Pricing in the Japanese Bond Markets
---Using asset swap spreads to identify relative-value of fixed-income---

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Abstract

Both in the theoretical and applied literature of finance the difference in yield-to-maturity between corporate bonds and government bonds has been used as a measure of the risk of the former over the latter. While this approach has sometimes provided interesting results, the usefulness of yield spreads is lessened by ignoring the term structure of interest rate.

This paper presents an alternative measure, “Asset swap spread”, use asset swaps to convert fixed income cash flows to floaters which refer LIBOR plus spread as index coupon rate. This spreads show much broader characteristics as well as riskiness of each corporate and government bonds. Effectively by using the swap curve to create a set of equal and opposite fixed-rate cash flows, we create a synthetic floating rate note (FRN) with an index coupon rate. Moreover, this value is now being captured through the trading of bond asset swap packages.

Based on these ideas,

• We provide an introduction to government and corporate bond asset swaps, explaining their basic mechanics
• The use of asset swap spreads in identifying and capturing relative value is discussed
• The market drivers of asset swaps spreads are examined

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1 Introduction

In recent years Japanese bond markets, as a whole, expanding in its volume of transaction, and its variety. The Japanese Government Bonds (JGBs) are issued in various maturities, just from two types of long-term bonds: 10YRs and 20YRs in maturity, to more long and mid term maturities. Also corporate straight bonds began to have their varieties. In this paper, we investigate how the Japanese bonds are priced in the relative value view, from the estimation of “asset swap spread”.

Asset swaps are ideal for expressing relative-value views. The matching of fixed-rate cash flows limits exposure to the overall level of interest rates and incorporates coupon effects. Furthermore, both positions will roll down the curve at the same rate, limiting exposure to curve shape. At any point the NPV of the asset swap package will be determined by cost of unwinding the swap and selling the bond - a value driven by the yield spread between bonds and swaps and termed the asset swap spread of the bond.

For the reason above, practitioners commonly use the asset swap spreads for the analysis of bond markets, there are few articles to investigate the pricing of bond markets using the asset swap spreads. Tonge, D. (2001) estimated asset swap spreads and main driver for them, and tried to apply for CEEMEA Fixed Income Strategy. For the Japanese markets, Ieda and Ohba (1998) estimated the asset swap spreads in the Japanese straight corporate bond markets from May 1997 to Mar 1998, and investigate the factors which mostly affect the spreads. They found the years to maturity, coupon rates, and the credit ratings are the major determinants to the spreads. Takahashi (1999) investigated the asset swap spreads for the JGB market.

Swap spreads, showing the quoted spreads of the yields on government bonds, mainly T-notes, and the interest rate swaps are widely investigated. Grinblatt (2001) attributes the swap spread to the liquidity difference between Treasury bonds and Eurodollar borrowings. Longstaff and Schwartz (1995), Duffie and Huang (1996), Lekkos and Milas (2001), Blanco, et al. (2005), In, Brown and Fang (2003), and Afonso and Strauch (2007) model swap spreads as a risk premium to compensate swap counterparties for various risks. Their results were supported by the empirical tests. However, Lekkos and Milas (2001) have noted that the impact from changes in the term structure on swap spreads is not uniform across swap maturities. Huang and Chen (2007) find that liquidity premium is the only contributor to the 2-year swap spread variance in monetary tightening cycles, and the impact of default risk varies across both

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1 Asset swap spreads in Japanese markets are mostly called “LIBOR spreads”. Ieda and Ohba (1998) and Takahashi(1999) are the examples.
monetary cycles and swap maturities. They have analyzed whether the relative importance of these determinants and consequently the swap spreads generating process vary according to the different monetary policy regimes in the USA.

For the Japanese market so far except for a few recent studies by Eom, et al. (2000), Eom, et al. (2002), Fehle (2003) and Huang et al. (2008). These authors examined the determinants of the Japanese swap spreads and provided empirical evidence that some risk factors such as default risk of counterparty, interest rate volatility, liquidity risk of LIBOR and slope of term structure affects the swap spreads depending on the length to maturity of the swap contract and the sample periods they analyze. The Japanese economy has experienced two major financial crises of the “Lost Decade of Japan” originated by the stock prices bubble collapse from 1990 to 2001 and the global financial crisis initiated by subprime loan problem from 2007, in the last two decades. The monetary policy and market condition in Japan are very different among the regimes of the pre-zero-interest-rate period, the zero-interest-rate period and the post-zero-interest-rate period. However, neither Eom et al. (2000) nor Fehle (2003) investigated the effects of regime changes on the determinants of swap spreads. Only Huang et al. (2008) explicitly analyzed the effects of regime changes by applying a smooth transition vector autoregressive model. Moreover their study only used the sample data up to 2005 and did not deal with the sample period of global financial crisis. Shimada et al (2010) investigated three risk factors which have been taken as determinants of swap spreads on the Japanese markets and compare the relative importance of factors between the three different regimes of Lost Decade of Japan, zero-interest rate period and global financial crisis classified by the Japanese economic condition. They apply a standard static regression model with the GARCH error terms as well as an alternative regression model which allows the coefficients possibly change along with time.

This paper is broken into following sections. In section 2 we take a brief look at the Japanese secondary bond markets from its transaction data. We also investigate the interest rate swap market in Japan. Section 3 reviews the mechanics of a bond asset swap, and studies the use of asset swaps in identifying and capturing relative value. Section 5 interpreting the asset swap spread (2004–2009), and analyzes factors that influence asset swap spreads. Finally, section 5 summarizes our conclusions.

2 Japanese bond markets

Just take a brief look at Japanese bond OTC markets, from the “Reference Statistical Prices [Yields] for OTC Bond Transactions” published by the Japan
Securities Dealers Association for the bond trading data. Figure 1 shows the variety of fixed income traded in the OTC markets, from Dec 1998 to Nov. 2005. Every figures are denominated in 100milion yen, left axis for JGB and right axis for other fixed-incomes.

<Figure 1>

This figure shows the trading volume is expanding in this period, showing a little cyclical movement. Figure 2 shows the components of JGB sales. This figure shows long-term JGB has the biggest trade volume, and sales in mid-term JGB is growing dramatically, and also short-term JGB is also growing rapidly.

<Figure 2>

Next, we can see the annual trading share 1 year from Dec. 2004 in Figure 3. This chart shows that the share of JGB in fixed income trading is the biggest and other securities are traded under 10%. Trading in corporate bonds is growing, but still the trades are mostly concentrated to JGB.

<Figure 3>

We also show the other public bonds in Figure 4. This is also supporting that the share of JGB is extraordinary big, and in the JGB trading, long-term bonds have the largest share.

<Figure 4>

The market for interest rate derivatives, in general, and for swaps, in particular, has grown exponentially in the last decade. Recent estimates indicate that in the notional outstanding volume of transactions of privately negotiated (over-the-counter) derivatives at the end of December 2007, the total notional amount of interest rate swaps outstanding amounted to $310 trillion from that of $29 trillion at the end of 1997.

Among the major players, Japanese yen interest rate swap plays a pivotal role in the global interest rate derivatives market. It amounts to an average of 17% of the total.

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2 From the website of Japan Securities Dealers Association
http://www.jsda.or.jp/html/toukei/index.html

3 At that period, All counterparties (net) Notional amounts outstanding is Euro 119, US dollar 96, Japanese yen, 49, Pound sterling 23 (in millions of US dollars). And interest rate swap market share by currency is Euro 40%, USD 34%, Yen 17% and Pound sterling 8%. Source: BIS(2009) OTC derivatives market activity in the second half of 2008
outstanding interest rate derivatives worldwide. Given the importance of the yen in international trade and finance, it is not surprising that yen interest rate swaps form a substantial proportion of this volume, next to those denominated in US dollars. The expansion in the Japanese yen interest rate swap speaks for the importance of understanding the yen swap pricing mechanism.

Interest rate swaps are sometimes quoted at a margin or spread above the government bond nearest in maturity to the final date of the swap. This is because the government bonds are often used as a partial hedge for mismatched swap portfolios or books. But in JPY swaps, we have the different quotation system. Interest rate swaps in Japan are not quoted by spread, but are quoted by absolute level. This is partly because of the historical background of JPY interest rate swaps.

In mid 1980's interest rate swap in Japan has launched. Many Japanese banks started to run Swap desks, to hedge their swap position. In 1986, a US bank started market make of the interest rate swaps in the Japanese market. At that time, JGB was thought to be "kinky" market. Transactions are concentrated on "benchmark issue"(shihyo meigara), arbitrages were insufficient. For these reasons, the Japanese interest rate swap rates, not the JGB rate, plays as a reference rate for mid to long term transaction, quotation was not based spreads over JGB yields. The situation began to change in late 1990's. The financial deregulation accelerates, and the Ministry of Finance came to issue JGB of various varieties in maturity. Trades dispersed, and the arbitrage became active and the role of the “benchmark issue” was over by the end of March 1999.

3 Relative-value analysis using asset swaps

3.1 Asset swap spreads

The essence of relative-value analysis is replication of cash flows at cheaper cost - usually by taking "basis risk". This contrasts with yield curve analysis that is centered on the valuation of mismatched cash flows. Asset swaps are ideal for relative-value analysis of government bonds because the process of constructing a synthetic FRN creates a level playing field.

- For government bonds there are no variations in credit risk
- By replicating bond's fixed cash flows with swaps, we hedge mismatches in
  - coupon
  - interest-rate duration (directional risk)
  - curve exposure
- The asset swap package can be transacted

The price of the complete package and the notional are fixed at par. Typically there will be an up-front exchange of cash flows to compensate for the non-par price of the
bond. Par asset swap packages are transacted more commonly than any other asset swap. In this case, synthetic FRN cash flow will be that of Figure 5.

In Figure 5, \( \ell_{i,j} = 100 \left( L_{i,j} + \alpha_i \right) \frac{t_{i,j} - t_{i,j-1}}{360} \)

This synthetic FRN will contain the package of underlying bond and asset swap, which pays index rate (LIBOR plus spread) and receive the equivalent amount of cash flow to the coupon payment. This will be realized by the asset swap trade shown in Figure 6. And net present value: NPV of an asset swap cash flow should satisfy the following equation.

\[
\frac{C_i}{2} \sum_{j=1}^{n} d(t_{i,j}) + 100 = 100 \sum_{j=1}^{n} \left( L_{i,j} + \alpha_i \right) \frac{t_{i,j} - t_{i,j-1}}{360} \cdot d(t_{i,j}) + \left( P_i + A_i \right)
\]

Thus asset swap spread of bond \( \alpha_i \) can be estimated using the following equation.

\[
\alpha_i = \frac{\frac{C_i}{2} \sum_{j=1}^{n} d(t_{i,j}) + 100 - \left( P_i + A_i \right) - 100 \left[ 1 - d(t_{i,n}) \right]}{100 \sum_{j=1}^{n} \frac{t_{i,j} - t_{i,j-1}}{360} \cdot d(t_{i,j})}
\]

The asset swap spreads estimated by the equation above indicate a relative value of bonds by showing the return from investment on the bonds. If the asset swap spreads are high, the returns on investments are high, so the relative values of the bonds are

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4 Symbols in equation (1) represent:
- \( n \): number of coupon payment to maturity of bond \( i \)
- \( t_{i,j} \): number of days at the \( j \)th coupon \( j = 1, 2, \ldots, n \) of bond \( i \)
- \( C_i \): coupon payment of bond \( i \)
- \( d(t) \): discount factor at \( t \)
- \( P_i \): clean price of bond \( i \) (at face value ¥100)
- \( A_i \): accrued interest rate of bond \( i \)
- \( L_{i,j} \): LIBOR index at the period of \([t_{j-1}, t_{j-1}]\) which corresponds to the cash flow of bond \( i \)
- \( \alpha_i \): asset swap spread of bond \( i \)

5 Asset swap spread in equation (2) shows in the decimal numbers. Most practitioners show the spreads in basis point (bp = 0.01%), and we also follow this customs multiplying the result from equation (2) by 10000.
3.2 Data and estimation

We estimated the asset swap spreads in the Japanese bond markets on 20th of every month (in case of holidays, the following business day) from January 2004 to December 2009, using the following data:

- “Reference Statistical Prices [Yields] for OTC Bond Transactions” Published by the Japan Securities Dealers Association for the bond trading data.
- BBA LIBOR and TSR for the JPY money market and interest rate swap trading data to estimate the swap curve (discount factor for the JPY cash flows) 6.
- Credit rating published by JCR and R&I7.

4 Main driver for fluctuations

4.1 Visual inspections

Figure 7 shows asset swap spreads for the period of Jan 2004 to Dec 2005. Horizontal axis is in the years to maturity (Years) and vertical axis is the asset swap spreads (bps), and shows asset swap spreads of every individual bonds. We also show these spreads separately by date and credit rating. For the asset swap spreads on 20 Jan 2004, we show separately by the credit rating from Figure 8 to Figure 18. On 20 Dec 2004, from Figure 19 to Figure 29, on 20 Jan 2005 from Figure 30 to Figure 40, respectively. Figure 41 to Figure 43 shows the time series movement of average asset swap spread for each credit rating.

These figures show that if the ratings become lower, asset swap spreads seem to be higher and its volatility also be higher.

4.2 Regression analysis

We try to investigate the drivers for the asset swap spreads by cross sectional regression more precisely. The drivers we thought were years to maturity (YR), current yield (CY), and credit rating. We used dummy variable for each credit including + or – sub-notches. As we mentioned earlier, when the years to maturity became longer, the credit for bonds might be lower, so the investors need higher return i.e. higher asset swap spreads, because the probability to default will be higher, if other things are being

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6 BBA stands for British Bankers Association and TSR for Tokyo Swap Reference Rate. We estimated the JPY discount factor from the real cash flow data, using linear interpolation estimation method for market data and discount factors. See Takahashi [2002] for the details of the estimation method.

7 The results are shown only those that has BBB—(2004-2005) or BB+(2008-2009) or higher ratings.
equal. This will lead the coefficient for YR positive. Current yield shows the rate of coupon return from bond investments, coupon payment divided by the market price of the bonds. Usually, coupon payment will set higher for the lower grade bonds issued in the same period, current yields tend to be higher. And lower credit bonds will have higher asset swap spreads, the coefficient for CY will be positive. Credit ratings are, of course, shows directly the default level. This will lead the coefficient for credit rating dummy will be positive.

Table 1 to Table 3 show the regression results, denoting the significance of 5% level by the shadowed cells (pinks are the same direction, and grays are opposite direction to our expectation.). Looking into the results shown in these table, we found that those of 2005-2006 are quite different from 2008-2009. Table 2 show the coefficients of CY are not significant or significantly negative, except Aug, Sep, Oct, Dec 2007, contrary to our expectation. These results may show that the “current yield preference” of Japanese investors, especially institutional investors, was not prevailing any more. Other coefficients are all significant and the directions of effect form drivers are as we expected. The negative signs of constant show the base asset swap spreads, i.e. those of JGB with zero year to maturity, are negative. This is quite familiar for the government bond markets. Positive YR and Credit rating dummy coefficients are showing that the graphs in year to maturity and spreads are positively sloped and shifted upward by the rating get low.

Looking at the Table 1 to Table 3, we see the adjusted $R^2$ decreased dramatically, and coefficients of YR and credit ratings became insignificant or even negative and significant which are inconsistent to the theory. Many CY coefficients became positive and significant.

<Table 1>
<Table 2>
<Table 3>

5 Concluding remarks

In this paper we provide an introduction to government and corporate bond asset swaps, explaining their basic mechanics and use the asset swap spreads in identifying and capturing relative value. Visually inspected by the average asset swap spreads in each credit rating, their trends show that the low credit ratings tend to be high spreads. This is quite a normally expected result.

After that the market drivers of asset swaps spreads are examined. The years to
maturities, current yields, and credit rating (in dummy variables) are used as a dependent variables in cross-sectional regressions. The result coefficients are quite different between 2005-2006 and 2008-2009.

In 2005-2006 results, years to maturities are positive and significant in all periods, as we expected. And those of current yields are positive and significant only on Jan and Feb 2004 and Dec 2005. These results may show that the “current yield preference” of Japanese investors, especially institutional investors, was not prevailing any more. Other coefficients are all significant and the directions of effect form drivers are as we expected. Credit ratings affected positive and significant to the asset swap spreads. The negative signs of constant show the base asset swap spreads, i.e. those of JGB with zero year to maturity, are negative. This is quite familiar for the government bond markets. Positive YR and Credit rating dummy coefficients are showing that the graphs in year to maturity and spreads are positively sloped and shifted upward by the rating get low.

For the estimated coefficients of 2008-2009, we see the adjusted $R^2$ decreased dramatically, and coefficients of YR and credit ratings became insignificant or even negative and significant which are inconsistent to the theory. Many CY coefficients became positive and significant.

We make an investigation to the markets as a whole in this paper. Looking much closer, we can find interesting sub-groups in each credit rating groups, especially in the low grade. This could be a interesting source of arbitrage and should be investigated carefully. These are for our future research topics.

References


Koike, T. “New Approach in Evaluating the Long-Term Government Bonds”, working paper No.16 (Sumitomo Trust Bank) 1992


Miyakoshi, T., and Tsukuda, Y. (2007), Assessments of the Program for Financial
Rockinger, M., and Urga, G. (2001), A Time-Varying Parameter Model to Test for
Predictability and Integration in the Stock Markets of Transition Economies,
Swap Pricing” paper presented at the 18th Annual Conference on PBFEAM
markets” Studies in Financial Management vol.9.
Information” in Ohno, Ogawa, Sasaki, and Takahashi ed. Financial Market in
the Pacific Basin Economies Research Institute, Takachiho University, TRI01-28,
Markets”, Chuo Business Review 11
Finance 47, 1503-1516.
identify government bond relative-value ---” Citibank
No.99-J-5 Bank of Japan
Figure 1 Trading Volume of Over-the-Counter Bonds

Figure 2  Share of JGB in the trade of bond markets

Figure 3 Share in trading volume in bond markets

Figure 4 Share in trading volume (other than JGBs)

Figure 5  Synthetic FRN cash flow

asset swap cash flow

Figure 6  asset swap for synthetic FRN
Figure 7  asset swap spread (2004/1~2005/12) overall

Figure 8  asset swap spread (2004/1/20) JGB
Figure 9  asset swap spread (2004/1/20)  AAA

Figure 10  asset swap spread (2004/1/20)  AA+
Figure 11  asset swap spread (2004/01/20)  AA

Figure 12  asset swap spread (2004/01/20)  AA−
Figure 13  asset swap spread (2004/1/20)  A+  

Figure 14  asset swap spread (2004/1/20)  A
Figure 15  asset swap spread (2004/01/20)  A−

Figure 16  asset swap spread (2004/01/20)  BBB+
Figure 17  Asset swap spread (2004/01/20)  BBB

Figure 18  Asset swap spread (2004/01/20)  BBB –
Figure 19  asset swap spread (2004/12/20)  JGB

Figure 20  asset swap spread (2004/12/20)  AAA
Figure 21  asset swap spread (2004/12/20)  AA+

Figure 22  asset swap spread (2004/12/20)  AA
Figure 23  asset swap spread (2004/12/20)  AA−

Figure 24  asset swap spread (2004/12/20)  A+
Figure 25  asset swap spread (2004/12/20)  A

Figure 26  asset swap spread (2004/12/20)  A—
Figure 27  asset swap spread (2004/12/20)  BBB+

Figure 28  asset swap spread (2004/12/20)  BBB
**Figure 29**  
Asset swap spread (2004/12/20)  
BBB

**Figure 30**  
Asset swap spread (2005/01/20)  
JGB
Figure 31  asset swap spread (2005/1/20)  AAA

Figure 32  asset swap spread (2005/1/20)  AA+
Figure 33  asset swap spread (2005/1/20)  AA

Figure 34  asset swap spread (2005/1/20)  AA—
Figure 35  asset swap spread (2005/01/20)  A+

Figure 36  asset swap spread (2005/01/20)  A
Figure 37  

Figure 38  

Figure 39  asset swap spread (2005/01/20)  BBB

Figure 40  asset swap spread (2005/01/20)  BBB
Figure 41 average asset swap spread (2004~2009 JGB~BBB-)

Figure 42 average asset swap spread (2004~2009 JGB~A-)

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Figure 43 average asset swap spread (2004~2009 JGB~AA-)
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Shadowed cells show 5% significance level

Table 3 Regression results for asset swap spread (2008-2009)