency result of monotonicity condition, the output distance function is more appropriate to examine the technical efficiency of Japanese trust banks rather than the input distance function. With regard to the estimated technical efficiency, the traditional domestic trust banks have experienced superior technical efficiency as compared with other foreign-owned trust banks and trust subsidiaries. These results are consistent with the other findings of Berger *et al.* (2000) on U.S. banks stating that the foreign banks are, on average, less efficient than domestic banks. Furthermore, regarding the foreign-owned trust banks and trust subsidiaries, the results also indicate, to a certain degree, the relationship between lower technical efficiency and exit. Although the temporal variations in the mean technical efficiency are not identical, the results reveal that consolidation yields some negative impact on the technical efficiency for a short duration irrespective of bank groups. Nevertheless, an initial decrease followed by an increase in the technical efficiency indexes is observed for the traditional domestic trust banks. In this sense, it could be concluded that mergers have some delayed impact on technical efficiency.

The policy implications resulting from this study indicate that relaxing the entry barriers in the Japanese trust banking market has had no significant effect on the technical efficiency of new entrants. This can be possibly attributed to the inequality in the conditions of competition, such as the permitted range of trust banking business, which has benefited the incumbent traditional domestic trust banks. Undoubtedly, until recently, the traditional domestic trust banks were being protected not only from new entrants but also from other commercial banks. In other words, although entry barriers were gradually relaxed, the complete liberalization of business areas was not necessarily implemented. In this regard, the findings of this study not only indicate that the gradual deregulation of the Japanese financial market substantially benefited the traditional domestic trust banks but also partly reflect the consequence of an ill-conceived deregulation of the Japanese financial market.

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[1] Life insurance companies have also been permitted to manage the pension trust business. In contrast to the trust bank business, foreign life insurance companies (as well as non-life insurance companies) have been permitted to enter the Japanese insurance market since the 1950s.

[2] With regard to the banking efficiency literature, the previous studies using the distance function approach are very few as compared to those using the production or cost function approaches. For instance, Cuesta and Orea (2002) have employed this procedure to Spanish savings banks, and Marsh *et al.* (2003) to the U.S. commercial banks. In contrast to this, the applications involving distance functions have become common in other recent literature of public services industry (see, e.g. English *et al.*, 1993; Fare *et al.*, 1993; Coelli and Perelman, 1999; and Grosskopf *et al.*, 1997).

[3] See, for e.g. Cornes (1992) for a more theoretical foundation of the distance function.

[4] To my knowledge, there are no previous studies on Japanese banks that included foreign banks in their sample; this can be attributed to the difficulty of data availability.

[5] Undoubtedly, in allowing for differences in business operations, there are also several studies that exclude trust banks from the data set in order to investigate the efficiency or the economies of scale in the Japanese banking industry (see, e.g. Fukuyama, 1993; and Altunbas *et al.*, 2000).

[6] Resona Bank (formerly Daiwa Bank)—the only city bank permitted to engage in the trust banking business as a side business from an early time due to the various historical complicated reasons—is included in the sample. In addition, a few master trust companies that are the specialized master trust asset management banks are also included. Although a certain segment of regional banks were also allowed to directly engage in the trust banking business, they are excluded from the data set since the permitted range of trust banking business for them was extremely limited as compared with the trust subsidiaries.

[7] There are two main approaches for expressing the behavior of banks—the production approach and the intermediation approach. Although there is no agreement on these two alternative approaches, the intermediation approach is more popular in the banking cost studies pertaining to Japan (see, e.g. Tachibanaki *et al.*, 1991; Kasuya, 1986; McKillop *et al.*, 1996; and Solomon, 2005). In this approach, loans and investments are generally regarded as outputs and labor and capital, and deposits are regarded as inputs. Unfortunately, there are very few studies investigating the behavior of trust banks.

[8] 'Other operating income' can be defined as the total operating income minus commissions on trust account and interest income. This output includes other fees and commissions, trading income, etc.

[9] When surplus funds have been generated through the management of trust assets, lending to the banking account is permitted. In the financial statement, it is commonly termed 'Loans to Banking Account' in the trust account (asset side) and 'Due to Trust Account' in the banking account (debt side). Usually, these two figures coincide.

[10] The data pertaining to the number of employees were not released in this data source; therefore, they were obtained from the Nihon Kinyuu Meikan, which is published by the Japan Financial News Co., Ltd.

[11] As a result of examining the cases in which other outputs and inputs are used as a numeraire, the robustness evidence, which states that the estimated values of each parameter are approximately consistent, has been obtained; however, the *t*-ratios on some values have been changed slightly.

[12] See Kasuya (1986), Tachibanaki *et al.* (1991), Yoshioka and Nakajima (1987), and Solomon (2005).

[13] Although the number of domestic trust banks remain unchanged from 2000 to 2001, an entry and an exit have occurred simultaneously. The former was due to the division of the one trust bank, and the latter due to the merger.

[14] In May 2000, the DMG Trust and Banking (formerly Deutsche Morgan Grenfell Trust and Banking) changed its designation to The Master Trust Bank of Japan, which is the first specialized master trust company in Japan. However, at the time of the company's foundation, several traditional domestic trust banks and life-insurance companies also made an equity investment. Consequently, the foreign capital held a mere three percent stake in this company. Therefore, it was excluded from the classification of the foreign-owned trust banks. On the other hand, in April 1999,

the BNP Paribas Trust and Banking (formerly BNP Trust and Banking) was founded. Since the operating period was less than one year and the magnitude of commissions on the trust account was extremely low, the BNP Paribas Trust and Banking was excluded from the sample for the year 1999.

[15] A major cause of the extremely brief disappearance of many of these trust subsidiaries is the consolidation of each of their parent companies.

[16] On the other hand, besides the studies pertaining to the U.S., Strum and Williams (2004) have found opposite results pertaining to Australian banks. Using the DEA models, it is revealed that foreign banks are more efficient than domestic ones; however, they are not superior in terms of profit.

[17] See the survey by Berger *et al*. (1999) for summaries of the literatures on consolidation of the financial services industry.

Table1

Descriptive statistics of selected variables (million of YEN, except x_3)

	1994		2005	
	Mean	Std. dev.	Mean	Std. dev.
Total samples				
y_1	32,185	(52,254)	19,974	(27,162)
y_2	160,339	(275,778)	25,424	(44,646)
y_3	59,243	(100,541)	76,885	(162,332)
x_1	8,587,025	(12,893,900)	31,707,400	(42,774,100)
x_2	2,048,790	(3,917,172)	3,529,491	(7,248,582)
x_3	1,926	(2,977)	1,527	(2,678)
No. of observations	24		22	
Domestic trust banks				
y_1	93,599	(51,211)	62,231	(25,593)
y_2	447,021	(287,821)	78,271	(46,313)
y_3	157,840	(88,622)	216,725	(170,615)
x_1	25,460,900	(10,936,800)	51,364,400	(34,869,400)
x_2	4,578,253	(2,587,409)	9,573,105	(7,156,862)
x_3	5,095	(1,770)	4,178	(2,487)
No. of observations	7		5	
Foreign-owned trust banks				
y_1	1,429	(871)	4,155	(3,172)
y_2	440	(603)	1,980	(1,368)
y_3	699	(540)	788	(1,192)
x_1	799,584	(570,215)	5,390,547	(4,487,899)
x_2	4,333	(9,747)	30,518	(53,793)
x_3	69	(34)	170	(75)
No. of observations	9		4	
Trust subsidiaries				
y_1	220	(142)	2,055	(1,543)
y_2	27	(43)	570	(604)
y_3	4,464	(4,061)	3,411	(5,866)
x_1	364,970	(338,204)	5,569,851	(6,842,697)
x_2	107,898	(92,753)	328,785	(628,972)
x_3	48	(27)	87	(69)
No. of observations	7		8	

Table2

Estimated parameters

Coefficient	Output distance function			Input distance function		
	Estimator		t-ratio	Estimator		t-ratio
α_0	-0.1078		-1.5099	0.0656		0.9464
α_1	—		—	-0.5102	***	-10.9103
α_2	0.3600	***	10.9219	-0.2030	***	-5.3654
α_3	0.2463	***	7.4565	-0.1025	***	-2.7720
β_1	-0.1421	***	-3.8301	—		—
β_2	-0.1269	***	-2.6841	-0.1341	***	-2.8782
β_3	-0.8842	***	-15.6387	0.8673	***	18.7994
α_{11}	—		—	-0.0381	***	-9.2504
α_{12}	—		—	0.0222	***	3.2989
α_{13}	—		—	0.0179	*	1.9406
α_{22}	0.0054	*	1.9060	-0.0135	***	-6.8718
α_{23}	0.0171	***	3.9321	-0.0105		-1.6201
α_{33}	0.0197	**	2.4299	0.0072		0.7131
β_{11}	0.0869	***	4.6385	—		—
β_{12}	0.0040		0.3243	—		—
β_{13}	-0.0292		-1.2836	—		—
β_{22}	0.0202	*	1.8660	0.0029		0.2950
β_{23}	-0.0475	***	-2.7250	0.0021		0.1519
β_{33}	0.0103		0.1841	-0.0395		-1.4186
ρ_{11}	—		—	—		—
ρ_{12}	—		—	-0.0281	***	-2.5882
ρ_{13}	—		—	0.0361	*	1.8939
ρ_{21}	0.0113		1.0757	—		—
ρ_{22}	0.0000		-0.0003	-0.0027		-0.7338
ρ_{23}	0.0498	***	3.4076	0.0254	***	2.5718
ρ_{31}	-0.0052		-0.4749	—		—
ρ_{32}	-0.0110		-1.1490	-0.0094		-0.9396
ρ_{33}	0.0172		0.9318	-0.0157		-1.2171
σ^2	0.2721	***	7.5713	0.1690	***	4.9659
γ	0.8217	***	13.7535	0.5793	***	3.3723
Log Likelihood	-126.9540			-100.6160		
LR-statistic	15.4750			1.8996		

[a] *, **, *** denote a significant estimator at the 10%, 5%, and 1% level, respectively.

[b] σ^2 and γ denote $\sigma_v^2+\sigma_u^2$ and $\sigma_u^2/(\sigma_v^2+\sigma_u^2)$, respectively.

Table 3

Descriptive statistics of efficiency values: output-distance function model

Year	Total samples			Domestic trust banks			Foreign-owned trust banks			Trust subsidiaries		
	Mean	Std. dev.	Number	Mean	Std. dev.	Number	Mean	Std. dev.	Number	Mean	Std. dev.	Number
1994	0.6761	0.1747	24	0.7094	0.0437	7	0.8157	0.0916	9	0.4814	0.1629	7
1995	0.7219	0.1224	24	0.7454	0.0598	7	0.7550	0.0994	9	0.6766	0.1801	7
1996	0.6829	0.1889	31	0.8385	0.0438	7	0.7114	0.1780	9	0.5995	0.1959	14
1997	0.6938	0.1550	34	0.7612	0.0535	7	0.7281	0.1656	9	0.6588	0.1692	17
1998	0.7257	0.1303	33	0.7010	0.0676	7	0.6914	0.1697	9	0.7691	0.1142	16
1999	0.7179	0.1202	32	0.7571	0.0815	7	0.7236	0.1331	9	0.7076	0.1266	15
2000	0.7017	0.1419	30	0.7434	0.0938	6	0.7164	0.1300	9	0.7440	0.0770	12
2001	0.6873	0.1681	27	0.6724	0.2195	6	0.7070	0.1034	9	0.6977	0.1117	9
2002	0.6816	0.1040	28	0.7354	0.0796	6	0.7027	0.1072	9	0.6481	0.0974	8
2003	0.7381	0.1167	28	0.7649	0.0864	6	0.7930	0.1113	9	0.6798	0.1426	8
2004	0.7358	0.1161	26	0.7890	0.0767	6	0.7131	0.1701	7	0.7222	0.1190	8
2005	0.7215	0.1089	22	0.7971	0.0439	5	0.6810	0.1827	4	0.6769	0.1070	8
1994-2005	0.7068	0.1399	339	0.7507	0.0934	77	0.7308	0.1351	101	0.6794	0.1498	129

Notes: The total sample includes a few other financial institutions that has been permitted to pursue the trust banking business. as a side business.

Table 4

Descriptive statistics of efficiency values: input-distance function model

Year	Total samples			Domestic trust banks			Foreign-owned trust banks			Trust subsidiaries		
	Mean	Std. dev.	Number	Mean	Std. dev.	Number	Mean	Std. dev.	Number	Mean	Std. dev.	Number
1994	0.7581	0.1119	24	0.7465	0.0442	7	0.8443	0.0381	9	0.6578	0.1450	7
1995	0.7922	0.0678	24	0.7732	0.0371	7	0.8266	0.0567	9	0.7692	0.0955	7
1996	0.7917	0.0914	31	0.8578	0.0368	7	0.8193	0.0645	9	0.7466	0.1026	14
1997	0.7991	0.0790	34	0.8172	0.0390	7	0.8161	0.0666	9	0.7871	0.0963	17
1998	0.8151	0.0640	33	0.7825	0.0369	7	0.7966	0.0757	9	0.8462	0.0518	16
1999	0.7921	0.0855	32	0.7841	0.0607	7	0.7976	0.0545	9	0.7979	0.1113	15
2000	0.7681	0.0944	30	0.7960	0.0480	6	0.7735	0.0667	9	0.7940	0.0810	12
2001	0.7685	0.0956	27	0.7625	0.1454	6	0.7686	0.0520	9	0.7835	0.0481	9
2002	0.7599	0.0704	28	0.7700	0.0734	6	0.7638	0.0800	9	0.7810	0.0669	8
2003	0.7926	0.0674	28	0.8006	0.0528	6	0.8267	0.0602	9	0.7870	0.0819	8
2004	0.7906	0.0690	26	0.8102	0.0493	6	0.7775	0.1021	7	0.8078	0.0651	8
2005	0.7692	0.0771	22	0.7971	0.0465	5	0.7276	0.1518	4	0.7793	0.0675	8
1994-2005	0.7844	0.0826	339	0.7916	0.0639	77	0.7985	0.0730	101	0.7841	0.0933	129

Notes: The total sample includes a few other financial institutions that has been permitted to pursue the trust banking business. as a side business.

Table 5

Efficiency values comparison in non-merged and merged: output-distance function model

Year	Domestic trust banks				Foreign-owned trust banks				Trust subsidiaries			
	Non-merged		Merged		Non-merged		Merged		Non-merged		Merged	
	Mean	Number	Mean	Number	Mean	Number	Mean	Number	Mean	Number	Mean	Number
1994	0.7094	7	–	–	0.8157	9	–	–	0.4814	7	–	–
1995	0.7454	7	–	–	0.7550	9	–	–	0.6766	7	–	–
1996	0.8385	7	–	–	0.7517	7	0.5703	2	0.5995	14	–	–
1997	0.7612	7	–	–	0.7788	6	0.6269	3	0.6588	17	–	–
1998	0.7010	7	–	–	0.7689	6	0.5364	3	0.7691	16	–	–
1999	0.7592	6	0.7438	1	0.8027	4	0.6604	5	0.7179	14	0.5633	1
2000	0.7811	3	0.7058	3	0.6912	5	0.7481	4	0.7586	9	0.7004	3
2001	0.5349	2	0.7412	4	0.7162	4	0.6996	5	0.7437	5	0.6402	4
2002	0.8237	1	0.7177	5	0.7111	4	0.6959	5	0.6826	5	0.5907	3
2003	0.6593	1	0.7861	5	0.7701	4	0.8114	5	0.7457	5	0.5699	3
2004	0.6625	1	0.8143	5	0.7484	4	0.6660	3	0.7632	5	0.6538	3
2005	0.7862	1	0.7998	4	0.5469	2	0.8150	2	0.7120	5	0.6185	3
1994-2005	0.7251	50	0.7515	27	0.7554	64	0.6683	37	0.6906	109	0.6197	20

Notes: This table is based on the results of the output-distance function model in Table 3.