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JAPAN PREMIUM AND STOCK PRICES: TWO MIRRORS OF JAPANESE BANKING CRISES

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ABSTRACT

This paper investigates how financial weakness among Japanese banks in the second half of the 1990s was reflected in pricing in the financial markets. Two indicators, the Japan premium (JP) and the stock price spread (SP)—deviation between the bank stock index (BINDEX) and stock price index excluding banks (NINDEX)—were examined. The structural change occurring in the relationship between BINDEX and NINDEX is much earlier than the crisis of November 1997. The Granger causality tests reveal that concerns on profitability and solvency reflected in stock prices affect foreign banks' worry over dollar liquidity positions of the Japanese banks. Copyright © 2005 John Wiley & Sons, Ltd.

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1. INTRODUCTION

The purpose of this paper is to investigate how financial weakness among Japanese banks in the second half of the 1990s was reflected in pricing in the financial markets. Two indicators are examined: the spread (SP) between the Japanese banking sector stock price index (BINDEX) and the Japanese stock index excluding the banking sector (NINDEX); and the difference between the offshore dollar interest rate for western banks and that for Japanese banks, namely the Japan premium. Based on a structural break co-integration technique, a break in the long-run relationship between BINDEX and NINDEX was found in the summer of 1995, much earlier than the commonly thought break point of November 1997. The Granger causality tests reveal that SP influenced JP, but JP did not influence SP. That is, concerns on profitability and solvency reflected in stock prices affect foreign banks' worry over dollar liquidity of Japanese banks, but not *vice versa*.

The novelty of this paper is twofold. First, the paper analyses the effect of a bank failure on both the Japan premium and stock prices of other banks relative to other sectors. Second, although there have been several papers on financial weakness of Japanese banks, this paper is the first to link two different pricing indicators in different markets. By investigating the link between the two, different risks perceived by different market participants (profit performance by equity investors vs. liquidity concern by western banks) can be contrasted. The paper shows that stock market concerns influence the liquidity concern, indicating profit performance, or an increase in default risk in extreme cases, but that dollar liquidity concerns do not necessarily affect stock values of Japanese banks. This is an interesting result by itself, and

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it also shows a general method and direction of research in investigating the linkage between different types of risk.

Japanese financial institutions, in particular banks, experienced large shocks in the second half of the 1990s. The deterioration of balance sheets forced some banks to fail or to withdraw from operations abroad. The problem started with an increase in nonperforming loans due to the bursting of asset bubbles in the first half of the 1990s and a difficulty compounded by incomplete disclosure of bank balance sheet conditions and a lack of regal framework to deal with near-insolvent banks effectively. Nonperforming loans became a serious policy issue from the mid-1990s, but market participants could not have enough information to make accurate judgement on how serious the banks' conditions were. Since 1995, as some banks actually failed and discussion on dealing with failing banks took place, investors have changed their evaluation on the Japanese banking industry as a whole and individual Japanese banks. In November 1997, two banks—including one of the top 10 banks—and two securities firms—including one of the Big Four—have failed. Faced with a widespread fear of financial meltdown, the government decided to help strengthen the banking sector. Capital injection—subscription to preferred shares or purchase of subordinated bonds—into major banks using fiscal money took place in March 1998 and, again, in March 1999. The second fiscal injection, at that time, seemed to have put an end to a saga of the 1990s banking crisis in Japan, although problems started to reappear three years later.

How foreign and domestic market participants evaluate the net worth or default risk of Japanese bank is reflected in two different indicators, stock prices of banks in the Tokyo stock exchange and the Japan premium (defined as the difference between the Eurodollar interbank interest rate for Japanese borrowers and that for European/American borrowers).

In order to extract the Japanese banks' reputation among stock market investors, we construct the stock prices of the banking sector relative to the rest of the market. The banking-sector stock price index (Banking-TOPIX) has been publicly available. The bank stock index, BINDEX, reflects profitability, growth potentials, soundness in balance sheets and other performance indicators of banks, judged by stock market investors. Of course, these banking performances would partly reflect the strength of the economy in general. In order to control for the economy-wide factors, the difference between the bank stock index and the stock price index excluding banks, we have constructed the index of general stock prices excluding the banking index (TOPIX less the banking sector).

The stock price index excluding banks, NINDEX, is defined as the difference between the TOPIX and the market value weight-adjusted bank stock index. Then the log-difference between NINDEX and BINDEX is called the banking spread in the stock markets, or SP. This indicator shows how investors regard the health of the banking sector relative to the economy-wide business conditions. The spread started to become large in 1995 and continued to become larger in the second half of the 1990s.

As an alternative approach, based on a standard portfolio theory, extracting the Japanese banks' reputation among stock market investors can be obtained in the beta of the capital asset pricing model (CAPM). One difficulty in using the model is that banks' share in the market index such as TOPIX is large enough so that it will not be appropriate to treat TOPIX as a 'market' index. Therefore, the dramatic deterioration in the health of the Japanese banking sector has been examined by using the market value weight-adjusted bank index.

The relationship between NINDEX and BINDEX has changed over time. In the long run, the two indices are cointegrated. However, the cointegration relationship seems to have changed its structure, as the two indices behave differently in the second half of the 1990s. We employ an econometric test developed by Seo (1998) in order to determine when a structural change in the cointegration relationship took place. Although it has been recognized by casual observations that bank stock prices have deviated from the overall stock prices, our formal test to determine the timing of such a change is, to our best knowledge, the first in the literature. (For example, see Peek and Rosengren, 1997; Daigo *et al*., 1998 for the earlier studies on Japanese stock prices in the 1990s. Shimizu and Ui, 1999; Brewer *et al*., 2000 examine failures of 1997.)[1]

The Japan premium shows the fragility, in terms of credit and counterparty risk, of Japanese banks perceived by foreign banks. The Japan premium represents the premium that the Japanese banks could not satisfy their dollar liquidity needs among Japanese banks in the Tokyo market, but were eager enough to borrow even with a premium, as foreign banks regarded Japanese banks to be risky counterparties and they charged a risk premium. This can be understood in a framework of a simple risk–return profile. The premium was added on to the loan to Japanese banks in the interbank market, especially in the Eurodollar interbank market. (For earlier studies on the Japan premium, see Ito and Harada, 2000; Peek and Rosengren, 2001.) Since large Japanese banks experienced a much smaller premium in the Euroyen or domestic yen-based interbank market, it was rather a puzzle why they were charged a larger premium in the particular market. It is stipulated that foreign banks became concerned about dollar liquidity of the Japanese banks as counterparties.[2] However, it became a symbol of weakness and vulnerability of Japanese banks. In the second half of the 1990s, whenever bad news about Japanese banks hit the international press, the Japan premium seemed to have increased. The Japan premium started to increase in the summer of 1995 and, after some fluctuations, disappeared in April 1999. We will explore explanations of these movements.

After the behaviour of the bank stock prices and the Japan premium is described and analysed separately, the relationship between them is examined. Concerning evaluation of risks, the banking spread in the stock market reflects solvency risk and the interest rate differential accounts for liquidity and counterparty risks. One hypothesis is that these two mirrors of bank soundness are correlated closely. One indicator shows vulnerability, then the other follows. Another hypothesis is that one indicator could influence the other, but not *vice versa*. In order to test these hypotheses, a vector autoregression is conducted.

Although many market observers and policymakers were alerted by both stock prices of banks and the Japan premium, as a reflection of banking difficulties, changes in these two variables have not been analysed systematically. (A related paper is Ito and Harada, 2002, which focuses more on the effect of various news.) This paper is the first to test the relationship between the Japan premium and the bank stock prices.

In anticipation, conclusions can be summarized as follows: (1) the Japan premium (JP) has jumped up sharply on three occasions, the Daiwa Bank incident in 1995, the major failures of financial institutions in November 1997, and the period of nationalizing two long-term credit banks; (2) the bank stock index declined, that is the bank stock spread (SP) increased, in response to consecutive failures of financial institutions from the Hyogo Bank failure in August 1995 to the NCB (Nippon Credit Bank Ltd) failure in December 1998; (3) the bank stock index (BINDEX) and stock price index excluding banks (NINDEX) had exhibited a comovement until the mid-1990s—the structural change occurred in the BINDEX and NINDEX cointegration relationship some time in the summer of 1995; and (4) although SP and JP in general appear to be influencing each other, the Granger causality tests reveal that SP Granger-causes JP, but not *vice versa*.

The rest of the paper is organized as follows. Section 2 will describe the data. Section 3 will analyse the behaviours of BINDEX and NINDEX. Section 4 will investigate determinants of the Japan premium. Section 5 will present a vector autoregression model analysing a dynamic relationship between the Japan premium and the bank stock price spread. Section 6 will conclude the paper.

2. DATA

2.1. *Bank stock price index*

We would like to describe the movement of bank stock prices relative to other sectors. The bank stock price index is publicly available, but not the index for all industries except banking. Therefore, we construct the stock price index excluding banks by subtracting banking weights from TOPIX. Since TOPIX is the weighted average of 33 different sectoral indices, by removing the banking index from TOPIX, we can construct the stock price index excluding banking as follows:

$$\mathrm{TOPIX}_t = (1 - \alpha_t)\mathrm{NINDEX}_t + \alpha_t \mathrm{BINDEX}_t \tag{1}$$

$$\mathrm{NINDEX}_t = \frac{\mathrm{TOPIX}_t - \alpha_t \mathrm{BINDEX}_t}{1 - \alpha_t} \tag{2}$$

where $\alpha_t = \text{BINDEXMV}_t/\text{TOPIXMV}_t$, BINDEXMV_t is the current value of the banking market capitalization and TOPIXMV_t is the all-sector market capitalization.[3] All indices, TOPIX, BINDEX and NINDEX, are adjusted for stock splits. Figure 1 shows the BINDEX and NINDEX from January 4, 1994 to April 30, 1999 with the number of observations being 1282.

We may observe that deviations between the two indices are minor before August 1995, but after August 1995 the two indices start to diverge. The deviations seem to widen over time.[4]

The bank stock prices relative to other sectors are defined as the bank stock price spread, SP:

$$\text{SP}_t = \ln \text{NINDEX}_t - \ln \text{BINDEX}_t \quad (3)$$

In addition, we will construct a weak banks' stock price index. This index will be used to measure the impact of news events, including the failure of banks, on the weak banks. First, take Japanese banks with low credit ratings (Baa2 and Baa3 for long deposit credit ratings in the Moody's Investment Service, *Moody's Global Ratings Guide*), and define the weighted average of these banks' stock prices as the Baa bank stock price index.

2.2. *Japan premium*

The Japan premium is a premium imposed on Japanese banks' borrowing rate by US and European banks in the Eurodollar and Euroyen market. It reflects counterparty risk based on the western banks' belief that Japanese banks had a higher risk of default. Since the Japan premium emerged in the Eurodollar market the most, and less in the Euroyen market as described in Saito and Shiratsuka (2001) and Hanajiri (1999), it also reflects the liquidity problem with the dollars, rather than solvency or liquidity in the yen. In this paper, the Japan premium is defined as the difference between the Eurodollar TIBOR (the Tokyo interbank offered rate, or the Eurodollar interbank borrowing rate in Tokyo) and the Eurodollar LIBOR (the London interbank offered rate, or the Eurodollar interbank borrowing rate in London). The Eurodollar TIBOR market participants are mostly Japanese banks, only two banks are non-Japanese banks. Therefore, the TIBOR reflects Japanese banks' borrowing rate with the Japan premium. The LIBOR market has many western banks and only a few Japanese banks. The LIBOR calculation eliminates the extreme values, since the Japanese banks' rates are excluded. Hence, the difference between Eurodollar TIBOR and Eurodollar LIBOR is defined as the Japan premium (JP).[5]

$$\text{JP}_t = \text{TIBOR}_t - \text{LIBOR}_{t-1} \quad (4)$$

The relationship between SP and JP is shown in Figure 2. They are linked in terms of risk since both SP and JP represent weakness in financial positions of banks. But they are not identical, because SP represents investors' assessment of profitability and solvency risk, while JP indicates those of liquidity risk. Note that the bank stock spread (the difference in the ln BINDEX and ln NINDEX, which is normalized as 100 on January 4, 1994 in Figure 2) seems to be constant or slightly increasing at the end of the sample period, while the Japan premium has declined dramatically.

2.3. *Event study*[6]

Ito and Harada (2000) studied how the news of bank failures was received by the stock market in Tokyo. Table 1 shows the eight cases of financial institution failures. It shows the name of the failed bank, the announcement date of the failure, and anticipation (changes in 10, 5 and 3, days prior to the announcement) and reaction (changes in 3, 5 and 10 days following the announcement) of various stock price indices (BINDEX, Nikkei 225, the failed bank's (or securities firm's) stock price, Baa3, Baa2 and in some cases, related financial institution's price index).

From the table, the following observations can be made. First, for three banks that failed in 1995 and 1996, the failed banks' stock prices dropped sharply, as expected, but the other banks' stock prices, even the weak banks' stock prices, did not drop after the announcement of a particular bank failure. Therefore, each of the failures was regarded in the market as an isolated incident. Second, for the three financial institutions that failed in November 1997, the stock prices of banks with low credit ratio decreased sharply, namely the

Figure 1. Three indices BINDEX (right scale), TOPIX and NINDEX (left scale).

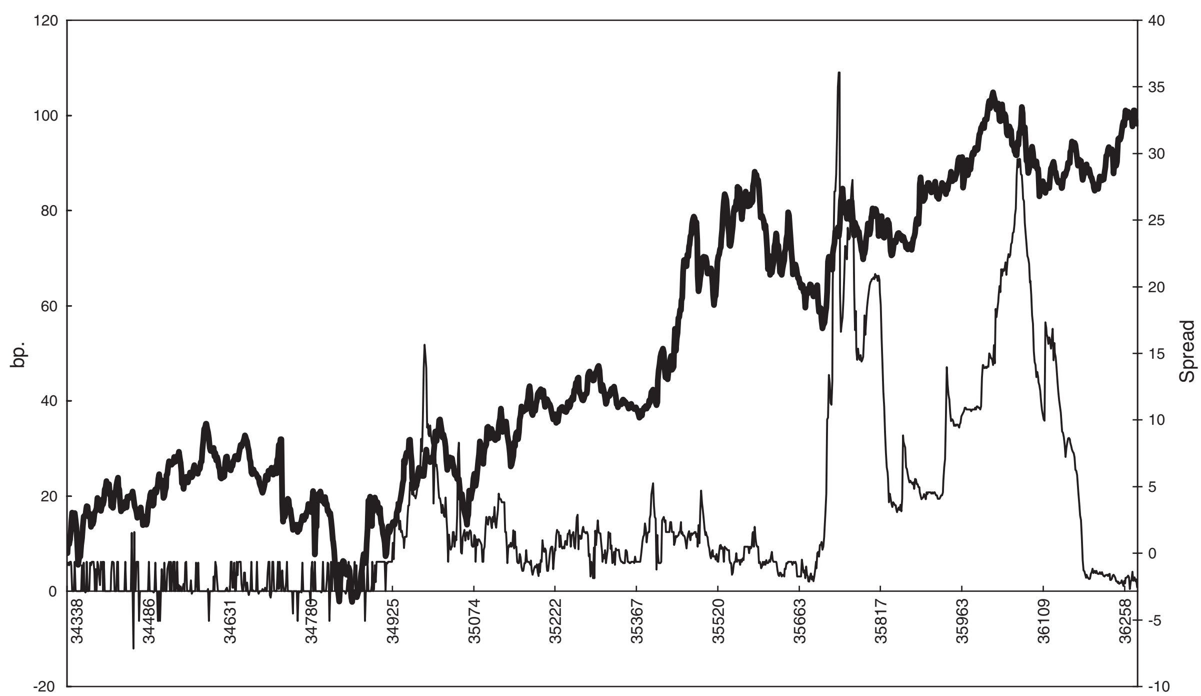


Figure 2. Japan Premium (in basis points, left scale, thin line) and bank stock spread (the difference in the BINDEX and NINDEX, right scale, bold line. Both are normalized as 100 on January 4, 1994.).

Table 1. Reactions of bank stock prices to bank failure announcement

Failed financial institutions (Reason of failure)	Default date		BINDEX	NKAVE	Failed institution	Baa3	Baa2	Yamaichi securities	Daiwa securities
Hyogo bank failure	30/08/1995	10 days before	3.84	0.13	−4.43	3.88	4.05		
(Announce of giving up rebuilding)		5 days before	−0.10	−2.22	3.94	0.95	−1.90		
		3 days before	−0.77	−2.01	3.94	0.48	−0.95		
		3 days later	−1.48	−2.03	−39.41	−4.74	−2.31		
		5 days later	−2.76	−2.74	−59.61	−5.85	−8.01		
		10 days later	1.88	2.74	−59.11	−2.57	3.06		
Taiheiyo bank failure	29/03/1996	10 days before	−4.38	−6.89	−0.69	−1.77	−6.81		
(Agreement of rebuilding plan)		5 days before	−1.69	−2.99	−1.03	−2.81	−3.07		
		3 days before	−0.80	−1.41	2.41	−1.71	−0.41		
		3 days later	−1.62	−0.48	−44.67	−2.57	−3.91		
		5 days later	−1.06	0.68	−65.29	−1.94	−2.34		
		10 days later	−0.22	0.50	−69.16	−1.19	−2.19		
Hanwa Bank	21/11/1996	10 days before	0.44	−2.02	5.98	0.40	0.28		
		5 days before	0.25	−0.77	8.37	−1.09	0.28		
		3 days before	−0.74	−1.89	5.98	−0.29	−0.98		
		3 days later	0.09	0.97	−39.84	−3.16	−0.01		
		5 days later	−0.65	−0.87	−60.96	−4.32	−2.34		
		10 days later	−3.63	−1.31	−61.75	−2.47	−5.93		
Sanyo securities firm	3/11/1997	10 days before	10.51	4.83	−12.00	1.84	9.11	26.01	11.29
Apply for corporation		5 days before	2.90	3.35	−18.67	2.96	1.54	28.25	−0.30
reorganization		3 days before	2.64	2.30	−13.33	4.57	0.53	3.59	4.90
		3 days later	−4.48	0.20	−64.00	−7.31	−8.50	−21.52	−7.28
		5 days later	−12.18	−4.64	−65.33	−7.62	−17.85	4.04	−27.34
		10 days later	−12.94	−8.20	−64.00	−16.18	−31.81	−21.52	−25.71
Hokkaido Takushoku bank	17/11/1997	10 days before	12.81	8.36	16.67	23.59	35.48		
failure		5 days before	0.85	3.73	7.69	7.13	14.98		
		3 days before	1.79	2.14	5.13	4.28	13.09		
		3 days later	−6.70	−2.54	−41.03	−3.24	−17.12		
		5 days later	−7.70	−5.22	−41.03	−10.19	−29.24		
		10 days later	−0.85	1.12	−42.31	−11.53	−24.68		
Yamaichi securities firm	22/11/1997	10 days before	−12.12	−6.53	35.03	4.54	15.63		3.88
failure		5 days before	−1.42	−2.79	3.82	1.59	8.54		1.55
		3 days before	−7.03	−5.60	−23.57	−8.50	2.32		−3.57
		3 days later	3.10	4.69	−32.48	−18.60	−22.15		−20.93
		5 days later	10.34	7.26	−31.85	0.81	10.84		−12.56
		10 days later	3.04	1.68	−32.48	−5.81	3.33		−24.96
Long-term credit bank of Japan	11/09/1998	10 days before	7.11	5.39	−3.70	0.85	2.44		
(Nationalization)		5 days before	1.68	4.48	0.00	−0.75	−4.27		
		3 days before	2.89	1.78	0.00	3.42	10.37		
		3 days later	−1.50	−2.65	−29.63	−4.23	−6.10		
		5 days later	−4.60	−4.53	−31.48	−7.90	−9.76		
		10 days later	−6.88	−2.92	−44.44	−6.77	−17.07		
Nippon credit bank	12/12/1998	10 days before	−1.45	−3.21	−9.20	−0.30	−6.14		
(Nationalization)		5 days before	0.01	2.14	8.05	1.94	1.56		
		3 days before	2.06	3.54	9.20	1.96	−0.43		
		3 days later	−3.45	−0.10	n.a.	−9.12	−2.04		
		5 days later	−2.12	0.56	n.a.	−9.69	−4.11		
		10 days later	−7.31	−2.70	n.a.	−12.75	14.84		

Baa2 and Baa3 indices, as well as BINDEX, after the failure announcement, with the fall of Baa2 and Baa3 exceeding the fall of BINDEX. These sharp reactions are consistent with the view that systemic risk of banking failures was perceived to have increased by these failures. Third, reactions to the nationalization announcements of Long-Term Credit Bank (LTCB) and Nippon Credit Bank (NCB) were much less dramatic, except for some reactions in the Baa3 and Baa2 index. In the case of the LTCB nationalization announcement, it was anticipated for a long time through the Diet debate, so that the reaction in BINDEX and Nikkei 225 was rather calm, although Baa2 reacted sharply. In the case of the NCB nationalization announcement, it was not anticipated in the market. However, the reaction of BINDEX and Nikkei 225 was also calm. Baa3 reacted sharply. The nationalization of LTCB and NCB was carried out under a new mechanism against systemic failure. Earlier in 1998, a new law was passed to make it possible for the authorities to nationalize very weak banks. The market took these failures without increased fears for systemic risk.

In sum, bank failures in 1995 and 1996 did not trigger bank stock price declines of other banks, but those in November 1997 brought down stock prices of other banks, especially those with low credit rating. Systemic risk of the banking system in general was feared. By 1998, the mechanism to deal with bank failures was in place, and nationalization of LTCB and NCB was received without a major impact on other banks' stock prices in general, but some weak banks were affected.

The event study has shown how stock indices such as BINDEX, Nikkei 225 and Baa immediately respond to the news of bank failures in the short-term event windows. However, news related to weakness of Japanese banks might have affected structural behaviours of bank stock spread, that is the relationship between BINDEX and NINDEX in the long run. In order to test the effect, structural break tests are conducted in the next section.

3. BANK STOCK PRICE MOVEMENTS

3.1. Casual observation

From a casual observation of Figure 1, the relationship between the BINDEX and NINDEX has been changing. From January 1994 to the end of August 1995, two indices show comovement. From September 1995 to December 1996, the deviation of the BINDEX and NINDEX seems to widen gradually over this period. From January 1997 to the end of April 1999, two indices maintain the same degree of deviation, or regain the tendency of comovement.

We can interpret this as follows. Before the Hyogo Bank failure in August 1995, the banking industry was quite a typical industry in the economy. The bank stock movement tracked the rest of the economy quite well. After the Hyogo Bank failure, the bank stocks started to do much worse than the rest of the economy. The Hyogo Bank failure was only the beginning of this deviating trend. By the end of 1996, the deviation between the two indices reached its maximum. From 1997, the deviation seemed to remain stable.

This assessment may appear to contradict the event study conclusion. According to the event study analysis, the Hyogo Bank failure did not alarm investors about other banks. However, that event seems to be the beginning of the deviation between the BINDEX and NINDEX. Since the event analysis covers only 10 days after the event, it does not capture a possible structural change over time. The failures of the large financial institutions in November 1997 are most dramatic and the event analysis shows that it had a large impact on other bank stock prices. It may be natural to expect that November 1997 is the turning point. However, the correlation of the BINDEX and NINDEX increases after November 1997. But, the deviation between the BINDEX and NINDEX had already become large. The stock market must have anticipated low returns in the banking sector, including some failures. After November 1997, not only the banking sector but also the economy in general headed for a contraction (e.g., the GDP growth rate became -2.5%), so that the relative positions of BINDEX and NINDEX may not have changed. Thus, just the event analysis or the correlation analysis does not give us a definite conclusion. It takes a more formal analysis to determine when the structural change took place.

3.2. Cointegration of BINDEX and NINDEX

In this subsection, the comovement of BINDEX and NINDEX will be formally analysed using the cointegration technique. The comovement of BINDEX and NINDEX might have been anticipated if it is considered that the banking sector is a crucial industry among others and that the economic slowdown or the fall in stock prices have affected bank capital by decreasing capital gains on share-holdings in the banking sector. However, as Figure 1 shows, BINDEX started to decrease more sharply than NINDEX after the summer of 1995, as the Japanese banking sector and financial system seems to be less credible.

Therefore, it is required to examine how market participants evaluated the seriousness of the Japanese banking sector and how that affected the long-run relationship of the two indices in the second half of the 1990s. First, a unit root test is conducted for BINDEX and NINDEX. Zivot and Andrews (1992) have developed unit-root tests allowing for a break point being estimated when a location of break point is unknown.[7] We applied their tests to each of the two indices, and found that each has a unit root (Table 2, panel A).[8] Then, the cointegration relationship between the two indices with an entire sample period is tested since their movements seem to keep a stable relationship however the deviations between the two indices seem to be gradually diverging. A simple ADF test of the residuals in order to test the null of no cointegration is applied. Since the null hypothesis is not rejected, it suggests that the two variables are not cointegrated for an entire sample period (Table 2, panel B). This result supports the view that the stability of the long-run relationship between BINDEX and NINDEX cannot be assessed by a simple ADF test.

We suspect that the relationship may have experienced a structural change. Our interest is to determine when the structural change took place as well as whether the structural change took place. We apply a technique developed by Seo (1998). Seo's technique will identify the timing of a structural change.[9]

The sample period is from January 4, 1994 to April 30, 1999 with a sample size of 1282. It is assumed that the admissible range of a break point is symmetrically set at [0.15, 0.85].

Consider a two-dimensional time series, BINDEX and NINDEX, generated by ECM with the 1 lag length selected by AIC. The long-run relationship is estimated as follows:

$$\begin{pmatrix} \Delta\mathrm{NINDEX}_t \\ \Delta\mathrm{BINDEX}_t \end{pmatrix} = \alpha\beta' \begin{pmatrix} \mathrm{NINDEX}_{t-2} \\ \mathrm{BINDEX}_{t-2} \end{pmatrix} + \Gamma_1 \begin{pmatrix} \Delta\mathrm{NINDEX}_{t-1} \\ \Delta\mathrm{BINDEX}_{t-1} \end{pmatrix} + \mu + u_t \tag{5}$$

Table 2. Unit root test and cointegration test

Panel A:					
Variable	Selected lag	Estimated break point	Break fraction	Min. test statistic	Critical value
NINDEX	8	359	0.28	−3.21	−4.58
BINDEX	5	361	0.28	−3.65	−4.58
Panel B:	Selected lag		AIC	SIC	ADF statistics
	1		4.254	4.26	−2.960
Panel C:	Selected lag	Estimated break point	Break fraction	Min. test statistic	Critical value for fixed fraction
SP	4	257	0.20	−3.98**	−3.77
JP	9	923	0.71	−3.97*	−3.66

**, * denote the significance at 5% and 10% level respectively.

The minimum test statistics of Panel A and C are calculated by Zivot and Andrews (1992) and ADF statistics of Panel B is based on ADF test of residuals.

For panel A, the 1%, 5% and 10% critical values are −5.34, −4.80 and −4.58 respectively by Zivot and Andrews (1992) Table 2, A.

For panel B, the 5% and 10% critical values are −2.86 and −2.57 respectively by Hamilton (1994) Table B.6, Case 2.

For SP in panel C, the 1%, 5% and 10% critical values are −4.39, −3.77 and −3.47 respectively by Zivot and Andrews (1992) Table 2, B for fixed $\lambda = 0.2$.

For JP in panel C, the 1%, 5% and 10% critical values are −4.42, −3.80 and −3.51 respectively by Zivot and Andrews (1992) Table 2, B for fixed $\lambda = 0.7$.

SP is the spread, $\log(\mathrm{NINDEX}_t) - \log(\mathrm{BINDEX}_t)$, JP is the Japan premium, $(\mathrm{TIBOR}_t - \mathrm{LIBOR}_t)$.

where α is the adjustment vector, β is the cointegrating vector. The tests of a structural change in joint vector $\beta\alpha$ and optimal LM test statistics are defined as follows:

$$\text{Ave LM}_n^i = \frac{1}{\bar{t} - \underline{t}} \sum_{t=\underline{t}}^{\bar{t}} \text{LM}_n^i([t/n]) \tag{6}$$

$$\text{Exp LM}_n^i = \log\left(\frac{1}{\bar{t} - \underline{t}} \sum_{t=\underline{t}}^{\bar{t}} \exp(\text{LM}_n^i([t/n])/2)\right) \tag{7}$$

$$\text{Sup LM}_n^i = \underset{t\in[\underline{t},\bar{t}]}{\text{Max}} \text{LM}_n^i([t/n]) \tag{8}$$

where the structural break point τ is assumed to lie in $\tau^* = [\underline{\tau}, \bar{\tau}]$, $\underline{t} = [n\underline{\tau}], \bar{t} = [n\bar{\tau}]$, $i = \beta, \alpha, \beta\alpha$. One time structural change is allowed for in the cointegrating vector at the break point τ. The break point τ intersects two subsamples, $t = 1, 2, \ldots, [n\tau]$ and $t = [n\tau] + 1, \ldots, n$. $[n\tau]$ is the integer operator of $[n\tau]$.

The test results are shown in Table 3, panel B. The plot of LM statistics is in Figure 3. From the table, the Sup LM test rejects the null hypothesis of parameter stability at the 5% size. In Figure 3, LM statistics show a spike that exceeds 5% critical value of the Sup LM test around 360.[10] This timing of the spike suggests a break point is approximately at the beginning of July 1995.

Next, we consider a direct test for structural change with a known break point to make sure the possible point of the break found by Seo's (1998) method can be supported by dividing the sample period into two

Table 3-1. Results of error correction model

Panel A: adjustment and vector		
Variable	α (adjustment vector)	β (cointegration vector)
NINDEX	−0.011	
s.e.	(0.006)	
BINDEX	−0.004	−1.065
s.e.	(5.453)	(0.227)

Panel B: tests for parameter stability, joint vector $\beta\alpha$		
	LM statistics	5% critical value
$\text{AveLM}_{\beta\alpha}$	2.763	4.320
$\text{ExpLM}_{\beta\alpha}$	3.099	3.240
$\text{SupLM}_{\beta\alpha}$	14.376*	12.550

Table 3-2. DOLS in two subsamples

γ	94/1/4-95/6/30	95/7/1-99/4/30
SOLS	2.388**	1.278**
DOLS	−0.035	−0.012

Table 3-3. Test for structural change

	γ	δ_0	δ_1	Wald statistics
DOLS	2.363**	950.01**	−1.085**	8.349*
rescaled s.e.	−0.048	39.24	−0.049	

*,** denote the significance at 5% and 1% level respectively.
The 5% and 1% critical values of χ^2 are 5.99 and 9.21, respectively.

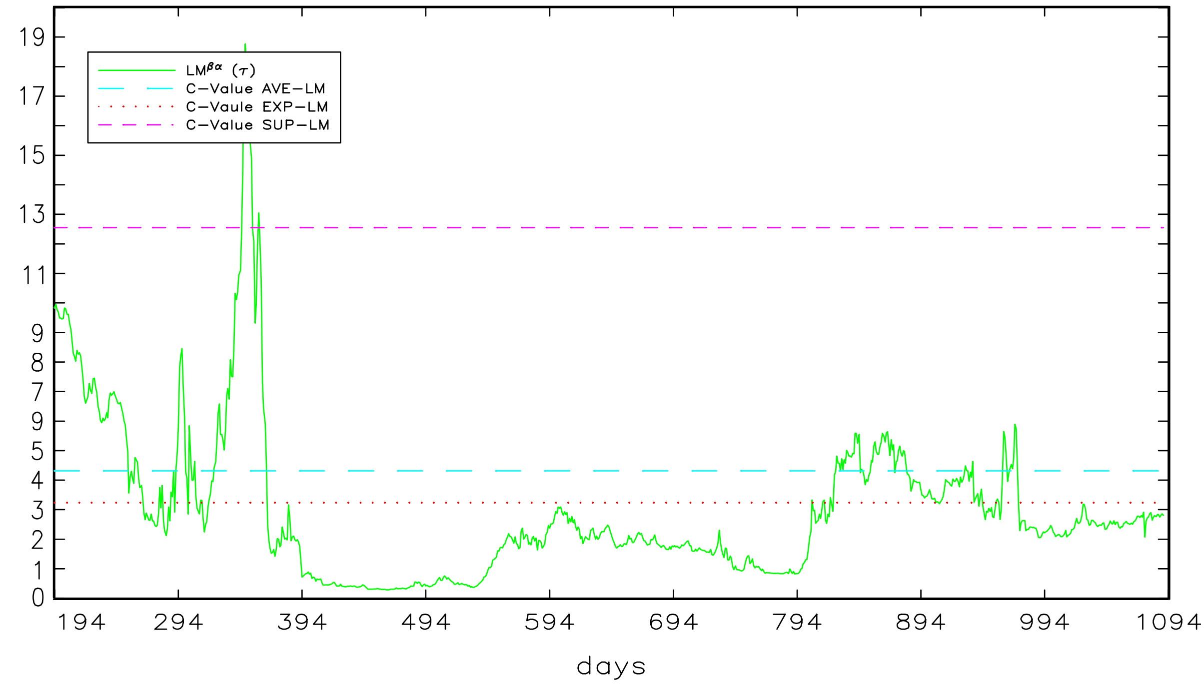


Figure 3. Stability Test of the Stock Index: 1994/1/4–1999/4/30.

parts. As Figure 3 shows, the sample period is divided into two subsamples: the first half is from January 1994 to June 31, 1995, the latter half is from July 1, 1995 to April 30, 1999.

Consider the following DOLS, dynamic OLS estimation. By including not just the current change but also past and future changes of the regressor, the OLS estimator of the cointegrating vector γ on this regression is referred to as the DOLS. The long-run relationship between two indices is defined as:

$$\begin{aligned} \text{NINDEX}_t = \mu &+ \gamma\text{BINDEX}_t + \beta_0\Delta\text{BINDEX}_t \\ &+ \beta_1\Delta\text{BINDEX}_{t+1} + \cdots + \beta_k\Delta\text{BINDEX}_{t+k} \\ &+ \beta_{-1}\Delta\text{BINDEX}_{t-1} + \cdots + \beta_{-l}\Delta\text{BINDEX}_{t-l} + z_t \end{aligned} \tag{9}$$

When the lag length is picked as 2 for the required regularity conditions based on Saikkonen (1991) and Hayashi (2000), the DOLS regression is as follows:

$$\begin{aligned} \text{NINDEX}_t = \mu &+ \gamma\text{BINDEX}_t + \beta_0\Delta\text{BINDEX}_t \\ &+ \beta_1\Delta\text{BINDEX}_{t+1} + \beta_2\Delta\text{BINDEX}_{t+2} \\ &+ \beta_{-1}\Delta\text{BINDEX}_{t-1} + \beta_{-2}\Delta\text{BINDEX}_{t-2} + z_t \end{aligned} \tag{10}$$

where the cointegrating vector γ is simply the static OLS estimator of γ. The rescaled t and Wald statistics based on DOLS have the asymptotic normal and chi-squared distributions. Therefore, the estimator is asymptotically equivalent to other efficient estimators.

Table 3 reports the parameter estimates by DOLS for two subsamples. The estimates of γ based on the first half of the sample and the latter half are very different, so the estimates are not stable over the sample. This finding suggests that the relationship of BINDEX and NINDEX has been broken around the end of June 1995.

Finally, the possibility could easily be tested by the Chow test of structural change to see whether the difference between the first half and the latter half is statistically significant, that is:

$$\begin{aligned}\text{NINDEX}_t = \mu + \gamma\text{BINDEX}_t + \delta_0 D_t + \delta_1 \text{BINDEX}_t D_t \\ + \beta_0 \Delta\text{BINDEX}_t + \beta_1 \Delta\text{BINDEX}_{t+1} + \beta_2 \Delta\text{BINDEX}_{t+2} \\ + \beta_{-1} \Delta\text{BINDEX}_{t-1} + \beta_{-2} \Delta\text{BINDEX}_{t-2} + z_t\end{aligned} \tag{11}$$

where D_t is a dummy variable whose value is 1 after June 30, 1995 and 0 otherwise. The Wald statistic for the null hypothesis that $\delta_0 = 0$, $\delta_1 = 0$ is asymptotically χ^2 (2). The DOLS estimate of (11) is shown in Table 2. Our test can reject the stability of parameters at the 1% size. The 1% significant Wald statistics support the view that the structural change occurred in the BINDEX and NINDEX cointegration relationship at the end of June 1995.

According to the results of cointegration analysis, the stability of the long-run relationship between the BINDEX and NINDEX was found to be broken at the end of June 1995.[11] Hence, it is anticipated that the bank stock spread, or SP, has increased in response to various news of financial troubles. Next, in order to show the effect of news on the bank stock spread, we regressed SP on various dummy variables in the next subsection.

3.3. Changes in SP

The previous subsection has shown that the long-run relationship between BINDEX and NINDEX has broken in the summer of 1995. In this subsection, we will investigate what kinds of news have caused the changes in SP, or the log difference between BINDEX and NINDEX. SP_t is shown to be a trend stationary variable as the null of the unit root was rejected at the 5% level (the unit root test is shown in Table 2, panel C) using the method of Zivot and Andrews (1992). We will take several news dummy variables to explain the changes in SP.[12]

The list of dummy variables and expected signs is summarized as follows:

- D1 the day of and one day after the announcement of major bankruptcies (+)
- D2 the news on public funds for recapitalization of funds (−)
- D3 seven days following the failures of financial institutions (+)
- D4 from the start of the Diet discussions on LTCB to the announcement of nationalization (?)
- D5 downgrading of any Japanese financial institutions[13] (+)
- D6 any day that had news on the Daiwa incident during one month following its announcement (September 26, 1995)[14] (+)
- D7 any day that had news on punishment by the US regulators on the Daiwa Bank operations in the United States from the announcement to the US decision to have the Daiwa withdraw from the United States (February 2, 1996) (+)

For D1 and D5, we use a two-day event window that includes the day of the announcement as well as the day after the announcement, in order to account for the fact that market participants may not have time to react to the announcement in the evening. (For the exact timing of the above events, see Table 3.1 in Cargill *et al*., 2000.) For D1, D2 and D7, the Nihon Keizai Shinbun newspaper, CD-ROM on news articles database, was consulted.

The following model is estimated for the above dummy variables:

$$\text{SP}_t = \beta_0 + \beta_1 \text{SP}_{t-1} + \beta_2 \text{JP}_t + \beta_3 T + \sum_{i=1}^{7} \alpha_i D_i + \varepsilon_t \tag{12}$$

where SP_t is the bank stock price spread ($\ln \text{NINDEX}_t - \ln \text{BINDEX}_t$) on day t, JP_t is the Japan premium ($\text{TIBOR}_t - \text{LIBOR}_{t-1}$) on day t,[15] β_0 is the intercept coefficient, T is the time trend variable and $\sum_{i=1}^{7} D_i$ are dummy variables explained above. Equation (12) is estimated by OLS.[16]

Table 4. OLS estimation of the SP

Const.	Time	SP_{t-1}	JP_t	D1	D2	D3	D4	D5	D6	D7	DW-h	R2
0.012***	0.00001***	0.984***	−0.002	0.0005	0.0001	0.0025***	0.0008	0.0008	0.0012	0.0027	8.77	0.997
(0.0043)	(0.000003)	(0.0056)	(0.0018)	(0.0016)	(0.0009)	(0.0012)	(0.0019)	(0.0019)	(0.0021)	(0.0022)		

*** denotes significance at 1% level.
SP_{t-1}, JP_{t-1} denote ($\log TOPIX_{t-1} - \log BINDEX_{t-1}$) and ($TIBOR_{t-1}$–$LIBOR_{t-2}$) respectively.
Parenthesis is standard error.

Table 4 presents the results from estimating equation (12) over the period between January 4, 1994 and April 30, 1999. The news on the failures of financial institutions (D3) is shown to have significant impact on SP. As expected, failures have made market participants believe that the health of financial institutions was worse than previously expected. While not statistically significant, the Diet discussion (D4) on the LTCB and a new framework for dealing with failing banks, as it dragged on, made SP increase instead of decrease. The effect of downgrading (D5) was not statistically significant, even though the sign was right, either because the Japanese investors who dominate the Tokyo stock market ignored the Moody's rating or because the downgrading had been well anticipated in the pricing.

4. DETERMINANTS OF JAPAN PREMIUM

As we have examined what kinds of news explain the structural changes in SP, to determine what kinds of news have caused the increase in the Japan premium, especially whether the response of the Japan premium was based on the domestic news or other news from abroad, the following model is estimated:

$$JP_t = \beta_0 + \beta_1 JP_{t-1} + \beta_2 SP_{t-1} + \beta_3 T + \sum_{i=1}^{7} \alpha_i D_i + \varepsilon_t \qquad (13)$$

where JP_t is the Japan premium ($TIBOR_t - LIBOR_{t-1}$) on day t, SP_{t-1} is the bank stock price spread ($\ln NINDEX_{t-1} - \ln BINDEX_{t-1}$) on day $t-1$, β_0 is the intercept coefficient, T is the time trend variable explained in note 16 and $\sum_{i=1}^{7} D_i$ are the dummy variables listed in the previous subsection.[17] The lagged endogenous variables SP_{t-1} and JP_{t-1} are ensured to be predetermined. There is no simultaneity problem in the model because of the time difference, as described in the Appendix. Therefore, it can be investigated whether SP made JP increase. JP_t is also shown to be a trend stationary variable as the null of the unit root is rejected at the 10% level (the test result is in Table 2, panel C).[18] Equation (13) is estimated by the generalized method of moments (GMM), because the standard errors of the OLS regression based on the equation are serially correlated.[19]

Table 5 presents the results from estimating equation (13) over the same period in the previous subsection. The lagged SP has a significant impact on JP. This evidence supports the idea that a decline in the bank stock index relative to other stock prices has a significant impact on increasing the Japan premium. In other words, the evaluation of the Japanese banking industry, which is determined in the domestic market, has affected the level of the Japan premium.

The news on the Daiwa Bank incident (D6) had a significant positive impact on the rise of JP, which is consistent with investors being uncertain about the transparency of Japanese banking information and about the effectiveness of the supervision system in Japan. Therefore the announcement on the incident increased JP. Our result is different from that of Peek and Rosengren (2001), who used a one-day event window for the Daiwa Bank incident and didn't obtain any significant effect on the Japan premium. Rating downgrading news (D5) has a statistically significant effect on JP. Downgrading Japanese financial institutions as expected raised the Japan premium. Foreign banks increased a premium in response to more default risk of Japanese banks as indicated in the rating change. The news on Diet discussions about LTCB for temporary nationalization (D4) did have a significant impact on the premium, probably because the

Table 5. GMM estimation of the JP

Const.	Time	JP_{t-1}	SP_{t-1}	D1	D2	D3	D4	D5	D6	D7	R2
-0.052^{***}	-0.00002	0.939^{***}	0.070^{***}	0.012	0.002	0.017^{**}	0.015^{**}	0.031^{**}	0.015^{*}	0.003	0.949
(0.0162)	(0.00002)	(0.009)	(0.029)	(0.072)	(0.005)	(0.0073)	(0.0074)	(0.013)	(0.0081)	(0.0073)	

*, **, *** denote significance at 10%, 5% and 1% levels respectively.
SP_{t-1}, JP_{t-1} denote ($\log TOPIX_{t-1} - \log BINDEX_{t-1}$) and ($TIBOR_{t-1} - LIBOR_{t-2}$) respectively.
Parenthesis is standard error.
Variance matrix in the GMM based on 3SLS for the initial value is estimated by Newly-West method, assuming 5 auto-correlation lags.

negotiation took a longer-than-expected period and foreign banks (investors) were sceptical about the effectiveness of the Japanese safety net. The Diet discussion ended with a new measure introducing effective measures to force banks to quickly recapitalize. However, the long discussion reflected scepticism among investors and increased the Japan premium.

The regression results presented above and in the preceding subsection show that the news about vulnerability and stabilization of Japanese financial systems has tended to widen the spread between the bank stock index and the general stock index. Although the banking spread in the stock markets, SP, has been affected by domestic news, the news that affects the Japan premium is sometimes different. The Japan premium tends to increase in response to news that made the international financial press, such as the Daiwa Bank incident in New York and the downgrading of Japanese financial institutions by foreign rating agencies. A dynamic causal relationship between SP and JP is also analysed by the same results since the two equations, (12) and (13), are in the same form.

The lagged endogenous variable SP_{t-1} in the JP equation (in Table 5) is statistically significant, and based on a simple t-test, the bank stock index is said to Granger cause the Japan premium. However, the lagged endogenous variable JP_{t-1} is not significant in the SP equation (in Table 4). Thus, the decline of the bank stock index relative to other stock prices affects the increase in the Japan premium, but not *vice versa*. We examine the VAR system in the next section to formally see Granger-causality in VAR with lags.

5. VAR WITH TWO LAGS

In this section we present the results of F-statistics by the VAR system. The two variables, SP and JP, are contemporaneous intraday variables, so that they can be treated by a regular time series model. A vector autoregressive model will be used to test Granger-causality. The VAR model can be written in the following form with 2 lags of the variables:

$$\begin{bmatrix} 1 & 0 \\ -\alpha & 1 \end{bmatrix} \begin{bmatrix} JP_t \\ SP_t \end{bmatrix} = \sum_{i=1}^{2} \begin{bmatrix} \pi_{11,i} & \pi_{12,i} \\ \pi_{21,i} & \pi_{22,i} \end{bmatrix} \begin{bmatrix} JP_{t-i} \\ SP_{t-i} \end{bmatrix} + \begin{bmatrix} u_{1t} \\ u_{2t} \end{bmatrix} \tag{14}$$

where $\begin{bmatrix} \pi_{11,i}\pi_{12,i} \\ \pi_{21,i}\pi_{22,i} \end{bmatrix}$ is a matrix of VAR coefficients and $\begin{bmatrix} v_{1t} \\ v_{2t} \end{bmatrix}$ is a vector of white noise process shocks to the model. In the model, adding constant, time trend and dummy variables described in Section 3.3 to equation (14), SP is said to Granger-cause JP if lagged values of SP have explanatory power in a regression of JP. This set of identifying restrictions can be implemented by estimating the structural form with least squares—equation by equation—to calculate F-statistics.

Only F-statistics in the above VAR for the sample period of January 1994 to April 1999 are shown in Table 6, since the result was very similar to the one presented in the previous section and SP and JP have a stationary process so that Granger-causality can be checked by looking at the F-test. The 'SP lags' in the JP equation are statistically significant, hence the bank stock index is said to Granger-cause the Japan premium. However, the 'JP lags' are not significant in the SP equation. The causal relationship is not

Table 6. F-statistics in VAR with 2 lags 1994/1/4-1999/4/30

	JP	SP
JP lags	5794.49**	0.469
SP lags	3.865*	16393.02**

, * denote significance at 5% and 1% levels respectively.
The critical values are 3.00 and 4.61 respectively at the 5% and 1% levels by F(2,∞).

changed. The determination of Granger-causality based on the test is robust and not affected by lag selection. We have also examined the VAR system with higher order of lags, but the results of the *F*-test didn't change.

The bank spread in the stock market and the Japan premium both contain important information to understand Japanese financial systems and explain their fragility. The joint analysis of the two indicators shows that announcements which increased the bank stock spread also affected the Japan premium over time.

6. CONCLUDING REMARKS

This paper investigates how financial weakness among Japanese banks was viewed by the market participants in Japan and abroad. Two indicators, the Japan premium (the premium that Japanese banks had to pay over western banks when they borrow Eurodollar and Euroyen in the interbank market) and the stock price index of the banking sector relative to other stock prices in Tokyo, were examined. How foreign and domestic market participants evaluate the net worth and default risk of Japanese banks is reflected in the bank stock prices and the Japan premium, respectively. The relationship between the bank stock index, BINDEX, and the stock price index excluding banks, NINDEX, is examined in several aspects.

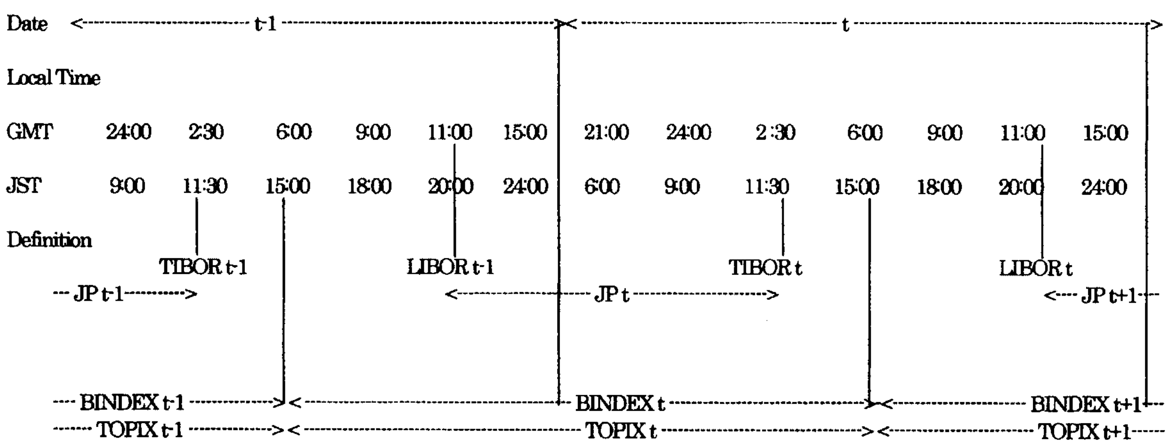
The Japan premium started to increase in the summer of 1995 and had three peaks between 1995 and 1998 before its disappearance in April 1999. Factors that contributed to the decreases were the second capital injection, an improved new regulatory system and an increase in latent capital gains of banks. However, the other indicator, the bank stock spread, remains high even after the Japan premium has disappeared. Therefore it seems that the Japanese financial crisis (in terms of credit and counterparty risk) has decreased in April 1999, but the profitability of Japanese banks (relative to other sectors in the Japanese economy) has remained low.

We examined how the news of bank failures was received by the stock market in the short term and found that bank failures in November 1997 significantly brought down stock price indices. Systemic risk of the banking sector was feared in that period. Stock prices of banks with low credit rating were especially hit hard. News on bank failures increased the spread between the bank stock index and the stock price index excluding banks in the long run. In order to show formally the deviation of the bank stock index from the stock price index excluding banks, we employed an econometric test allowing for an unknown break point. The breaking point is estimated to be the end of June 1995.

We also examined what kinds of news have caused the bank stock spread to widen and the Japan premium to increase. Changes in the bank stock spread were influenced by domestic news about vulnerability and stabilization of Japanese financial systems, including news on the failures of financial institutions. However, changes in the Japan premium were influenced by domestic news as well as news from abroad. News that affected the Japan premium and the bank stock spread was not identical. Based on regressions, news on the failures of financial institutions was shown to have significant impacts on the spread of the two stock indices. In the same way, we found that the lagged bank spread had a significant impact on the Japan premium. Therefore it is true that the evaluation of the Japanese banking sector, which is determined in the domestic market, has affected the level of the Japan premium. News of the Daiwa Bank incident and those of bank downgrading were also shown to have significant impact on the Japan premium.

A relationship between the two indicators has been analysed by VAR. Both the bank stock spread and the Japan premium have contained important information with regard to the financial system in Japan. The joint analysis has shown that announcements which have an impact on the bank stock spread increased the spread, then increased the Japan premium.

APPENDIX



Abbreviation:
GMT: Greenwich Mean time
JST: Japan Standard Time
TIBOR: Tokyo Interbank offered rate
LIBOR: London Interbank offered rate
JP: Japan Premium
BINDEX: Bank stock Index.

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NOTES

1. Brewer *et al.* (2000) came to our attention after we wrote Ito and Harada (2000) and the first draft of this paper.
2. Saito and Shiratsuka (2001) examine the Japan premium perceived in offshore money markets, the Eurodollar market as well as the Euroyen market, and observe that the premium was more serious in the dollar market. Hanajiri (1999) examines the Japan premium emerging in the Eurodollar, Euroyen and swap markets. Both papers, however, consider that the Japan premium emerged and caused trouble in the late fall of 1997.
3. Monthly market valuations are taken from *Statistics Monthly* of the Tokyo Stock Exchange. The monthly figures are adjusted for daily figures by price index changes, assuming that the number of issued stocks does not change within that month. Any problem with this assumption is corrected within the month.
4. One might ask whether divergence may be in any way related to a regular business cycle of a recession or a recovery or a cyclical movement of general stock prices, rather than a peculiarity of the time. Hence, we will check whether movements of the two indices in the second half of the 1990s are in any way typical or atypical in the long-run trend. Comparing the monthly index of TOPIX and BINDEX from 1985 to 1999, one can confirm that the relationship has been stable between the two indices until the mid-1990s, over the business cycles and stock price cycles.
5. Alternatively, the Japan premium can be measured as the borrowing rates of Japanese banks in London vs. the borrowing rates of western banks in London. In essence, our approach produces a premium very similar to that by the alternative approach. LIBOR

and TIBOR are money market interest rates and they are the only offered rate of each bank, that is on the bid rate or ask rate. Empirical behaviour is analysed by the difference of the two interbank offered rates. For the calculation of the TIBOR and LIBOR, see Hanajiri (1999) and Ito and Harada (2002), for example.

6. Our event study results are used in the time series analysis for the construction of the event dummy variables. The window size used for each dummy variable is based on the findings in this subsection.
7. Zivot and Andrews' (1992) procedure has been the most widely utilized in the literature. However, Lee *et al.* (1999) and some other recent papers find that a unit-root test of Zivot and Andrews (1992) leads to spurious rejections when the data generating process includes a structural break under the null hypothesis (see Lee *et al.*, 1999 for details). They suggest including a break under the null. We follow their suggestion. A one-time change in the level of the series is included in the testing regression.
8. Treating the break fraction as outcome of the estimation and using the critical values from the asymptotic distribution of $\inf_{\lambda\in\Lambda} t_{\hat{\alpha}}(\lambda)$, the unit root null is accepted for the two indices.
9. Perron (1989) was the first to argue that unit root tests would lead to a misleading result if there is a break in the deterministic trend of nonstationary series. Cointegrated relationships are also the same case. Gregory *et al.* (1996) showed the sensitivity of the residual-based test for cointegration if there is a single break. Andrews (1993) showed a test for a case where the timing of structural change is unknown. Seo has been based on Andrews and made the calculation easier. Quintos (1997) showed a similar test in the error correction model.
10. The estimated break point is equal to Zivot and Andrews' unit root break points that showed 359 and 361 for NINDEX and BINDEX, respectively.
11. It is known that the length of the time series is an important consideration in investigating cointegrated relationships. However, a longer period of the interbank borrowing data is not available. Although the power is somewhat lower, an analysis with a time period shorter than ideal can be done in seeking for a possible structural breaking point.
12. Not all pieces of news provide equal influence in terms of new information. The construction of event dummy variables is based on the results in Section 2.3 and those in Ito and Harada (2000). We believe that equal length windows don't capture the proper effect of the event. Therefore, creating a two-day event window or a seven-day event window does not mean that we assume an inefficient market.
13. We include only announcements in which at least two Japanese city banks are downgraded by foreign rating companies, Moody's, S&P and IBCA. We picked the news from the Nihon Keizai Shinbun newspaper reporting.
14. The Daiwa Bank incident was not a one-day event. The way we define the dummy variable reflects our view that the incident was not just a single event but a series of events, because it was almost one month later when the supervision problem of the Japanese authorities came to light. In fact, the Japan premium peak of 1995 coincides with a particular item of news related to the Daiwa Bank incident, in that it was revealed that Japanese authorities didn't report the incident to US regulators in time. Every day, newspapers reported the progress in the incident investigation and the incident became more serious. Therefore we created a dummy variable for any day a newspaper reported the Daiwa Bank incident, which lasted about a month since the first news broke.
15. JP_t in equation (12) is predetermined three and a half hours earlier, at 11:30 am. SP_t is determined at 15:00 pm. There is no simultaneity problem.
16. The hypothesis of the unit root null was not rejected when critical values of the asymptotic distribution were used. As it is known that SP data is trend stationary so that the trend is not removed by taking first differences in the estimations, a time trend is used instead. The time dummy variable in equation (12) takes 1 for the period June 1, 1995 through April 30, 1999 and 0 otherwise. This is based on the structural break unit root test results. Time trend T is not the dummy variable of the structural break point that is found in the relationship between BINDEX and NINDEX, here the spread variable SP is focused.
17. The asymmetry between equation (12) and equation (13) is not a puzzle. Taking time difference into consideration, the right-hand side variable should be predetermined. Therefore, (12) includes the contemporaneous value of JP and (13) includes the lagged value of SP. See the Appendix.
18. The result was the same as SP, based on the break fraction as the outcome of the estimation by the method of Zivot and Andrews (1992), that is, the unit root null was rejected for the fixed value of the break fraction. However, the hypothesis was not rejected when critical values of the asymptotic distribution were used.
19. The OLS standard errors of equation (13) showed serial correlation by White's test. The OLS variance of the same equation revealed heteroscedasticity-correlated standard errors by the Breusch–Godfrey test. Since the orthogonality condition between the error term and regressors is rejected, we apply GMM to the equation. For the weighting matrix, initial values are obtained by 3SLS and the Newey–West (1987) weighting scheme is used, assuming a five-period autocorrelation.

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