A Yen is not a Yen:
TIBOR/LIBOR and the determinants of the 'Japan Premium'

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Abstract

Pricing in the Euroyen market is based on LIBOR, the London Interbank Offered Rate, set at 11am London time or TIBOR, the Tokyo Interbank Offered Rate, set at 11am Tokyo time. Since the TIBOR panel is dominated by Tokyo city banks while the LIBOR panel is dominated by non-Japanese banks, the changing TIBOR-LIBOR spread reflects the credit risk associated with Japanese banks or the "Japan premium." In this paper, we investigate the determinants of this "Japan premium." The spread is modeled as a function of determinants of bank default and firm value suggested by a theory of credit spreads. Our results suggest that systematic variation in the spread can be explained by interest rate and stock price effects along with public information flows of good and bad news regarding Japanese banking, with a separate individual role for Japanese bank credit downgrades and upgrades.

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I. INTRODUCTION

Japanese yen pricing in the international money market known as the "Euroyen" market uses two bases: LIBOR, the London Interbank Offered Rate, set at 11 a.m. London time, or TIBOR, the Tokyo Interbank Offered Rate, set at 11 a.m. Tokyo time. Floating interest rate yen-denominated issues settled during European trading hours use LIBOR as the pricing basis. But to avoid interest rate risk, issues settled during Asia-Pacific trading use TIBOR for pricing. There was once a time when there was no substantive difference between these two pricing measures. Figure 1 contains a plot of the TIBOR-LIBOR spread from the early 1990s. It can be seen that the spread appears to fluctuate randomly around zero until around mid-1995. Then during the 1995-1999 period, the spread is significantly positive with a mean of about 10 basis points. By late 1999, the spread seems to disappear, only to reappear by 2001. Since TIBOR is determined essentially by Japanese banks, the positive TIBOR-LIBOR spread may be thought of as a "Japan premium." This paper will explore the determinants of this "Japan premium."

The effect of changing credit risks on the interbank interest rates resulted in seemingly bizarre intraday interest rate dynamics in the last half of the 1990s. If one examines the online Reuters pages displayed on money market participants' computer monitors, one finds that there were systematic shifts in the yen interest rates depending upon time of day. Since Japanese banks dominated quoting during Asian business hours, yen interest rates at this time of day were systematically higher than yen quotes at other times. This intraday split between lower-credit-rated Japanese banks and higher-credit-

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rated banks of other time zones created spurious statistical effects of high absolute values

of returns (changes in interest rate levels) over 12 hour time intervals and strong negative

autocorrelation of returns at 12 hour lags. These effects were due solely to the shifting

credit ratings of the banks that dominated the different time zones.[1] In terms of TIBOR

and LIBOR, if one asked what *the* interbank interest rate was on the yen, the answer

would depend upon the time zone in which this question was asked. For Asian markets

where TIBOR is quoted, one would have a systematically higher yen rate than for

Western Europe and the Americas where LIBOR is quoted. One must take into account

these time-of-day effects when modeling yen interest rates over this period.

Why did the Japan premium arise? We will focus our empirical work below on

the determinants identified in Section III, but before proceeding to the analysis, it is

useful to take a broader look at the issue. Kanaya and Woo (2000) provide a nice

summary of the 1990s banking crisis in Japan. They argue persuasively that the roots of

the crisis are found in the deregulation of Japanese financial markets at the same time as

the capital markets were significantly deepened in the late 1980s.[2] Banks faced greater

competition so that their risk-adjusted interest rate margins shrunk. They reacted to this

new state of heightened competition by relaxing credit conditions and extending the

average maturity of loans. When the regulators tightened bank lending to the real estate

market, aimed at halting the upward spiral in land values, real estate prices began a

decline. In turn, bank asset growth began to shrink and the quality of bank loans and

balance sheets turned downward. While the situation deteriorated in the early 1990s, the

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[1] Discussion of these spurious statistical effects is provided in section 2.3 of Gençay, Dacorogna, Müller, Olsen, and Pictet (2000).
[2] Ito and Melvin (2000) provide an overview of the deregulation of Japanese financial markets along with some early empirical effects on the foreign exchange market.

government authorities were reluctant to step in and make substantive changes as they were waiting for a revival of economic growth, which they hoped would allow the situation to be remedied without any further intervention. There was a fear in the government that any major moves might elicit a banking panic. The delay in taking substantive steps to shore up the system resulted in a lengthening of the crisis and the insolvency of problem banks. Kanaya and Woo argue that not until the creation of the Financial Supervisory Agency in June 1998 followed by capital injections associated with bank restructuring, was there a stabilization of the banking crisis.

Loans in the offshore banking industry have no lender of last resort guaranty if a bank fails. This risk will be priced in a premium that reflects the probability of failure and the expected payoff to creditors if a failure occurs.[3] In this regard, the likelihood of government bailouts of the banking system result in a lower probability of loss and, consequently, a smaller premium. The Japan premium appeared in 1995 with the failure of Hyogo Bank. Prior to this bank failure, the Japanese government had arranged take-overs of insolvent banks in order to avoid failures. The so-called "convoy system" had government protecting financial institutions so that the whole system was viewed in a paternalistic manner. In the mid-1990s there was a push towards deregulation of the Japanese financial market and more reliance on market discipline. The credit risk appeared greater in the new environment and the new government approach to bank insolvency resulted in the emergence of the Japan premium and a consequent greater cost of funds for the Japanese banking system.

There have been recent studies of the Japan premium that will be discussed in the following section. However we believe that the new research reported in this paper is the

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[3] A good intuitive discussion of this premium pricing is provided in Spiegel (2001).

first to examine interbank yen pricing in the context of the determinants of the TIBOR-LIBOR spread.[4] Others have focused on the rates of individual banks relative to LIBOR or the correlation between Japanese bank stock prices and the TIBOR-LIBOR spread. But for futures and options markets and pricing floating-interest-rate loans, it is important to understand the determinants of the TIBOR-LIBOR spread. With that goal in mind, the analysis covers nine years of data from the early 1990s to 2001, and includes the interesting periods containing the Japan premium. After discussing the theoretical framework of credit risk in which most empirical studies are based, we conduct a thorough empirical analysis of the determinants of the Japan premium. In addition to financial variables like interest rates, equity returns, and volatility as are standard in credit risk models, we also include important news related to Japanese banks and credit rating announcements that may be related to a change in the probability of a jump in firm value.

The paper is organized as follows. Section II discusses some institutional details of the market that are useful in understanding how the TIBOR-LIBOR premium arises followed by a brief overview of prior work. Section III provides a simple theoretical setting to structure the analysis that follows. Section IV discusses the data used in the present paper and the methodology. Section V presents the estimation results and discusses related issues including the robustness of the findings to alternative specifications. Finally, Section VI offers a summary and conclusions.

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[4] Ito and Harada (2000) study interbank *dollar* pricing in terms of TIBOR and LIBOR along with Japanese bank stock prices.

II. INSTITUTIONAL DETAILS AND RELATED RESEARCH

Loans in the euroyen market are typically made at floating interest rates quoted at a spread above a benchmark rate such as TIBOR or LIBOR. These benchmark rates are rates of interest at which banks borrow funds from other banks. In addition to the use of these benchmarks in pricing loans, LIBOR is also used as the basis for settlement of interest rate contracts on major futures and options exchanges such as the London International Financial Futures & Options Exchange (LIFFE), the Chicago Mercantile Exchange (CME), the Singapore Exchange (SGX), and others and TIBOR is used for settlement of the most actively traded contract on the Tokyo International Financial Futures Exchange (TIFFE) along with settlement of euroyen futures and options at SGX.[5]

II.A. TIBOR and LIBOR Fixings

The British Bankers' Association (BBA) fixes a value for LIBOR each day at 11:00 a.m. London time for each major currency. The value is drawn from a panel of contributing banks chosen based upon their reputation, level of activity in the London market, and perceived expertise in the currency concerned. Shortly before 11:00 each business day, each bank reports the rate at which it could borrow funds of a reasonable market size by accepting inter-bank offers from banks other than the LIBOR panel of contributing banks. The contributed rates are ranked in order and only the middle two quartiles are averaged in determining LIBOR. The banks contributing quotes for the Japanese yen are: Bank of Tokyo Mitsubishi, Bank of America, Barclays Bank, Deutsche Bank, Dai-Ichi Kangyo Bank, Fuji Bank, HSBC, Industrial Bank of Japan, JP Morgan,

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[5] Singapore has Euroyen contracts for both LIBOR and TIBOR.

Norinchukin Bank, Rabobank, Royal Bank of Scotland, Sanwa Bank, Sumitomo Bank, UBS, and Westdeutsche Landesbank.[6]

TIBOR rates are fixed each day by the Japanese Bankers Association (JBA or "Zenginkyo").[7] TIBOR is calculated based upon rates quoted by a panel of eighteen banks chosen according to their activities in the Japan Offshore Market. TIBOR rates are based on the view of the panel banks at 11:00 a.m. Tokyo time as to the current offered rate for Euroyen deposits. TIBOR is calculated by dropping the two highest and two lowest quotes submitted and then averaging the rest. The contributing banks are: Dai-Ichi Kangyo Bank, Sakura Bank, Fuji Bank, Tokyo-Mitsubishi Bank, Asahi Bank, Sanwa Bank, Sumitomo Bank, Tokai Bank, Bank of Yokohama, Mitsui Trust & Banking, Mitsubishi Trust & Banking, Yasuda Trust & Banking, Sumitomo Trust & Banking, Industrial Bank of Japan, Barclays Bank, Credit Suisse First Boston, Zenshinren Bank, and Norinchukin Bank.[8] The fact that TIBOR is fixed with only two non-Japanese banks while LIBOR has a minority of Japanese banks involved in the fixing (whose higher quotes would tend to be eliminated by the trimming to the middle quartiles) gives rise to the Japan premium in the TIBOR-LIBOR spread.

As we shall review below, there exists research on the Japan premium that uses TIBOR and LIBOR on eurodollar deposits. We have chosen to focus on the euroyen market for several reasons. First, as noted in Hanajiri (1999), the Japanese Bankers Association does not publish a TIBOR rate for eurodollars. As a result, he uses as a

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[6] As listed on the BBA website www.bankfacts.org.uk. Royal Bank of Scotland replaced National Westminster Bank on October 2, 2000. On January 20, 1999, Bank of China, Citibank, Tokai Bank, and Sakura Bank were replaced by Deutsche Bank, Norinchukin Bank, Rabobank, and West LB.
[7] The Japanese Bankers Association was established in April 1999. Its predecessor was the Federation of Bankers Associations of Japan.
[8] As listed on the JBA website www.zenginkyo.or.jp. The Bank of Yokohama replaced the Long-Term Credit Bank of Japan on July 1, 1999.

proxy the eurodollar interest rate indication in the Japan Offshore Market. We examined

the "TIBOR" data collected by Bloomberg as a proxy for the true unpublished TIBOR.

Bloomberg states that their "TIBOR" data are taken at the Tokyo close, so the time of

day is not the same as the true TIBOR fixing and Bloomberg does not reveal who the

data contributors are. It is often said that the Japan premium in the eurodollar market is

greater than that in the euroyen market. Using the Bloomberg TIBOR data, we find that

in absolute terms that is true. Over the 1992-2001 period of our sample, the mean

TIBOR-LIBOR premium was 11.6 basis points for eurodollars and 4.8 basis points for

euroyen. However, in relative terms as a fraction of the mean level of the TIBOR rate for

each currency, we find the mean Japan premium on eurodollars was equal to 2.2 percent

of the mean dollar TIBOR while the mean Japan premium on euroyen was equal to 3.8

percent of the mean yen TIBOR. So relative to the underlying interest rates, the Japan

premium was more than 70 percent higher on euroyen than eurodollars. Given the

difficulty of finding true TIBOR data for eurodollars, and the greater relative magnitude

of the Japan premium on the euroyen, we have chosen to focus on the Japan premium in

the euroyen market.

II.B. Related Research

The Japan premium has been studied in terms of several different markets.

Perhaps the study closest in spirit to ours is Ito and Harada (2000). They study the

interaction between Japanese bank stock prices and the TIBOR-LIBOR spread on the

U.S. dollar. An important finding of theirs of relevance to our study is that the bank

stock prices exert a causal influence on the TIBOR-LIBOR spread on the dollar but there

is no reverse causality. Hanajiri (1999) examines the Japan premium in the eurodollar, euroyen, and dollar/yen swap markets in the fall of 1997 and 1998. He finds that the swap rate diverges from the theoretical value derived from the underlying assets and conjectures that this may be due to a widening information asymmetry between Japanese and non-Japanese market participants. Peek and Rosengren (2001) study the premium paid by two Japanese banks, Bank of Tokyo-Mitsubushi and Fuji Bank, over an average rate paid by a group of U.S. and U.K. banks as measured by their contributed rates to LIBOR. They estimate models of the two-day change in this premium for each bank as a function of government announcements. The two-day window is used since Japanese banks have closed by the time LIBOR is announced at 11:00 London time. Using relevant news related to government announcements as reported in the *Wall Street Journal*, they find that government announcements not associated with concrete actions had no effect. Announcements of funds injections into the banking system lowered the premium, actions to strengthen supervision and actions threatening to return to the "convoy system" increased the premium.

Packer (1999) investigates the changing patterns of yields on Japanese corporate debt and finds that structural changes have occurred. By 1997, credit ratings became much more important than they used to be in determining corporate bond yields in Japan. Furthermore, yields have increased most on bonds issued by firms belonging to a *keiretsu*. Keiretsu are networks of firms that have intertwined business ties including a large bank. Historically, it was expected that debt default by a member firm would be avoided through bailouts by the main keiretsu bank. The rise in yields among debt of keiretsu firms indicates that such bank bailouts are less likely than in the past. Perhaps

this is not surprising in an era when Japanese banks are in crisis and facing credit downgrades.

Eom, Subrahmanyam, and Uno (2000) examine the evidence related to yen interest rate swaps. Since over-the-counter swaps are not backed by the guarantee of an exchange, each counterparty is exposed to the default risk of the other. The authors find that proxies for default risk (corporate bond yields) have positive and significant effects on yen swap spreads (the swap rate above the corresponding maturity Japanese government bond rate). While the authors do not explicitly address a changing "Japan premium" over their sample, their evidence does reveal an increase in the yen swap rates relative to the government bond rate (the "no-default return") in the mid 1990s compared to the early 1990s. So it appears that one can infer an increase in the Japan premium as measured by yen swaps as the mid 1990s arrive.

Overviews of the banking crisis in Japan help us to place events in the proper context. However, to actually date events and identify which events had important impacts on the market, we must turn to empirical analysis of the relevant data. The next section will provide a framework in which to conduct such research.

III. DETERMINING CREDIT SPREADS

We follow the structural models of credit spreads in motivating our analysis of the Japan premium. In particular, the model developed by Longstaff and Schwartz (1995), that incorporates both default risk and interest rate risk, will be used to structure the discussion. A version of this model was recently used by Collin-Dufresne, Goldstein, and Martin (2001) to model credit spreads on corporate bonds. In this setting, firm value V follows the dynamic process

$$dV / V = (r - \delta)dt + \sigma dZ + \lambda(dq - pdt) \tag{1}$$

where V is the value of the firm, r is the riskless interest rate, δ is the payout rate to claimants in case of a default, σ is firm volatility, dZ is a standard Wiener process, λ is a jump in the value of the firm, p is the risk-neutral probability of a jump, and the risk-neutral transition density of the jump process dq is equal to *1 (0)* with probability *pdt (1-pdt)*. If the value of the firm reaches a threshold value K, default occurs.

In the context of this structural model of default risk, credit spreads are determined by the interest rate r and the firm's return on equity. So an empirical model of the price of credit risk (the Japan premium in our case) should include variables relevant to these two factors. We will explore the effects of the following:

a) the yield on Japanese government securities – we expect this effect to be negative due to the argument in Longstaff and Schwartz that "an increase in the interest rate increases the drift of the risk-neutral process for V, which in turn makes the risk-neutral probability of a default lower" (p. 808).

b) the yield curve – if shifts in the term structure have implications for expected future short-term rates, then a steeper yield curve should imply higher future short-term rates and a lower credit spread. So a negative effect is expected on the long rate minus the short rate. The level of interest rates and the slope of the term structure have been frequently used in empirical models of credit spreads (see, for instance, Duffee (1998)).

c) stock values – Changes in stock prices for Japanese banks should contain information related to the credit risk associated with interbank loans. In addition to the Japanese bank stock price index, we will also explore the information contained in some additional stock price indexes. Since banks make large loans to finance real estate and new construction, the deterioration of Japanese bank balance sheets has been linked to downturns in the real estate and construction industry. A fall in the Japanese real estate or construction industry stock index should have a positive impact on the Japanese bank credit spread. We will also investigate the effect of a broad measure of the Japanese stock market, the TOPIX index, and its relation to the Japan premium.

d) stock price volatility – credit spreads should increase with the volatility of firm value. Increased stock price volatility and the associated higher volatility of firm value should increase the probability of default. So credit spreads should rise with stock price volatility.

e) change in the probability of a negative jump in firm value as measured by public news – Rating agency news and other news regarding Japanese banking are employed. If rating agencies downgrade Japanese banks, we expect a higher probability of a negative jump in firm value and a rise in the credit spread. Upward revisions in bank credit ratings should

have the opposite effect. Public news regarding Japanese banks may be positive (as in the case of a government bailout) or negative (as in the case of a bankruptcy announcement). Discussion of the exact empirical proxies employed to measure these variables will be provided below in Section IV.

IV. DATA AND METHODOLOGY

The goal of our empirical study is to identify important factors related to the Japan premium. Since we measure this premium by the difference between TIBOR and LIBOR, time-of-day issues are important. If we calculate the spread between TIBOR and LIBOR on the same day t, $(T_t - L_t)$, then the TIBOR fixing precedes the LIBOR fixing and we focus on the impact of news between 11 a.m. Tokyo time and 11 a.m. London time. If we calculate the spread as the difference between TIBOR today and LIBOR yesterday, $(T_t - L_{t-1})$, we focus on the impact of news between 11 a.m. in London yesterday and 11 a.m. in Tokyo today. In this sense, the twenty-four hour day is broken into two periods as far as the flow of information and yen pricing in the money market. For this reason, it is not enough to simply know the day that important information is received by the market, we must also know the time.

The first step involves constructing a data set of important news related to the Japanese banking industry. As discussed in Section III, such news affects the probability of a negative jump in firm value. The data include news about credit rating changes and more general news. To identify the timing of credit rating announcements, we searched the Bloomberg rating pages to identify the date that a rating change was announced. Then, given that date, we identify the time of day the announcement occurred via a search of the Bloomberg news pages for the rating announcement. Consultation with personnel at Moody's and Standard and Poor's in Singapore confirmed that rating announcements are generally made in the London morning, after 11:00 in Tokyo. So rating changes generally fall in the time interval after the TIBOR fixing and before the

LIBOR fixing. For more general news, we searched the Lexis/Nexis data base for Japanese bank news that appeared in the *Wall Street Journal* or *Asian Wall Street Journal*. After identifying the days that important news appeared, we then searched the Bloomberg news pages for the exact time that the news was announced. This methodology allows us to place each event in the proper time period between 11:00 London time and 11:00 Tokyo time. Each news event was classified into either a "good news" or "bad news" variable and zero-one dummies were created for each. Similarly, credit rating announcements were classified as either rating upgrades or downgrades, and zero-one dummies were created for each.

The earliest availability of the news data in electronic form defines the starting period of our data set as August 3, 1992. We collected data through March 22, 2001. Data on the 90-day (the deepest market) TIBOR and LIBOR interest rates were taken from Datastream. The empirical measures of the other determinants of the Japan premium are as follows: current government interest rate, the yield on the 3 month Japanese treasury bill; the slope of the yield curve, the 10-year Japanese government bond yield minus the 3-month bill rate; and various measures of Japanese stock prices. In addition to the Japanese bank stock index, we also employ the construction index, real estate index, and TOPIX index. All of these series are from Datastream.

Before proceeding to the estimation of credit spread models, we present summary statistics for the basic measures of TIBOR, LIBOR, and the spread in Table 1. As expected, TIBOR has a higher mean than LIBOR and the mean spread, constructed as the difference between TIBOR today and LIBOR yesterday, is positive. Over the sample period, TIBOR (LIBOR) reached a maximum value of 4.1875 (4.1250) and a minimum

value of 0.1008 (0.0775). Based upon the Jarque-Berra statistics, we can reject the

hypothesis of normality for each variable in terms of its skewness and kurtosis.

V. ESTIMATION RESULTS

V.A. Model Specification

Since the world of yen pricing in the money market is split into two segments, one must take care in model specification to ensure that information flows are matched with the proper timing of the TIBOR-LIBOR spread. We define the spread between TIBOR on day t and LIBOR on the prior day t-1 as *premium$_t$*. This choice of spread definition is justified by the timing of events displayed in Figure 2. Figure 2 illustrates the intra-day events of concern. Consider what could happen if we measured the Japan premium by the difference between TIBOR and LIBOR on day t. News arriving between the time of the TIBOR fixing and the LIBOR fixing (*news2$_t$* in Figure 2) will most immediately affect the next LIBOR fixing. Suppose news is received that raises euroyen interest rates but also raises the Japan premium so that TIBOR will rise relative to LIBOR. Measuring the premium as $TIBOR_t$-$LIBOR_t$ would have the measured premium fall in response to the news as LIBOR changes while TIBOR is fixed until tomorrow. To avoid such spurious results due to the timing convention, we specify our empirical model in terms of $TIBOR_t$-$LIBOR_{t-1}$. This measured Japan premium, *premium$_t$*, will be conditioned upon news arriving between TIBOR and LIBOR at time t-1 (*news2$_{t-1}$* in Figure 2) and news arriving between LIBOR at t-1 and TIBOR at time t (*news1$_t$* in Figure 2). The news and ratings events were classified as falling into one or the other time segments of the day so that we estimate a general model for each time period as:

$$dpremium_t = \alpha_0 + \alpha_1 dbill_{t-1} + \alpha_2 dyield_{t-1} + \alpha_3 dstock_{t-1} + \alpha_4 stockvol_{t-1}$$
$$+ \beta_1 badnews1_t + \beta_2 goodnews1_t + \beta_3 downgrades1_t + \beta_4 upgrades1_t \qquad (2)$$
$$+ \beta_5 badnews2_{t-1} + \beta_6 goodnews2_{t-1} + \beta_7 downgrades2_{t-1} + \beta_8 upgrades2_{t-1}$$

where the variables are:

dbill=change in 90-day Japanese treasury bill rate

dyield=change in slope of yield curve (10 year govt. bond rate – 3 month bill rate)

dstock=change in log of stock price index (Japanese bank stocks index)

stockvol=equity market volatility as measured by the conditional variance of stock market index returns from a rolling GARCH model using approximately one years' data (250 observations)

badnews= dummy for bad news received

goodnews=dummy for good news received

downgrades=dummy for credit downgrades

upgrades=dummy for credit upgrades

The suffix *1* on a variable refers to an event that occurred between the LIBOR fixing and the next TIBOR fixing (a *news1* variable in the terms of Figure 2). The suffix *2* refers to an event that occurred between the TIBOR and LIBOR fixing on the same day (a *news2* variable in the terms of Figure2). Unit root tests reveal that the TIBOR-LIBOR spread is approximately I(1) so all interest rate and stock index variables are first differenced to achieve stationarity. The stock price index is the first difference of the log of the index.

V.B. Estimation Results

Estimation results are given in Table 2. The interest rate has a negative impact on the Japan premium as suggested by Longstaff and Schwartz's (1995) model. The argument is that a rise in the interest rate increases the drift in the value of the firm and reduces the probability of default. Similarly, the slope of the yield curve has a negative

effect on the TIBOR-LIBOR spread. A steeper slope may lead to forecasts of higher future short-term rates so that the expected future interest rate effect is discounted to the present and the probability of default falls. The bank index for the Tokyo stock market has a negative, but statistically insignificant, effect on the spread. As bank stock prices fall, we expect the Japan premium to increase. The volatility of the bank stock index has a positive effect on the Japan premium. As the volatility of the bank index increases, the probability of Japanese bank default increases.

Reviewing the Table 2 results for the news variables, which may capture changes in the value of banks not captured by the interest rate and stock proxies, it is seen that bad news received between the LIBOR fixing yesterday and TIBOR today has a significant positive impact on the spread. Good news received in the same time interval is reflected in lower spreads. Bank credit downgrades announced during that time interval have a significant impact on raising spreads. However, upgrades announced during that time interval have no significant effect on spreads. In terms of information received between the Tokyo fixing yesterday and the London fixing later on the same day, bad news is insignificant and good news has a significantly negative spread effect. Credit downgrades and upgrades received during this period have no significant impact on spreads.

In terms of economic significance, we use the estimated coefficients to measure the change in the spread given the arrival of a particular type of information. Bad news arriving between the LIBOR fixing yesterday and the TIBOR fixing today, increases the spread by about 1.5 basis points, on average. Good news that arrives during the same time interval, decreases the spread by about 1.6 basis points, on average. Credit downgrades received during this time interval increases the spread by about 0.8 basis

points. Good news received during the period between the TIBOR fixing yesterday and the LIBOR fixing later yesterday decreases the spread by about 1.2 basis points

A general finding is that news received between the LIBOR fixing and the following TIBOR fixing has a larger impact on spreads than information received between the TIBOR fixing and the later LIBOR fixing on the same day. In addition, it appears that credit downgrades have a greater effect on spreads than do credit upgrades. Given the sensitivities of the market to problems in Japanese banking, these results indicate that bad rating news was taken as a more important signal of bank quality than good rating news. Likelihood ratio tests on the news and creditworthiness rating changes indicate that they are jointly highly statistically significant (p-value of 0.00).

V.C. Robustness to Alternative Specifications

An examination of Figure 1 suggests that there may be important structural breaks in the data. Likely breaks in the process are August 3, 1995 when the Hyogo Bank failure was announced and March 30, 1999 when the Japan premium returned to zero. Testing the hypothesis that the period of the high premium from August 3, 1995 to March 30, 1999 involved a structural break from the rest of the sample, we find an F-statistic of 15.5 (p-value, 0.0).[9]

Table 3 reports estimation results allowing for a structural break in the news effects. A dummy variable, *dumlow*, is created which is equals one for the two low-premium subsamples and equals zero for the high Japan premium middle period of August 30, 1995 to March 30, 1999. The equation estimated includes each news variable

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[9] Since the *upgrade2* variable is zero during the early sample period through August 3, 1995, this variable had to be omitted for the test of structural breaks.

interacted with *dumlow*. The second column of Table 3 reports the coefficient estimates

and p-values for the variables entered individually. These results look quite similar to

those reported in Table 2. The third column of Table 3 reports the coefficient estimates

and p-values for the news variables interacted with *dumlow*. It is seen that some of the

variables have statistically significant shifts in value during the period of the low-Japan

premium relative to the whole period. To test that a variable has an insignificant effect

during the low-premium period, Wald tests are calculated and the associated F-statistics

and p-values are given in the fourth column of Table 3. In general, it is seen that the

news regarding Japanese banking has an insignificant effect on the Japan premium during

the period prior to the Hyogo Bank failure and in the late, post-March 30, 1999 period,

following the return of the premium to zero. So the role of the news variables in

explaining credit risk and the Japan premium comes during the time when the market

perceived a substantial risk exists. Times when the TIBOR-LIBOR spread fluctuates

around zero have little role for such variables since there is essentially nothing to price.

Japanese bank stock prices reflect pricing issues relevant to equity holders. Since

the assessment of credit risk incorporates the factors specified in Section III, it may be

that the assessment of the probability of default and recovery may find alternative

measures of the Japanese stock market more useful than the stock index for banks. Since

it is well known that real estate and construction loans have been particularly problematic

for Japanese banks, we will explore the value of stock price indexes of these industries

insofar as they may capture effects of non-performing loans on banks' creditworthiness.

Alternatively, a broad market index like the TOPIX may capture the effect of changes in

the value of equities held on bank balance sheets and the consequent change in

creditworthiness of banks. Reestimating the model reported in Table 3 (with the structural breaks modeled) and replacing the bank index with alternative stock price indexes for real estate, construction and the TOPIX index, we can evaluate the robustness of the findings to alternative specifications.

Table 4 summarizes the effects of incorporating the alternative measures of stock prices over the sample period of the high Japan premium. For purposes of comparison, the bank index results that were incorporated in Table 3 are repeated in Table 4. Note that all coefficients except the change in the bank stock index are statistically significant and the overall explanatory power of the regressions is similar regardless of which specification is used. The construction index is marginally superior and appears to be most useful in terms of explanatory power for understanding the evolution of the Japan premium. An interpretation is that changes in the construction index may mirror changes in the nonperforming bank loans to the construction industry and the associated change in the creditworthiness of banks.

It is important to note that the coefficients and statistical significance of the other variables in the regressions are qualitatively unchanged by the alternative variables included and omitted in the tests of this section. This indicates a lack of multicollinearity in the explanatory variables. Thus, results are robust with respect to the alternative specifications estimated.

VI. SUMMARY AND CONCLUSIONS

Since the mid-1990s, there have been times when there was no such thing as *the* interbank interest rate on the yen. The price of yen depended upon whether Japanese banks or non-Japanese banks were quoting. This difference reflected the "Japan premium" whereby the fragile condition of Japanese banks and the recession in Japan led to Japanese banks having to pay a higher rate on interbank deposits than other banks. As a result of the TIBOR rate being dominated by Japanese banks relative to LIBOR, there was a systematic fluctuation in the yen interbank rate between the London morning and the Tokyo morning. We model this Japan premium in terms of the TIBOR-LIBOR spread. Since TIBOR and LIBOR are quoted at 11a.m. Tokyo and 11a.m. London time, respectively, we define the spread as the difference between TIBOR today and LIBOR yesterday and then date the explanatory variables so that only the appropriate conditioning information is used.

The Japan premium is modeled as a function of determinants of bank default and firm value suggested by a theory of credit spreads. These determinants include interest rate and stock market effects along with good and bad news reported in the business press regarding Japanese banking and a separate category of news for Japanese bank credit downgrades and upgrades. We find the following systematic effects on the spread: 1) lower Japanese interest rates raise the premium; 2) a flatter yield curve raises the premium; 3) a decline in stock prices raises the premium; and 4) more volatile stock prices raise the premium. For the news variables, the following is found: 1) bad news received between the LIBOR fixing yesterday and the TIBOR fixing today leads to a

significant increase in the premium; 2) good news received during the same time interval leads to a significant decrease in the premium; 3) credit downgrades received in this time interval have a significant and positive impact on the spread; and 4) credit upgrades during this time period have no significant impact. Regarding news received between the TIBOR and LIBOR fixings yesterday, good news has a significant negative effect on the spread and this is the only significant news finding.

The Japan premium briefly dissipated by the summer of 1999 so that one could, once again, speak of *the* yen interbank interest rate since TIBOR and LIBOR were approximately equal. Yet, during the period from summer 1995 to 1999, there was a consistent premium of TIBOR over LIBOR that exhibited considerable variability and then in 2001, the Japan premium returned again. The smaller magnitude of the premium in 2001 probably reflected the likelihood of government intervention to bailout bank creditors so that even if the probability of default had risen, the expected loss to creditors was small. The analysis of this paper indicates that systematic variation in this spread can be explained by interest rate and stock price effects along with public information flows of good and bad news regarding Japanese banking, with a separate individual role for Japanese bank credit downgrades and upgrades.

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Table 1: Descriptive Statistics for TIBOR, LIBOR, and the Spread

	TIBOR	LIBOR	$TIBOR_t - LIBOR_{t-1}$
Mean	1.2606	1.2126	0.0463
Median	0.6850	0.6016	0.0190
Maximum	4.1875	4.1250	0.4613
Minimum	0.1008	0.0775	-0.2789
Std. Deviation	1.1261	1.1495	0.0784
Skewness	1.0188	1.0381	1.8995
Kurtosis	2.7320	2.7057	7.8166
Jarque-Berra	396	413	3533

Notes: The data are for the period August 3, 1992 to March 22, 2001. P-values for the Jarque-Berra statistics are all zero.

Table 2: Estimation Results for TIBOR-LIBOR Spread

The table reports the results of estimating a model incorporating default risk and interest rate risk related to the Japan premium as measured by the TIBOR-LIBOR spread ($premium_t$, T_t-L_{t-1}). Explanatory variables include the change in the 3 month Japanese treasury bill rate (*dbill*), the change in the slope of the yield curve as measured by the 10-year government bond rate minus the 3-month T-bill rate (*dyield*), the change in the log of the bank index for the Tokyo stock market (*dstock*), and the conditional variance of dstock (*stockvol*), news regarding Japanese bank credit rating changes (*downgrade* and *upgrade*), and other news related to the Japanese banking industry (*badnews* and *goodnews*). News variables are defined over two regions of the day to account for the fact that TIBOR is set at 11:00 in Tokyo (2:00 London time) and LIBOR is set at 11:00 in London. A suffix *1* (*2*) on a variable denotes information between yesterday's (today's) LIBOR fixing and today's TIBOR fixing.

Independent Variable

Constant	-0.0013 (0.00)
dbill	-0.0348 (0.00)
dyield	-0.0253 (0.00)
dstock	-0.0296 (0.24)
stockvol	3.6276 (0.00)
badnews1	0.0150 (0.00)
goodnews1	-0.0164 (0.00)
downgrade1	0.0077 (0.01)
upgrade1	-0.0001 (0.98)
badnews2	0.0035 (0.43)
goodnews2	-0.0122 (0.00)
downgrade2	0.0041 (0.16)
upgrade2	0.0070 (0.38)

R^2	0.235
Q_{24}	27.9 (0.14)
LR test for news coefs=0	64.8 (0.00)

Notes: P-values are in parentheses. The following noise models were fitted to each equation to account for the autocorrelation in the residuals: MA(1), MA(2), MA(12). The interest rate, yield curve, stock index, and news variables with a suffix *2* were lagged 1 day.

Table 3: Estimation Results Allowing for Structural Change

The table reports the results of estimating a model incorporating default risk and interest rate risk related to the Japan premium as measured by the TIBOR-LIBOR spread. To accommodate a structural break for the period of the high Japan premium of August 30, 1995 to March 30, 1999, an interactive dummy variable (*dumlow*) is set equal to 1 during the low premium periods and zero for the high premium period. Explanatory variables include the change in the 3 month Japanese treasury bill rate (*dbill*), the change in the slope of the yield curve as measured by the 10-year government bond rate minus the 3-month T-bill rate (*dyield*), the change in the log of the bank index for the Tokyo stock market (*dstock*), and the conditional variance of dstock (*stockvol*), news regarding Japanese bank credit rating changes (*downgrade* and *upgrade*), and other news related to the Japanese banking industry (*badnews* and *goodnews*). News variables are defined over two regions of the day to account for the fact that TIBOR is set at 11:00 in Tokyo (2:00 London time) and LIBOR is set at 11:00 in London.   A suffix *1* (*2*) on a variable denotes information between yesterday's (today's) LIBOR fixing and today's TIBOR fixing.

Independent Variable		Interact variable with *dumlow*	Wald test, sum of coeffs=0
Constant	-0.0012 (0.00)		
dbill	-0.0372 (0.00)		
dyield	-0.0278 (0.00)		
dstock	-0.0313 (0.21)		
stockvol	3.3362 (0.00)		
badnews1	0.0177 (0.00)	-0.0062 (0.47)	2.95 (0.09)
goodnews1	-0.0156 (0.00)	0.0142 (0.06)	0.045 (0.83)
downgrade1	0.0147 (0.00)	-0.0205 (0.00)	1.52 (0.22)
upgrade1	-0.0010 (0.93)	-0.0081 (0.61)	0.649 (0.42)
badnews2	-0.0015 (0.70)	0.0042 (0.50)	0.307 (0.58)
goodnews2	-0.0101 (0.00)	0.0060 (0.27)	0.988 (0.32)
downgrade2	0.0018 (0.53)	0.0037 (0.39)	2.549 (0.11)
upgrade2	0.0071 (0.38)	-0.0026 (0.83)	0.260 (0.61)

R^2	0.241
Q_{24}	30.6 (0.08)
LR test for news coefs=0	82.6 (0.00)

Notes: P-values are in parentheses. The following noise models were fitted to each equation to account for the autocorrelation in the residuals: MA(1), MA(2), MA(12). The interest rate, yield curve, stock index, and news variables with a suffix *2* were lagged one day.

Table 4: Sensitivity Analysis to Alternative Stock Market Indexes

The table reports the results of estimating a model incorporating default risk and interest rate risk related to the Japan premium as measured by the TIBOR-LIBOR spread and incorporating structural breaks in news variables over the period of the high Japan premium from August 30, 1995 to March 30, 1999. The model is as specified in Table 3 with the exception of the stock price index used. To investigate the robustness of the results to alternative specifications, the following indexes are included in turn: bank, real estate, construction, and TOPIX. To conserve space, the table only reports the coefficient estimates and associated p-values of the stock index variables along with the regression R^2 for each alternative equation estimated.

Bank Index

dstock	-0.0313 (0.21)
stockvol	3.3362 (0.00)
R^2	0.241

Real Estate Index

dstock	-0.0559 (0.01)
stockvol	2.4667 (0.00)
R^2	0.241

Construction Index

dstock	-0.1155 (0.00)
stockvol	4.3824 (0.00)
R^2	0.242

TOPIX Index

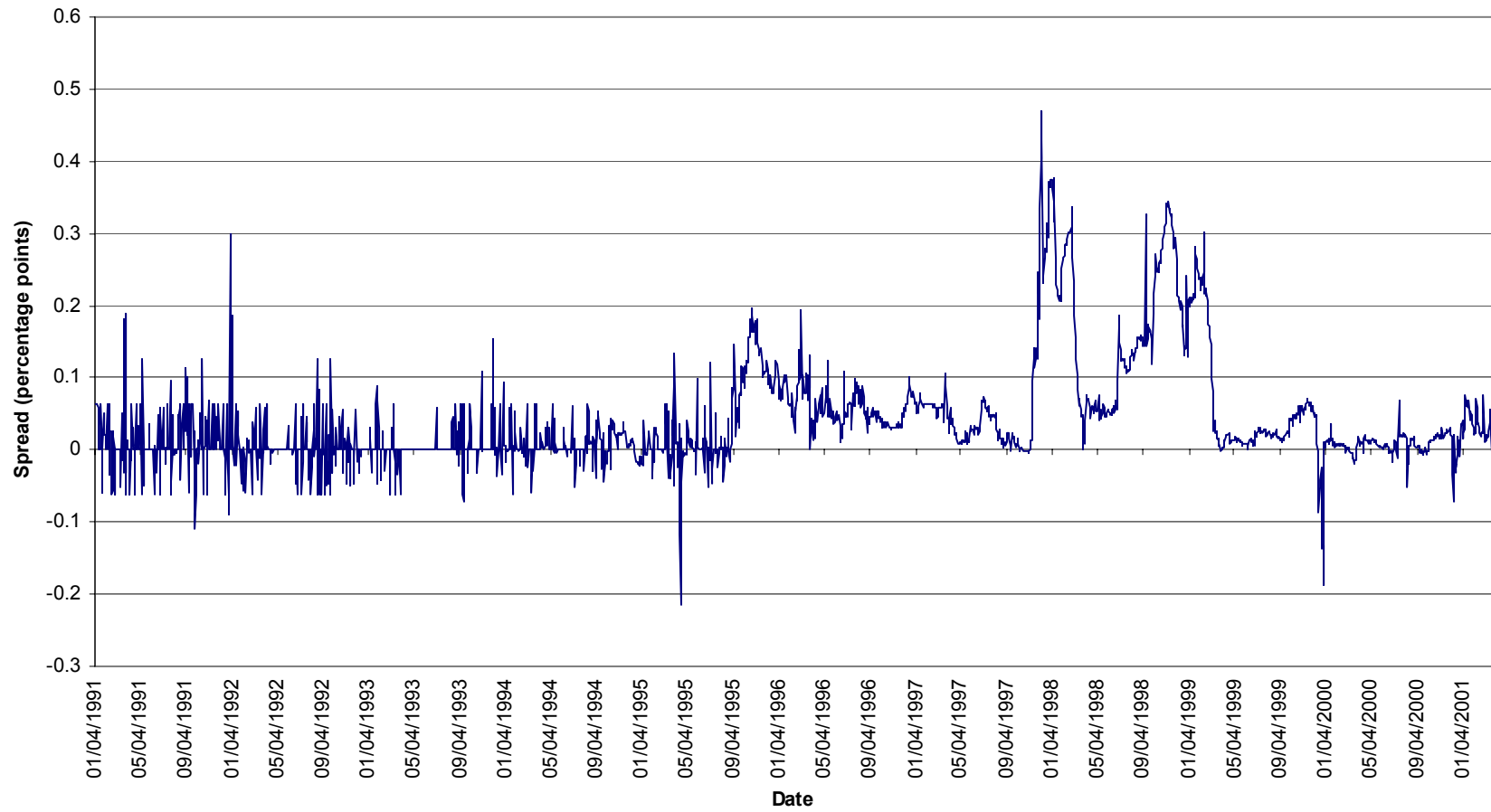|	
dstock	-0.0744 (0.04)
stockvol	8.256 (0.00)
R^2	0.240

Figure 1: TIBOR-LIBOR Spread

Figure 2: Intra-Day Timing of Information and the TIBOR-LIBOR Spread

LIBOR is set at 11:00 London time (GMT) while TIBOR is set at 11:00 in Tokyo (2:00 GMT). As news arrives, it is priced in the euroyen market. News that arrives between the TIBOR fixing and the next LIBOR fixing (*news2*) will most immediately affect LIBOR while news that arrives between the LIBOR fixing and the next TIBOR fixing (*news1*) will most immediately affect TIBOR. If the Japan premium is measured $TIBOR_t-LIBOR_t$ and *news2* arrives that raises the euroyen rate in both markets but more for TIBOR than LIBOR, on day t we will observe the new $LIBOR_t$, but will not observe the new, higher rate in Tokyo until tomorrow with $TIBOR_{t+1}$. This timing convention for the Japan premium would have the spread $TIBOR_t-LIBOR_t$ fall with the news. To avoid such spurious results due to the timing convention, we specify our empirical model in terms of $TIBOR_t-LIBOR_{t-1}$. With this definition of the Japan premium, we see that both $LIBOR_{t-1}$ and $TIBOR_t$ will condition on the information in *news2$_{t-1}$* and, in addition, $TIBOR_t$ will condition on the information in *news1$_t$*.