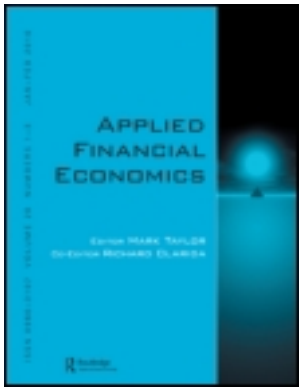

Applied Financial Economics
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/rafe20

Global financial crisis and US interest rate swap spreads

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Published online: 04 Dec 2009.

To cite this article: Takayasu Ito (2010) Global financial crisis and US interest rate swap spreads, Applied Financial Economics, 20:1-2, 37-43, DOI: 10.1080/09603100903262921

To link to this article: http://dx.doi.org/10.1080/09603100903262921

Applied Financial Economics, 2010, **20**, 37–43

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Global financial crisis and US interest rate swap spreads

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This article investigates the determinants of US interest rate swap spreads in the period including the financial crisis. The asymmetric impacts of the financial crisis on interest rate swap spreads are focused by dividing the whole sample period into two. Four determinants of swap spreads – default risk, the slope of yield curve, T-bill and EuroDollar (TED) spread and volatility – are chosen. The default risk measured both in Aaa and Baa corporate bonds are negatively incorporated in the period of financial crisis. The slope is positively incorporated in short- and long-term maturities in the period of financial crisis. The liquidity premium is positively incorporated in short- and long-term maturities in normal period and only in short-term maturity in the period of financial crisis. The market participants were uncertain as for the future of monetary policy by Federal Reserve Board (FRB). Thus the speculation on the path of monetary policy is considered to cause more volatility in the market. The volatility can be a positive determinant of US swap spreads in the period of financial crisis.

I. Introduction

This article investigates the determinants of US interest rate swap spreads in the period including the financial crisis. The asymmetric impacts of the financial crisis on interest swap spreads are focused by dividing the whole sample period into two. One sample includes the period when the financial market was relatively stable and the other sample includes the period when the financial market was volatile under the financial crisis. Four determinants of swap spreads – default risk, the slope of yield curve, T-bill and EuroDollar (TED) spread and volatility – are chosen. As for default risk, two kinds of default risk are used to investigate the sensitivity of swap spreads to Aaa and Baa corporate bond spreads.

An interest rate swap is an agreement between two parties to exchange cash flows in the future. In a typical agreement, two counterparties exchange streams of fixed and floating interest rate payments. Thus fixed interest rate payment can be transformed into floating payment and vice versa. The amount of each floating rate payment is based on a variable rate that has been mutually agreed upon by both counterparties. For example, the floating rate payment could be based on 6-month London Interbank Offered Rate (LIBOR).

The market for interest rate swaps has grown exponentially in the 1990s. According to a survey by Bank for International Settlements (BIS), the notional outstanding volume of transactions of interest rate swaps amounted to 328 114 billions of US dollars at the end of December 2008.[1] Differences between swap rates and government bond yields of the same maturity are referred to as swap spreads. If the swap and government bond markets are

[1] Statistics are cited from Over-The-Counter (OTC) derivatives market activity in the second half of 2008. For details, see BIS (2009).

Applied Financial Economics ISSN 0960–3107 print/ISSN 1466–4305 online © 2010 Taylor & Francis
http://www.informaworld.com
DOI: 10.1080/09603100903262921

efficiently priced, swap spreads may reveal something about the perception of the systemic risk in the banking sector.

As for the analysis of the interest rate swap spreads in US market, previous studies such as Sun *et al.* (1993), Brown *et al.* (1994), Duffie and Huang (1996), Cossin and Pirotte (1997), Minton (1997), Lang *et al.* (1998), Lekkos and Milas (2001), Fehle (2003) and Huang and Chen (2007) are cited.

Sun *et al.* (1993) examine the effect of dealers' credit reputations on swap quotations and bid-offer spreads by using quotations from two interest rate swap dealers with different credit ratings (AAA and A). The AAA offer rates are significantly higher than the A offer rates, and the AAA bid rates are significantly lower than the A bid rates. They also document the relation between swap rates and par bond yields estimated from LIBOR and London Interbank Bid Rate (LIBID) data. They identify some of the problems in testing the implications of swap pricing theory.

Duffie and Huang (1996) present a model for valuing claims subject to default by both contracting parties, such as swaps and forwards. With counterparties of different default risk, the promised cash flows of a swap are discounted by a switching discount rate that, at any given state and time, is equal to the discount rate of the counterparty for whom the swap is currently out of the money (i.e. a liability). The impact of credit-risk asymmetry and of netting is presented through both theory and numerical examples, which include interest rate and currency swaps.

Brown *et al.* (1994) analyse US swap spreads to find that (1) short-term, 1- and 3-year, swaps are priced differently from longer-term, 5-, 7- and 10-year, swaps and (2) the pricing dynamics for all five swap maturities changed substantially during the period spanning January 1985 to May 1991. Cossin and Pirotte (1997) conduct empirical analysis on transaction data and show support for the presence of credit risk in swap spreads. Credit ratings appear to be a significant factor affecting swap spreads not only for their pooled sample but for Interest Rate Swaps (IRS) and for Currency Swaps (CS) separately as well. In IRS, the credit rating impact on prices seems to come largely at the detriment of the nonrated companies.

Lang *et al.* (1998) argue that an interest rate swap, as a nonredundant security, creates surplus which will be shared by swap counterparties to compensate their risks in swaps. Analysing the time series impacts of the changes of risks of swap counterparties on swap spreads, they conclude that both lower and higher rating bond spreads have positive impacts on swap spreads.

Lekkos and Milas (2001) assess the ability of the factors proposed in previous research to account for the stochastic evolution of the term structure of the US and UK swap spreads. Using as factor proxies the level, volatility and the slope of the zero coupon government yield curve as well as the Treasury-bill (T-Bill)–LIBOR spread and the corporate bond spread, they identify a procyclical behaviour for the short-maturity US swap spreads and a countercyclical behaviour for longer maturity US swap spreads. Liquidity and corporate bond spreads are also significant, but their importance varies with maturity.

Minton (1997) directly tests the analogy between short-term swaps and Eurodollar strips and finds that fair-value short-term swap rates exist in the Eurodollar future market. However, proxies for differential probability of counterparty default are statistically significant determinants of the difference between OTC swap rates and the swap rates derived from Eurodollar futures prices for maturities of 3 and 4 years.

Fehle (2003) analyses 2- and 5-year swap spreads in seven countries (US, UK, Japan, Germany, France, Spain and the Netherlands). They conclude that corporate bond spread, LIBOR spread and the slope of yield curve are components of swap spreads.

Huang and Chen (2007) analyse the asymmetric impacts of various economic shocks on swap spreads under distinct Fed monetary policy regimes. The results indicate that (a) during the periods of aggressive interest rate reductions, the slope of the Treasury term structure accounts for a sizeable share of the swap spread variance although default shock is also a major player; (b) on the other hand, liquidity premium is the only contributor to the 2-year swap spread variance in monetary tightening cycles; (c) the impact of default risk varies across both monetary cycles and swap maturities and (d) the effect of interest rate volatility is generally more evident in loosening monetary regimes.

On the other hand, the number of previous studies analysing the market other than US is small. Castagnetti (2004) analyses the interest rate swap spreads in Germany. Hamano (1997), Eom *et al.* (2000), Ito (2007) focus on the swap spreads in Japanese market. Hamano (1997) focuses not on credit risk but on market factors such as TED spread and finds that swap spreads reflect TED spread and longer-term swap spreads are less influenced by TED spread. On the other hand, Eom *et al.* (2000) focuses on the credit risk and concludes that yen swap spread is significantly related to proxies for the long-term credit risk factor.

Ito (2007) investigates the determinants of interest rate swap spreads in Japan. Four determinants of swap spreads – TED spread, corporate bond spread, interest rate and the slope of yield curve from 12 July 1995 to 31 January 2005 are chosen. The swap spreads of 2 years through 4 years are mostly influenced by TED spread, interest rate and slope. The swap spread of 5 years is mostly decided by corporate bond spread and slope. The swap spreads of 7 and 10 years are mostly affected by corporate bond spread.

So far, no other previous works focused upon interest rate swap spread in the period of financial crisis. This article will be the first one to analyse interest rate swap spreads in the period of financial crisis. In addition to that, two kinds of default risk are used to investigate the sensitivity of swap spreads to Aaa and Baa corporate bond spreads.

II. Determinats of Swap Spread

Default risk

According to Brown *et al*. (1994), Minton (1997), Eom *et al*. (2000), Lekkos and Milas (2001), the default risk in swaps can be proxied with the information from the corporate bond market. Any such proxy is imperfect as mentioned in the previous studies because the characteristics of swap and corporate bond are not totally comparable. Nevertheless, since swap default spreads are unobservable, the difference between the yield on a portfolio of corporate bonds and the yield on an equivalent government bond can be used as a proxy for the default premium.

Liquidity premium

For instance, during periods of weak economy, Treasury securities are considered more liquid, and swaps thus command a larger liquidity premium. Liquidity effect may be absent in the aggregate data, but can be arguably pronounced under certain market conditions. Brown *et al*. (1994), Hamano (1997), Minton (1997), Eom *et al*. (2000), Lekkos and Milas (2001) check the influence of TED (LIBOR–T-bill) spread.

Slope of yield curve and volatility

Following the Sorensen and Bollier (1994) framework, in which the slope of the term structure and interest rate volatility determine the value of the option to default, these two variables are incorporated into empirical model. It is notable that the impacts of the yield curve and the interest rate volatility on swap spreads may not be symmetrical under various market conditions. For example, due to investors' risk aversion, risk premium may not necessarily be as responsive to the changes in interest rate volatility during periods of little default risk.

Similarly, as Huang and Chen (2007) describe, swap spreads may be more responsive to the shape of yield curve during periods of a steep yield curve due to the 'flight to quality' concern. Aggregating time series data over different market conditions, therefore, produces results that are in favour of finding no impact of economic shocks on swap spreads because asymmetrical impacts may cancel out over monetary policy cycles. Eom *et al*. (2000) find that swap spreads are negatively related to the slope of the term structure. Huang and Chen (2007) use the slope of yield curve and volatility. They calculate the volatility of 2-year US Treasury note by using Exponential General Autoregressive Conditional Heteroscedastic (EGARCH) model.

III. Data

About 4 years of daily data ranging from 3 January 2005 through 12 March 2009 are chosen. These data are quoted from the Federal Reserve Statistical Release (H.15). The whole sample is divided into two depending upon the financial crisis. First period (Sample A) is from 3 January 2005 to 7 February 2007. Second period (Sample B) is from 8 February 2007 to 12 March 2009. First period includes relatively calm market. Second period includes the financial crisis.

This article regards the beginning of financial crisis as 8 February 2007, because market participants began to recognize that sub-prime loan problem would be a tough one on the day. The announcement by The Hongkong and Shanghai Banking Corporation (HSBC) holdings on a previous day that its charge for bad debts would be more than $10.5 billion for 2006 was a surprise. This number was 20% more than the expectation of financial analysts.

US interest rate swap spread

US interest rate swap rate minus US government bond yield in the corresponding maturity is defined as swap spread. SS2 is 2-year swap spread. SS10 is 10-year swap spread. The movements of swap spreads

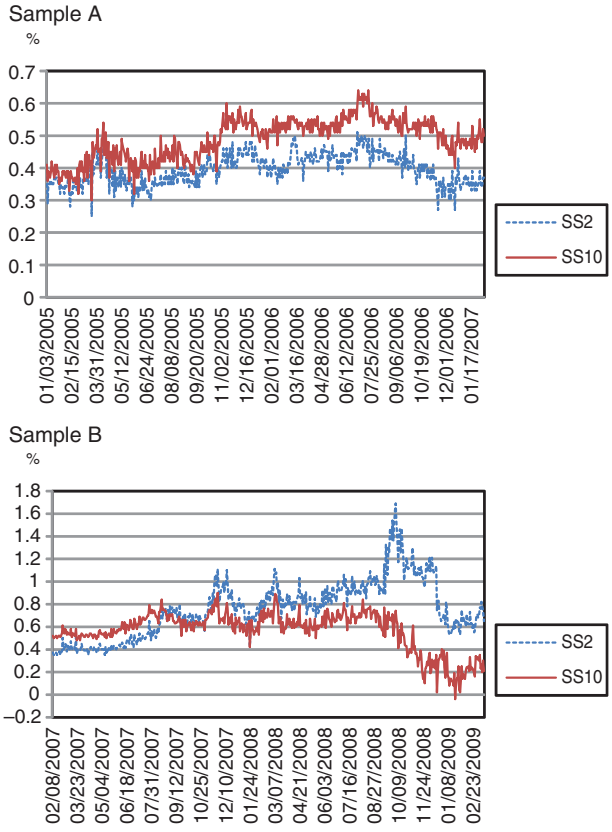

Fig. 1. Movement of swap spread
Data Source: Federal Reserve Statistical Release.
Notes: Sample A = from 3 January 2005 to 7 February 2007; Sample B = from 8 February 2007 to 12 March 2009; SS2 = 2-year swap spread, SS10 = 10-year swap spread.

in 2 and 10 years in each sample period are shown in Fig. 1. The descriptive statistics of swap spreads in each sample period are provided in Table 1.

Determinants of swap spread

Default risk. Default risk is defined as the yield spread between corporate bond issued and 10-year US Treasury Bond yield. Corporate bond spread is considered to represent default risk. Two kinds of corporate bond are used for the analysis. They are Moody's seasoned Aaa corporate bond and Baa corporate bond. According to Moody's Investors Service, Aaa corporate bonds are judged to be of the highest quality, with minimal credit risk. Baa corporate bonds are subject to moderate credit risk. They are considered medium-grade and as such may possess certain speculative characteristics.

The movement of Aaa and Baa corporate bond spreads is shown in Fig. 2. The correlation of Aaa corporate bond and Baa corporate bond spreads in each sample period is shown in Table 2. During a

Table 1. Descriptive statistics of swap spreads

Variable	Average	SD	Min	Max	Median
Sample A					
SS2	0.394	0.047	0.250	0.510	0.400
SS10	0.488	0.065	0.300	0.640	0.500
Sample B					
SS2	0.756	0.257	0.350	1.690	0.750
SS10	0.564	0.172	−0.040	0.900	0.610

Notes: Sample A = from 3 January 2005 to 7 February 7 2007; Sample B = from 8 February 8 2007 to 12 March 2009; SS2 = 2-year swap spread, SS10 = 10-year swap spread.

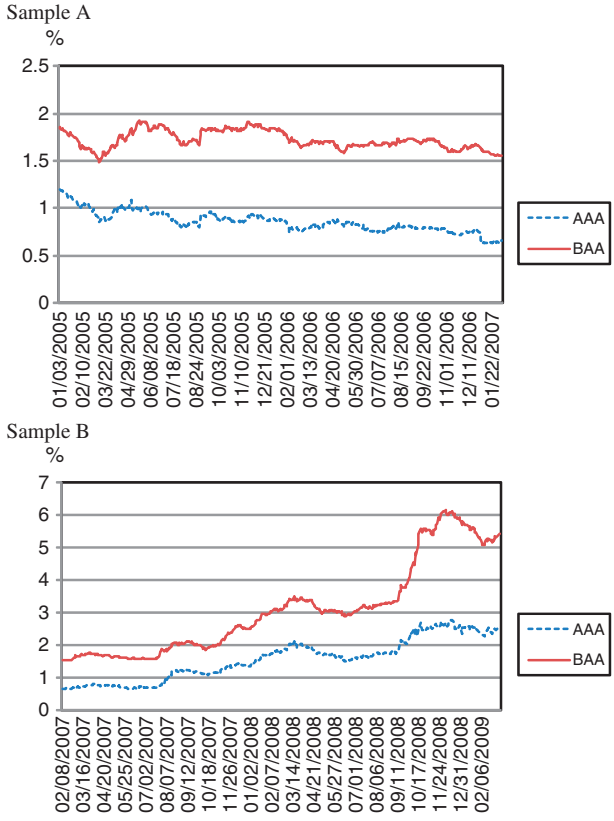

Fig 2. Movement of corporate bond spread
Data Source: Federal Reserve Statistical Release.
Notes: Sample A = from 3 January 2005 to 7 February 2007; Sample B = from 8 February 2007 to 12 March 2009; AAA = Aaa corporate bond spread, BAA= Baa corporate bond spread.

normal time the correlation between these two is relatively low. But during the financial crisis the correlation is very high. This fact indicates that when credit risk increased, Aaa corporate bond became more sensitive to default risk together with Baa corporate bond.

Table 2. Correlation of default risk

Variables	Correlation coefficient
Sample A	
AAA–BAA	0.550
Sample B	
AAA–BAA	0.964

Notes: Sample A = from 3 January 2005 to 7 February 2007; Sample B = from 8 February 2007 to 12 March 2009; AAA = Aaa corporate bond spread, BAA = Baa corporate bond spread.

Table 3. Descriptive statistics of determinats of swap spreads

Variable	Average	SD	Min	Max	Median
Sample A					
AAA	0.859	0.109	0.630	1.200	0.850
BAA	1.723	0.095	1.480	1.920	1.700
SLOPE	0.190	0.315	−0.190	1.130	0.090
TED	0.391	0.097	0.150	0.570	0.410
VOLA	0.044	0.007	0.029	0.070	0.043
Sample B					
AAA	1.577	0.641	0.640	2.790	1.630
BAA	3.110	1.402	1.530	6.160	2.990
SLOPE	1.095	0.755	−0.140	2.600	1.365
TED	1.458	0.925	0.390	4.680	1.285
VOLA	0.082	0.026	0.029	0.169	0.084

Notes: Sample A = from 3 January 2005 to 7 February 2007; Sample B = from 8 February 2007 to 12 March 2009; AAA = Aaa corporate bond spread, BAA = Baa corporate bond spread, TED = TED Spread, SLOPE = Slope of yield curve, VOLA = Volatility.

Liquidity premium. Liquidity premium is defined as TED spread between 6-month Eurodollar rate and 6-month T-bill.

Slope of yield curve. The slope of yield curve is defined as the differential between 2- and 10-year US Treasury note yields as in Huang and Chen (2007).

Volatility. Yield volatility calculated by EGARCH model is defined as volatility.[2] The 2-year US Treasury note yield is used for the calculation as in Huang and Chen (2007).

The descriptive statistics of determinants of swap spreads in each sample period are provided in Table 3.

IV. Framework of Analysis and Result

Here how to analyse the determinants of interest rate swap spread is indicated. First, Ordinary Least Square (OLS) is used to estimate Equation 1. Aaa corporate bond spread is used for default risk. The serial correlations of ε_t are adjusted by the method by Newey and West (1987). The lag periods of 12 are used.[3] The analysis for each sample period is conducted. The results are shown in Table 4.

$$\text{spread}_t = \alpha + \beta_1 \text{AAA}_t + \beta_2 \text{SLOPE}_t + \beta_3 \text{TED}_t + \beta_4 \text{VOLA}_t + \varepsilon_t \quad (1)$$

where AAA = Aaa corporate bond spread, SLOPE = slope of yield curve, TED = TED spread VOLA = volatility.

First, the analysis on Sample A is conducted. As for Aaa corporate bond spread, the positive coefficients of 2- and 10-year spreads are not significant within 5% level. As for slope, negative coefficient of 10-year spread is significant at 5% level. As for TED spread, the positive coefficients of 2- and 10-year spreads are significant at 1% level. The coefficient of 10-year spread is larger than 2-year spread. As for volatility, the negative coefficients of 2- and 10-year spread are significant at 1% level. The coefficient of 2-year spread is larger than 10-year spread.

Next, the analysis on Sample B is conducted. As for Aaa corporate bond spread, the negative coefficients of 2- and 10-year spread are significant at 1%. The coefficient of 10-year spread is larger than 2-year spread. As for slope, the positive coefficients of 2- and 10-year spreads are significant at 1% level respectively. The coefficient of 2-year spread is larger than 10-year spread. As for TED spread, the positive coefficient of 2-year spread is significant at 1% level. The negative coefficient of 10-year spread is not significant within 5% level. As for volatility, the positive coefficients of 2- and 10-year spreads are significant at 1% level. The coefficient of 10-year spread is larger than 2-year spread.

Next, OLS is used to estimate Equation 2. Baa corporate bond spread is used for default risk. The serial correlations of ε_t are also adjusted by the method by Newey and West (1987). The lag periods of 12 are used (see footnote 3). The analysis for each sample period is conducted. The results are shown in Table 5.

$$\text{spread}_t = \alpha + \beta_1 \text{BAA}_t + \beta_2 \text{SLOPE}_t + \beta_3 \text{TED}_t + \beta_4 \text{VOLA}_t + \varepsilon_t \quad (2)$$

[2] See Nelson (1991) as for EGARCH model.
[3] As for the lag periods, I also checked 6. But results are the same as in the case of 12.

Table 4. Result of regression analysis

	α	β^1(AAA)	β^2(SLOPE)	β^3(TED)	β^4(VOLA)	R^2	SER
Sample A							
SS2	0.248	0.115	0.011	0.375	−2.276	0.399	0.037
	(3.736)***	(1.447)	(0.360)	(5.463)***	(−4.044)***		
SS10	0.399	0.053	−0.068	0.381	−2.091	0.656	0.038
	(6.031)***	(0.645)	(−2.149)**	(5.907)***	(−4.040)***		
Sample B							
SS2	0.428	−0.305	0.282	0.155	3.346	0.844	0.102
	(6.816)	(−4.429)***	(5.503)***	(5.484)***	(4.737)***		
SS10	0.755	−0.451	0.239	−0.034	3.759	0.704	0.093
	(15.708)***	(−8.657)***	(5.437)***	(−1.656)	(5.910)***		

Notes: Values in the parentheses are *t*-statistics. The serial correlations of errors are adjusted by the method by Newey and West (1987). AAA = Aaa corporate bond spread, SLOPE = Slope of yield curve, TED = TED spread, VOLA = Volatility. *** and ** indicate significance at 1 and 5% levels, respectively.

Table 5. Result of regression analysis

	α	β^1(BAA)	β^2(SLOPE)	β^3(TED)	β^4(VOLA)	R^2	SER
Sample A							
SS2	0.249	0.047	0.046	0.386	−2.168	0.391	0.037
	(2.678)***	(0.953)	(2.037)**	(5.841)***	(−3.907)***		
SS10	0.447	−0.011	−0.049	0.393	−1.920	0.655	0.038
	(4.672)***	(−0.203)	(−2.388)**	(6.583)***	(−3.560)***		
Sample B							
SS2	0.420	−0.110	0.217	0.180	2.202	0.851	0.099
	(6.558)***	(−4.407)***	(5.509)***	(6.463)***	(2.707)***		
SS10	0.758	−0.170	0.150	0.007	1.934	0.760	0.084
	(14.928)***	(−7.920)***	(4.489)***	(0.357)	(2.898)***		

Notes: Values in the parentheses are *t*-statistics. The serial correlations of errors are adjusted by the method by Newey and West (1987). BAA = Baa corporate bond spread, SLOPE = Slope of yield curve, TED = TED spread, VOLA = Volatility. *** and ** indicate significance at 1 and 5% levels, respectively.

where BAA = Baa corporate bond spread, SLOPE = slope of yield curve, TED = TED spread VOLA = volatility.

First, the analysis on Sample A is conducted. As for Baa corporate bond spread, the positive coefficient of 2-year spread is not significant within 5% level. The negative coefficient of 10-year spread is not significant within 5% level. As for slope, the positive coefficient of 2-year spread and the negative coefficient of 10-year spread are significant at 5% level. As for TED spread, the positive coefficients of 2- and 10-year spreads are significant at 1% level. The coefficient of 10-year spread is larger than 2-year spread. As for volatility, the negative coefficients of 2- and 10-year spreads are significant at 1% level. The coefficient of 2-year spread is larger than 10-year spread.

Next, the analysis on Sample B is conducted. As for Baa corporate bond spread, the negative coefficients of 2- and 10-year spreads are significant at 1% level. The coefficient of 10-year spread is larger than 2-year spread. As for slope, the positive coefficients of 2- and 10-year spreads are significant at 1% level. The coefficient of 2-year spread is larger than 10-year spread. As for TED spread, the positive coefficient of 2-year spread is significant at 1% level. The positive coefficient of 10-year spread is not significant within 5% level. As for volatility, the positive coefficients of 2- and 10-year spreads are significant at 1% level. The coefficient of 2-year spread is larger than 10-year spread.

V. Concluding Remarks

The purpose of this article is to investigate the determinants of US interest rate swap spreads in the

period including the financial crisis. The asymmetric impacts of the financial crisis on interest rate swap spreads are focused by dividing the whole sample period into two. First period (Sample A) is from 3 January 2005 to 7 February 2007. Second period (Sample B) is from 8 February 2007 to 12 March 2009. First period includes relatively calm market. Second period includes the financial crisis.

Four determinants of swap spreads – default risk, the slope of yield curve, TED spread and volatility – are chosen. As for default risk, two kinds of default risk are used to investigate the sensitivity of swap spreads to Aaa and Baa corporate bond spreads.

The default risks measured both in Aaa and Baa corporate bonds are negatively incorporated in US interest rate swap spreads in the period of financial crisis. The negative impacts of default risk both in Aaa and Baa corporate bonds are greater for long maturities. The negative impacts of Aaa corporate bond are greater than Baa corporate bond. It is surprising that swap spreads in the period of financial crisis did not incorporate credit risk positively. The function of price discovery in the market might have been lowered because of financial shocks.

The slope is negatively incorporated in the spread of long-term maturity in normal period. But the slope is positively incorporated in the spreads of short- and long-term maturities in the period of financial crisis. The liquidity premium is positively incorporated in swap spreads in both short- and long-term maturities in normal period and only in short-term maturity in the period of financial crisis. This fact indicates that the market participants paid attention to liquidity premium in short- and long-term maturities in normal time, but they took care of liquidity premium only in the short-term swap in the period of financial crisis.

The volatility is positively incorporated in the spreads of short- and long-term maturities only in the period of financial crisis. In normal time there was no change of monetary policy by Federal Reserve Board (FRB). On the other hand, FRB started to change monetary policy from 18 September 2007. Afterwards FRB continued to ease monetary policy. They decided to lower the operating target of federal fund rate to 0.0% through 0.25% on 16 December 2008. The market participants were uncertain as for the future of monetary policy by FRB. Thus the speculation on the path of monetary policy is considered to cause more volatility in the market. The volatility can be a positive determinant of US swap spreads in the period of financial crisis.

Acknowledgements

The author thanks the anonymous referees for helpful comments. The research for this article is supported by Grant-in Aid for Scientific Research (KAKENHI 19530271) from JSPS.

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