Actual factors to determine cross-currency basis swaps: An empirical study on US dollar/Japanese yen basis swap rates from the late 1990s

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1 Introduction

Cross-currency basis swap rate between USD Libor and JPY Libor has fluctuated since the latter half of the 1990s, and it is increasingly important for market players to figure out such swap rate movement. While the pricing theory on cross-currency swaps was established and the basis swap market has been developed long while, the factors of deciding cross-currency basis swap rate in actual financial market have been discussed variously, not well-organized. As there have not been many empirical analyses on the factors of cross-currency basis swaps in actual market, this study summarizes and demonstrates determining factors of cross-currency basis swaps, especially on USD Libor and JPY Libor from the latter half of the 1990s to the present.

2 Definition and concept on cross-currency basis

According to Bank of England (2004), cross-currency basis swaps are defined as exchanges of interest rate payments in two different currencies where the underlying reference rates are floating interbank interest rate indices. In principle, the price (basis) in cross-currency swaps should be zero, unless there are differences in credit risk embedded in the underlying reference rates of one currency relative to another. However, in practical cross-currency swap market the payment in USD Libor-flat rate cannot be exchanged for the receipt in JPY Libor-flat rate, because there is a difference in the credits between the fundings which are always able to finance in USD Libor flat and those which are always able to finance in JPY Libor flat. Since reference banks are different between USD and JPY Libor, or financial conditions in US and Japanese markets differ to some extent, it is natural for market players to consider that the credit reflected by USD Libor flat is different from that by JPY Libor flat. In this sense, the basis in cross-currency swaps is determined by the difference in credit levels reflected by USD and JPY Libor.

3 Practical determining factors of cross-currency basis

In addition to the above factor, in practice, there could be another factors such as balance of demand and supply for swaps, which have direct effects on pricing cross-currency swaps. Flavell (2002) suggests three factors that determine cross-currency basis: (A) Difference in credit levels in USD and JPY Libor, (B) Demand and supply for cross-currency basis swaps, (C) Effect of foreign exchange market.

The first factor, which Flavell (2002) considers most important, is the one described in the last section. The second is what market players regard as a dominant factor of determining the short-term level of the basis. Nomura Securities Co., Ltd. (2005) describes four typical flows of USD and JPY Libor into and out of basis swap market: (a) Issues in JPY by foreign fundings, (b) Asset swaps from foreign currency to JPY, (c) Issues on foreign currency by Japanese fundings, (d) Assets swaps from JPY to foreign currency.

For an example of the case (a), when high-quality fundings such as IBRD issue privately-placed JPY-denominated bonds of 30-year maturity, or when samurai/euro MTN yen-denominated bonds of super-long maturity, issuers pay USD Libor flat to a swap house and receive JPY coupon from the house. The house pay USD Libor flat to basis swap market and receive JPY Libor minus the basis (α) by USD and JPY Libor swaps from the market, and therefore this transaction will increase α. In the same way, the case (b) presents transactions by investors that pay USD coupon to a swap house and receive JPY Libor flat from it, and by the houses that pay USD Libor flat and receive JPY Libor minus α in swap market. Bond houses often repackage subordinated international bonds that were issued by Japanese banks but being left at lower price, and sell them to Japanese investors. This is another reason for increasing α, but it is practically considered that the amount of the case (a) is far larger than (b).

On the other hand, α decreases in the cases (c) and (d). The case (c) will occur when Japanese banks issue subordinated bonds denominated by USD to receive USD coupon from swap houses and pay JPY Libor flat to them. As the houses pay JPY Libor minus α and receive USD Libor flat in swap market, α will decrease. For an example of the case (d), when super-long, around 30-year-maturity JGBs or Zaito bonds are issued and foreign investors buy them, they pay JPY coupon to swap houses and receive USD Libor flat from the houses, and the houses pay JPY Libor minus α and receive USD Libor flat in swap market and thus α will decrease.

The third factor of determining the basis level is the effect of foreign exchange market. When Japanese banks had a lot of troubles in financing by US dollar from foreign market in the middle of the 1990s, they exchanged JPY for USD in spot market, and sold USD and bought JPY in forward exchange market in order to finance USD. Forward exchange rate can be expressed in such a generalized form as below:

$$F = S\left(\frac{1 + R_{JPY}}{1 + R_{USD}}\right) \tag{1}$$

where F denotes forward exchange rate, S denotes spot exchange rate, and R_{JPY} and R_{USD} denote interest rates of JPY and USD, respectively.

At that time, because the demand for selling USD and buying JPY increased, JPY tended to be traded based on the assumption that R_{JPY} would be lower than R_{USD}, and thus the basis was determined that USD Libor flat was traded largely under JPY Libor flat. Besides, even at present, FXA (Forward Exchange Agreement) is considered to have a similar effect on determining the basis level. Under FXA, an importer, who believes that the present JPY exchange rate would be strongest to USD, will be encouraged to fix an exchange rate in the next 3-5 years at the present level. Banks increase demand for buying USD and selling JPY for their hedging will reduce α.

4 Model specification

In order to demonstrate the basis of USD and JPY swap in a practical manner, we specify a model as follows:

$$B = C + \alpha F_1 + \beta_i F_{2,i} + \gamma F_3 + u \tag{2}$$

where B denotes basis of USD/JPY swap, C is a constant term, u is residual, and F_1 to F_3 denote the three factors of determining B, which are explained in the last section.

F_1 is the difference in the credits reflected by USD and JPY Libor. More specifically, it can be defined as the difference in credit risk premiums between Japan and foreign banks, which is so-called "Japan Premium". As Nishioka and Baba (2004) describes, we can use (1) to express Japan Premium. At first, the cost of financing USD by Japanese banks and that of financing JPY by foreign banks are expressed as follows:

$$1 + i^* + \phi^* = \frac{S}{F}(1 + i + \phi) \tag{3}$$

$$1 + i + \theta = \frac{F}{S}(1 + i^* + \theta^*) \tag{4}$$

where i and i^* respectively denote risk-free rates in JPY and USD markets, ϕ and θ respectively denote credit risk premiums of Japanese and foreign banks in JPY markets, and ϕ^* and θ^* respectively denote credit risk premiums of Japanese and foreign banks in USD markets. We can obtain the following equation from (3) and (4):

$$\frac{1 + i + \theta}{1 + i + \phi} = \frac{1 + i^* + \theta^*}{1 + i^* + \phi^*} \tag{5}$$

(5) can be logarithmically approximated and expressed as follows:

$$\theta^* - \theta \approx \phi^* - \phi \tag{6}$$

$$\phi - \theta = \phi^* - \theta^* \tag{7}$$

(7) means that the difference in credit risk premiums of Japanese and foreign banks in JPY market is equal to that in USD market. Such difference is considered as Japan Premium, and we measure the value of Japan Premium by this definition as F_1.

$F_{2,i}$ indicates the factor regarding demand and supply for USD and JPY currency swaps. Among the four flows of USD and JPY Libor in basis swap market we introduce in the last section, we choose the cases of (a), (c) and (d) and take these flows into account as $F_{2,a}$, $F_{2,c}$ and $F_{2,d}$, respectively.

F_3 indicates the effect of exchange market, and thus we use forward exchange rate for F_3.

5 Data

Our data are basically obtained from Telerate and Bloomberg, and we cover daily data from April 1, 1996 to April 20, 2005. The quote of 10-year USD/JPY basis swaps, and 5-year forward exchange rate are obtained from

Telerate. Obtaining from the datasets of Telerate and Nikkei NEEDS, we use 3-month rates of JPY and USD Tibor for $i+\phi$ and $i^*+\phi^*$, and use those of JPY and USD Libor for $i+\theta$ and $i^*+\theta^*$. Also, we use 3-month rate of JGB (FB) for i, and that of US Treasury Bill for i^*.

The data regarding $F_{2,a}$, $F_{2,c}$ and $F_{2,d}$ are obtained from Bloomberg. $F_{2,a}$ includes JPY-denominated bonds over 10-year maturity, issued by supranational and the fundings in G7 countries except Japan, in Samurai, Euro including Euro MTN, and privately placed formats. $F_{2,c}$ includes international bonds over 10-year maturity, issued by Japanese fundings. Those amounts of all issues are converted to USD with each exchange rate at issuing. $F_{2,d}$ includes JPY-denominated bonds over 20-year maturity, issued by Japanese fundings including government.

6 Estimation results

Table 1. shows the results of estimating our model, equation (2). According to the result from Case 1, which is a standard OLS model, all signs of explanatory variables except $F_{2,a}$ are consistent to our explanation in the earlier sections. F_1 and F_3 are significant at 1% level. If the Japan Premium, the difference between JPY and USD credit risk premium rates, increases by

1 bp, the USD/JPY basis will drop by 0.1 bp. While F_1 seems to have a considerable effect on the basis swap, the coeffcient of F_3 is relatively small and does not have much influence on the basis. On the other hand, the coefficients for $F_{2,i}$ are not significant, except that $F_{2,d}$ is significant at 10% level.

From this result, the difference in credit risk premiums between US and Japanese markets and forward exchange rate of USD/JPY have significant influences on USD/JPY basis in currency swaps.

Next, we specify how much lag distributions of $F_{2,i}$ have effects on B. In Case 2, we assume polynomial distributed lags upon $F_{2,i}$ in the model (2), represented by a second order polynomial and distribution over 4 periods.

$$\beta_{i,j} = \delta_0 + j\delta_1 + j^2\delta_2, \quad i = a, c, d, \quad j = 0, 1, 2, 3, 4 \tag{8}$$

In the result from Case 2, we observe that the sums of the coefficients in $F_{2,i}$ seem significant, and that the most significant distributed lag in $F_{2,a}$ is in 3 periods, that in $F_{2,c}$ is in 1 period, and that in $F_{2,d}$ is in 3 periods. Also, it turns out that $F_{2,d}$ constantly has a significant effect on B. It can be recognized that the balance of demand and supply caused by assets swaps from JPY to foreign currency would have an effect on USD/JPY basis. Considering those results, we estimate that USD/JPY basis would shrink cumulatively by 0.7 bp, if a 10 million-yen superlong bond is issued.

7 Conclusions

It is widely recognized that there are various factors of determining basis of cross-currency swaps, but there have not been many empirical studies on what factors have significant effects on the basis in practical currency swap market. Using a simple model of explaining USD/JPY basis with the difference of credit risk premiums between US and Japan, demand and supply for USD/JPY currency swaps, and USD/JPY exchange rate, we demonstrate that the difference in credit risk premiums and the forward exchange rate have significantly influenced the basis in USD/JPY swaps since the latter half of the 1990s. In addition, assets swaps of foreign investors from JPY to foreign currency possibly have an effect on USD/JPY basis.

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Table 1.

	Case 1		Case 2			
Variable	Coefficient		Coefficient		Polynomial lag distribution	
C	5.137	**	4.343	**		
	(0.629)		(0.658)			
α	-0.128	**	-0.125	**		
	(0.008)		(0.008)			
β a	0.603		3.031		*j=0*	0.545
	(0.660)		(1.459)			(0.629)
					j=1	0.593
						(0.403)
					j=2	0.623
						(0.460)
					j=3	0.637
						(0.401)
					j=4	0.634
						(0.621)
β c	1.413		5.007		*j=0*	1.097
	(0.998)		(2.233)			(0.941)
					j=1	1.013
						(0.612)
					j=2	0.965
						(0.699)
					j=3	0.954
						(0.611)
					j=4	0.978
						(0.939)
β d	0.134	*	0.708		*j=0*	0.134
	(0.076)		(0.180)			(0.071)
					j=1	0.142
						(0.048)
					j=2	0.146
						(0.054)
					j=3	0.145
						(0.048)
					j=4	0.141
						(0.072)
γ	0.009	**	0.009	**		
	(0.000)		(0.000)			
F-Statistic	361.5	**	167.5	**		
Adj.R-squared	0.434		0.438			

Note: 1. Standard deviations are reported in parentheses.
2. ** and denote statistical significance at 1% and 10% levels.