



An analysis of global credit risk spreads during crises

Credit risk
spreads during
crises

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Abstract

Purpose – The purpose of this paper is to model the components of credit risk in primary debt markets and evaluate changes in these factors in times of crisis.

Design/methodology/approach – The authors use a unique dataset consisting of nearly 163,000 new loans and bond issues in the USA and internationally during the period January 1992 through December 2005.

Findings – The authors find that credit spreads are related to market liquidity, best represented by total proceeds, ratings and the interaction between maturity and rating. The authors control for various crisis periods, including regional financial crises and find that spreads generally increased in response to the Asian Crisis with the international markets exhibiting the larger increases. There is mixed evidence of asymmetric effects of shocks. In the US loan markets, the adjustment factor reduces forecast variance ($\Theta_1 < 0$). In contrast, the adjustment factor is not significant for US bonds, possibly indicating a more rapid adjustment and greater efficiency in this market. The opposite effect is seen in the international loan and bond markets with $\Theta_1 > 0$, indicating a persistent increase in spread volatility.

Originality/value – The paper extends our understanding of the components of primary credit spreads and the interactions between primary debt markets during crisis periods.

Keywords International finance, Financial markets, Bonds, Loans, Bond markets, Loan markets, September 11, International financial markets, Financial crises, EGARCH

Paper type Research paper

1. Introduction

This paper investigates the effect of market characteristics and global financial crises on the credit spreads in the primary issue bond and bank loan markets. Using data on a sample of nearly 163,000 new loans and bond issues in the US and international markets during the period January 1992 through December 2005, we examine the degree to which market volatility, liquidity, credit ratings and financial crises explain changes in credit spreads. This research identifies factors that explain credit risk in individual primary debt markets: new US[1] region loans, international new loans, new US region bond issues and new international bond issues. We also evaluate the influence of these factors in five distinct time periods including the Asian crisis and September 11 period. The occurrence of a series of financial crises has provided frequent opportunity to evaluate capital market reactions to shocks. Much of previous research stems from an underlying assumption of market efficiency between similar markets. Capital markets have become more globally integrated in recent decades. Technology and telecommunications improvements have improved the information flow across markets. Consequently, we expect that shocks



JEL classification – G01, G15

to one segment will be transmitted to other markets, resulting in increased volatility and subsequent higher cost to borrowers. A key objective for this study is to evaluate factors that determine credit risk and to identify how the influence of these factors may change during crises. In particular, we evaluate two different types of shocks, the Asian crisis created by poor lending practices and the September 11 terrorist attacks. Therefore, a contribution of this research is the analysis of the responses in primary debt markets to economic and non-economic shocks.

We find that credit spreads are related to market liquidity, best represented by total proceeds, ratings and the interaction between maturity and rating. We control for various crisis periods, including regional financial crises. We find that spreads respond differently during the Asian crisis and September 11 crisis periods, including evidence of increasing risk levels in the US bond market compared to the international bond market since September 11. At the same time, negative coefficients are seen for these time-period dummies in the US loan market indicating declining spreads. There is mixed evidence of asymmetric effects of shocks. In the US loan markets, the adjustment factor reduces forecast variance ($\Theta_1 < 0$). In contrast, the adjustment factor is not significant for US bonds, possibly indicating a more rapid adjustment and greater efficiency in this market. The opposite effect is seen in the international loan and bond markets with $\Theta_1 > 0$, indicating a persistent increase in spread volatility.

The balance of the paper is organized as follows. Section 2 details the recent debt market research and the two crises included in this paper. Objectives are summarized in Section 3. Section 4 describes the sample. The methodology and models used are shown in Section 5. Section 6 describes the empirical results; conclusions and future research are provided in Section 7.

2. Credit spreads and the impact of shocks

There has been little research on the link between the primary markets for corporate loans and bonds. Key exceptions are research by Carey and Nini (2007), Amato and Remolona (2003), Kamin and von Kliest (1999) and Domowitz *et al.* (1998). Carey and Nini (2007) focus on primary loan syndication market between 1992 and 2002. They find a “home bias” in origination (88-97 percent US origination) and a significant European discount in the spreads (roughly 30 bps) against USA and other regions. Domowitz *et al.* (1998) analyze the 1994 Mexican crisis and its impact on primary market prices for Cetes and Tesobonos bonds. The authors found that shocks to debt markets translate into long-term increases in the premium demanded by investors with respect to currency and country factors. They assert that financial market stability influences investor expectations regarding the likelihood of future shocks. Kamin and von Kliest (1999) find decreasing credit spreads in the early 1990s and lower spreads in non-USD denominated loans and bonds that they estimate did not cover expected borrower riskiness.

2.1 Bond market spreads

Several bond market studies evaluate the reaction of bond spreads to market shocks. Spreads represent the varying risk premium that investors assign to prospective borrowers, including credit risk, liquidity risk and market risk throughout the business cycle and in response to financial shocks. Domowitz *et al.* (1998) show country and currency premia help explain equity returns and closed-end fund discounts. Additional evidence is provided showing that investors did not anticipate the magnitude or timing

of the currency devaluation of December 1994 and the subsequent financial crisis. Zhu (2006) compares the pricing of credit risk in the bond market and the credit default swap (CDS) market. The cointegration test confirms that the expected parity relationship between the two spreads hold as a long-run equilibrium condition. However, considerable deviation from the parity can arise in the short run. The panel data study and the VECM analysis suggest that the derivatives market moves ahead of the bond market in price discovery. The deviation is largely due to the higher responsiveness of CDS premia to changes in credit conditions. Moreover, it exhibits a certain degree of persistence in that only 10 percent of price discrepancies can be removed within a business day.

Gonzalez-Rozada and Yeyati (2008) find that a large fraction of the time variability of emerging market bond spreads is explained by the evolution of global factors such as risk appetite, global liquidity and contagion from systemic events such as the Russian credit crisis. This link is robust to the inclusion of country-specific factors and helps provide accurate long-run predictions. By contrast, changes in credit ratings appear to lag spread movements and elicit little additional effect on the pricing of emerging market debt. Dungey *et al.* (2006) identifies the transmission of shocks from both the Russian bond credit and the LTCM recapitalization announcement to bond markets in emerging and industrial countries. Based on daily data, they find substantial contagion emerging from the Russian credit, but little from the LTCM shock. Countries with greater exposures to the crisis country are more affected by contagion and the contagion appears to be regional in nature (consistent with Corsetti *et al.* (1999)). Finally, contagion is not necessarily more apparent in developing markets than in developed markets. They find clear evidence of contagion effects from Russia, to both emerging and developing countries. The effects from the LTCM recapitalization are smaller, perhaps reflecting the short duration of the event.

2.2 Sovereign bonds

Many studies have reviewed sovereign debt markets. Edwards (1998) found linkage between Mexican and Argentine bond markets after the 1994 Peso crisis. Other work on corporate bond markets include: Clare *et al.* (1995), Smith (2002), Santos and Tsatsaronis (2003) and Yang (2005). Also, recent work by Remolona *et al.* (2007, 2008) and Kim *et al.* (2006) modeled sovereign credit risk. However, these studies were conducted primarily using secondary bond market data and indices. The relationship among sovereign debt markets has been the subject of a number of previous studies. However, it seems the equities markets remain the primary focus for this type of research. Davies (2007) suggests a long-run equilibrium that is subject to occasional structural change, based on an analysis of daily bond market data from 1994-2006 for the US, German, Japanese, the UK, Swiss and Canadian sovereign bond markets. Smith (2002) argues that cointegration across markets violates traditional market efficiency since predictable long-term relationships between bond markets could be used to predict future movements. Using daily and monthly data of government bond yields, Codogno *et al.* (2003) find that the credit risk and general international factors dominate the liquidity effect in explaining yield differentials, suggesting that yield differentials reflect fundamentals rather than inefficient or incomplete markets. In another study of the underlying economic factors supporting bond market cointegration, Kashiwase and Kodres (2008) determine that spreads on emerging market countries' sovereign bonds fell dramatically since mid-2002.

The study attempts to distinguish between fundamental factors and liquidity factors to explain a fall in spread to levels seen prior to 1997 Asian crisis. In the same period, Sander and Kleimeier (2003) analyzed contagion between sovereign bond spreads as a measure of perceived country risk during the Asian crisis. They considered regional and global linkages as the Russian crisis started and found support for bond market integration in this crisis period. Kim *et al.* (2006) find evidence of strong and dynamic linkages between Euro zone bond markets with that of Germany, but much weaker linkages to accession countries of Czech Republic, Hungary and Poland.

2.3 1997 Asian Financial crisis

In 1997, a series of business failures and economic shocks caused significant currency depreciation throughout the Asian-Pacific region. Chatterjee *et al.* (2003) and Corsetti *et al.* (1999) identified five broad reasons for the Asian crisis. They observed that unusually high growth during the 1990s lead to a high proportion of long-term investment being funded by short-term borrowing of foreign funds. As growth slowed, the market value of the collateral used for these loans dropped below the loan values. The “under water” loans, coupled with lax risk management within the banking system and little government oversight contributed to the bursting of the asset bubble. The geographical and structural proximity of the Asian economies contributed to the contagion effect. Another factor contributing to the Asian crisis was the increased moral hazard resulting from implicit guarantees for financial institutions by governments and the guarantees of governments supported by the IMF and the World Bank (Chatterjee *et al.*, 2003). Kamin and von Kliest (1999) find that bond and loan spreads had fallen too low to cover risk prior to the 1997 Asian crisis. They assert that this decline in spreads reflect increased globalization where industrial country investors were willing to lend to emerging market countries on the same basis as industrial country borrowers due to stabilization programs in emerging markets and increased knowledge about and experience with emerging market borrowers.

2.4 September 11 crisis

In contrast, the terrorist attacks on September 11, 2001 were not fundamental economic issues, but an abrupt short-term shock to US financial markets. The attacks highlighted a new risk to American soil. This shock was different from other crises because it was not rooted in economic fundamentals. In contrast, it was an unanticipated terrorist action that had economic impact. Morgan and Murtagh (2009) investigated the linkages between US and global debt and bank loan markets before and after the September 11 attacks. Debt market spreads were linked prior to September 11, consistent with increasing globalization in loan syndication and bond markets. In the post-September 11 time period, they find increased linkage and feedback in three of the four debt series.

2.5 Bond market liquidity

Much of the previous research regarding the influence of liquidity on bond spreads has focused on secondary market data. Friewald *et al.* (2011) review several relevant streams of literature identifying alternative ways to define liquidity measures and evaluate the influence of liquidity effects during two recent financial crises. They utilize a wide range of liquidity measures and find that liquidity exerts considerably more influence on corporate yield spreads during the GM/Ford crisis and the subprime

crisis periods. Previous studies offer a range of alternate methods to define liquidity measures in the corporate bond market. Many of these studies define bond liquidity using bond characteristics such as coupon rates, proceeds, term to maturity, industry and special covenants; other studies define liquidity in terms of market measures including trading volume, number of dealers or bid-ask spread. These papers generally find that liquidity is priced in bond yields in the secondary market. In this paper, we extend the previous research to the primary debt markets for both bonds and bank loans. Evaluating credit spreads at the time of original issue prevents the use of some of the more commonly used market measures. Instead, this paper relies on characteristics of the original issues as a proxy for liquidity.

3. Objectives

The objective of this paper is to model factors that influence credit risk spreads, to compare the influence on these factors between primary debt markets and to assess how these influences change in response to crises. Following Gonzalez-Rozada and Yeyati (2008), we control for market liquidity, risk aversion, maturity, bond ratings, and specific financial shocks.

4. Data description

Our data sample consists of four debt series: US region and international loans; US and international bonds. US loan spreads are calculated as the total loan cost (all in drawn spread above LIBOR plus LIBOR) less the yield from a US Treasury of equal maturity. The US region includes loans and bonds from Canada and the USA. Bond spreads are calculated as the offer yield to maturity at issue minus the yield on a US Treasury of equal maturity. The sample was truncated to include only those observations where this spread was positive. While all negative spreads were dropped from the sample, these bonds present an interesting opportunity for future study. Final observations for each series are: US region loans, 52,717; International loans, 29,762; US region bonds, 61,215 and International bonds, 19,370.

Weekly averages were computed for each series over the period from January 1, 1992 to December 31, 2005. Loan data were sourced from Loan Pricing Corporation and bond data were sourced from Thomson SDC. The choice of weekly observations reduces the impact of short-term variations in bond and loan yields. The overall sample from January 1992 to December 2005 was partitioned into five sub-periods. The first sub-period (pre-Asian) begins in January 1, 1992 and ends December 23, 1996. The Asian crisis period begins January 1, 1997 and concludes December 24, 1998. The period between crises runs from January 1, 1999 through September 3, 2001. The September 11 crisis period begins September 10, 2001 and ends August 6, 2003. The post-September 11 recovery period runs from August 13, 2003 through December 31, 2005.

4.1 Credit spreads

Descriptive statistics for the spread series are shown in Table I. The series for loan and bonds are slightly skewed and demonstrate some kurtosis. In each of the periods analyzed, the credit risk spread on US region bonds is significantly (0.01) less than the spreads on the other series. Specifically, US bond spreads are 148-210 basis points (bps) lower than US region loan spreads, 85-254 bps lower than the international bond spreads, and 90-169 bps lower than the corresponding International loan spreads.

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Variable	<i>n</i>	Mean	SD	Kurtosis	Skewness
<i>Panel A: total period: January 1992-December 2005</i>					
US region loan spreads	728	268.10	48.64	0.66	0.65
International loan spreads	728	227.71	79.42	3.96	115
US region bond spreads	728	90.98	32.69	1.80	1.19
International bond spreads	728	223.76	99.11	4.14	1.57
<i>Panel B: pre-Asian crisis period: January 1992-December 1996</i>					
US region loan spreads	260	273.34	58.22	0.01	0.50
International loan spreads	260	193.74	89.94	4.78	1.45
US region bond spreads	260	103.97	35.61	2.01	1.14
International bond spreads	260	188.90	55.76	3.90	0.81
<i>Panel C: Asian crisis period: January 1997-December 1998</i>					
US region loan spreads	104	288.18	43.46	1.06	0.54
International loan spreads	104	247.27	84.11	1.84	1.22
US region bond spreads	104	78.19	26.06	1.54	1.48
International bond spreads	104	332.13	131.64	2.03	0.90
<i>Panel D: post-Asian/pre-September 11 period: January 1999-September 2001</i>					
US region loan spreads	140	260.51	44.65	0.14	0.68
International loan spreads	140	276.56	63.90	2.25	1.04
US region bond spreads	140	112.36	26.60	-0.27	0.40
International bond spreads	140	255.27	111.20	-0.17	0.58
<i>Panel E: September 11 crisis period: September 2001-August 2003</i>					
US region loan spreads	100	264.11	40.21	0.95	0.63
International loan spreads	100	234.94	40.49	0.14	0.79
US region bond spreads	100	74.68	13.62	0.03	0.53
International bond spreads	100	164.75	42.30	1.36	0.48
<i>Panel F: post-September 11: August 2003-December 2005</i>					
US region loan spreads	124	252.06	31.19	0.36	0.14
International loan spreads	124	221.51	53.16	33.05	4.34
US region bond spreads	124	63.52	11.64	6.14	1.85
International bond spreads	124	217.99	71.39	1.08	0.69

Table I.
Descriptive statistics for
spread series during
pre/post-Asian and
September 11 crises

Notes: Significance at: *.01, **.05 levels; this table details the descriptive statistics for US region and international loan spreads; US region and international bond spreads; the spreads were calculated as the yield or total loan cost minus the equivalent US treasury bond of equal maturity

This consistent difference in US bond spreads indicates a higher level of efficiency in the US bond market, or a consistently higher quality of borrowers in the US bond market. In contrast, relative US loan spreads generally exceed spreads in the international bond (29-80 bps) and loan markets (5-99 bps). However, US loan spreads were lower than international bond spreads (44 bps, 0.01) during the Asian crisis, and lower than international loan spreads in the post-Asian crisis period (16 bps, 0.01).

Additionally, we calculate the differences between the means for each of the series across the periods. A positive difference in spreads indicates the spread increased in the following period. As shown in Table II, mean spreads increased for US region loans (14.84 bps, 0.05), international loans (53.53 bps, 0.01), and international bonds (143.24 bps) during the Asian crisis period but US bond spreads declined 25.78 bps. In the period between the two crises, US region loan spreads and international bond spreads declined while US bond and international loan spreads increased. The change in spreads was more consistent in response to the September 11 attacks. Although there

Variable	<i>n</i>	Mean	<i>n</i>	Mean	Difference	% chg
<i>Panel A: Asian crisis minus pre-Asian period</i>						
	<i>Pre-Asian period</i>		<i>Asian crisis</i>			
US region loan spreads	260	273.34	104	288.18	14.84 ^{**}	5.4
International loan spreads	260	193.74	104	247.27	53.53 [*]	27.6
US region bond spreads	260	103.97	104	78.19	-25.78 [*]	-24.8
International bond spreads	260	188.90	104	332.13	143.24 [*]	75.8
<i>Panel B: post-Asian period minus Asian crisis</i>						
	<i>Asian crisis</i>		<i>Post-Asian period</i>			
US region loan spreads	104	288.18	140	260.51	-27.67 [*]	-9.6
International loan spreads	104	247.27	140	276.56	29.29 [*]	11.8
US region bond spreads	104	78.19	140	112.36	34.17 [*]	43.7
International bond spreads	104	332.13	140	255.27	-76.86 [*]	-23.1
<i>Panel C: September 11 crisis minus post-Asian period</i>						
	<i>Post-Asian period</i>		<i>September 11 crisis</i>			
US region loan spreads	140	260.51	100	264.11	3.60	1.4
International loan spreads	140	276.56	100	234.94	-41.62 [*]	-15.0
US region bond spreads	140	112.36	100	74.68	-37.68 [*]	-33.5
International bond spreads	140	255.27	100	164.75	-90.52 [*]	-35.5
<i>Panel D: post-September 11 period minus September 11 crisis</i>						
	<i>September 11 crisis</i>		<i>Post-September 11</i>			
US region loan spreads	100	264.11	124	252.06	-12.06 ^{**}	-4.6
International loan spreads	100	234.94	124	221.51	-13.43 ^{**}	-5.7
US region bond spreads	100	74.68	124	63.52	-11.16 [*]	-14.9
International bond spreads	100	164.75	124	217.99	53.24 [*]	32.3

Notes: Significance at: ^{*}0.01, ^{**}0.05 levels; this table details the differences between the means for US region and international loan spreads; US region and international bond spreads

Table II.
Differences between
mean spreads

was no statistical difference in US loan spreads, the other series exhibited declining spreads of 38-91 bps. Spreads declined further during the post-September 11 period except for international bonds (+53.24, 0.01). The percent change results demonstrate that the US region loans had the lowest relative changes between periods and that the bond markets showed more substantial changes from period to period. This result may indicate a greater shock absorbing effect in the US loan market compared to these other primary markets (Table III).

4.2 Average adjusted total proceeds (ATP11-ATP14)

Average weekly US region loan proceeds increased 102 percent, more than \$11.5 billion between the pre-Asian and Asian sub-periods. US loans sustained this higher volume until the September 11 crisis period during which weekly volume dropped over \$3.4 billion or 16 percent. Domestic loan volume recovered 37 percent (\$6.6 billion) in the post-September 11 period. Each of these volume reversals was significant at the 0.01 level. International loan volume also increased between the pre-Asian, Asian crisis, and post-Asian crisis periods. International loan volume declined during the September 11 period, but recovered in the post-September 11 period by posting gains of nearly 57 percent to level of \$21 billion per week. These international loan volume changes were significant at the 0.05 level or better. In the bond markets, US region bonds

	Mean			Diff.	% chg	Diff.	% chg
<i>Panel A:</i>	<i>Pre-Asian</i>	<i>Asian</i>	<i>Post-Asian</i>				
<i>variable</i>	<i>period</i>	<i>crisis</i>	<i>period</i>	<i>Asian – pre-Asian</i>		<i>Post-Asian – Asian</i>	
Vix	14.29	24.88	26.06	10.59 *	74.1	1.18 **	4.7
ATP11	11.24	22.74	21.19	11.51 *	102.4	–1.55	–6.8
ATP12	4.46	10.66	15.65	6.20 *	139.1	4.99 *	46.8
ATP13	6.39	9.41	12.24	3.02 *	47.2	2.82 *	30.0
ATP14	4.15	3.75	5.13	–0.40	–9.6	1.37 *	36.5
Rating11	21.89	22.53	21.52	0.64 *	2.9	–1.01 *	–4.5
Rating12	23.63	22.93	21.52	–0.70	–3.0	–1.41 *	–6.2
Rating13	13.85	14.34	13.60	0.49	3.6	–0.74	–5.2
Rating14	11.19	9.75	9.32	–1.44 *	–12.9	–0.43	–4.4
Tenor11	50.26	52.54	43.00	2.28 *	4.5	–9.54 *	–18.2
Tenor12	54.02	61.94	57.09	7.92 *	14.7	–4.85 *	–7.8
Tenor13	123.00	124.33	107.49	1.33	1.1	–16.84 *	–13.5
Tenor14	77.87	90.20	89.91	12.33 *	15.8	–0.29	–0.3
OBS	260	104	140				
<i>Panel B</i>	<i>Post-Asian</i>	<i>September</i>	<i>Post-</i>	<i>September</i>	<i>Post-September</i>		
	<i>period</i>	<i>11 crisis</i>	<i>September 11</i>	<i>11 – post-Asian</i>	<i>11 – September</i>		
Vix	26.06	29.60	14.88	3.54 *	13.6	–14.73 *	–49.7
ATP11	21.19	17.78	24.35	–3.41 *	–16.1	6.56 *	36.9
ATP12	15.65	13.36	20.95	–2.29 **	–14.6	7.59 *	56.8
ATP13	12.24	14.66	10.46	2.43 *	19.8	–4.21 *	–28.7
ATP14	5.13	12.39	10.58	7.27 *	141.8	–1.82 ***	–14.6
Rating 11	21.52	21.72	22.72	0.20	0.9	1.00 *	4.6
Rating 12	21.52	19.40	22.10	–2.13 *	–9.9	2.71 *	14.0
Rating 13	13.60	23.84	25.80	10.24 *	75.3	1.97 *	8.2
Rating 14	9.32	8.22	10.31	–1.10 *	–11.8	2.09 *	25.4
Tenor 11	43.00	36.50	49.02	–6.51 *	–15.1	12.52 *	34.3
Tenor 12	57.09	59.47	69.16	2.38 ***	4.2	9.69 *	16.3
Tenor 13	107.49	82.54	75.66	–24.95 *	–23.2	–6.88 *	–8.3
Tenor 14	89.91	85.95	92.37	–3.96	–4.4	6.43 ***	7.5
OBS	140	100	124				

Notes: Significance at: *0.01; **0.05 levels; this table includes the weekly means of the independent variables for each debt series by each sub-period; ATP – equals average total proceeds in billions of dollars; ratings are a numeric value ranging from 1 to 27 (1 through 11 equal investment grade; 12 through 17 non-investment grade and 18 through 27 levels – speculative quality; Tenor represents the maturity of the issue in months; series 11 – US region loans; series 12 – international loans; series 13 – US region bonds and series 14 – international bonds

Table III.
Difference between
means of independent
variables across
sub-periods

posted significant gains in average weekly proceeds in all periods until the post-September 11 period. During that period, US bond volume dropped 29 percent. A more erratic pattern of volume changes is seen in the international bond market.

4.3 Borrower quality (Rating 11-Rating 14)

On average, borrower quality for loans (US and International) were speculative grade ranging from 21 to 24 on our scale. In contrast, bond borrowers, domestic and international, generally were higher quality firms. The exception is seen in the average US region bond ratings during the September 11 crisis. During this crisis, average US bond quality dropped from a non-investment level of 13.6 to a speculative rating of 23.8. This significant

decline in borrower quality among US bonds could reflect the presence of the 2001 recession and its effect on borrower balance sheets and liquidity. An alternative view is that lower quality firms which had previously accessed loan markets shifted to US region bond markets. The corresponding effect on maturities is discussed in the next paragraph. International bond borrowers were consistently investment grade throughout all five sub-periods. This result indicates a difference in the nature of the US versus International bond markets. International bond borrowers improved quality in all periods except the most recent and remained investment grade throughout the entire sample.

4.4 Maturities (Tenor 11-Tenor 14)

Maturities for US region loans varied in each period, perhaps reflecting changes in project requirements. The patterns are not necessarily consistent with changes in borrower quality seen above in the rating changes. Changes between the periods were statistically significant. International loan maturities lengthen during the Asian crisis an average of eight months. Previous research suggests that increases in long-term borrowing may have precipitated the crisis (Chatterjee *et al.*, 2003; Corsetti *et al.*, 1999). On average, these maturities shorten after the crisis by four months, then increase in the September 11 and post-September 11 periods by 2.5 and ten months, respectively. International borrowers exhibit a consistently different behavior, borrowing on average ten to 20 months longer than their domestic counterparts. The opposite relationship is seen in the bond markets. Earlier in the sample period, US bond maturities exceeded international bond maturities by 30-50 months. During the September 11 crisis period, this difference is reduced to just three months. Since the September 11 crisis, international bond maturities exceed US bond maturities by 17 months. This pattern is consistent with a migration of high quality domestic borrowers to international bond markets.

Consistent with previous research, we find that US and international loan borrowers are lower quality than their bond counterparts as measured by average ratings. In the global bond markets, higher quality issuers can readily access capital. During the period studied in this sample, borrowers seemed to shift from domestic to international markets. This could also provide partial explanation for the observed decline in domestic bond spreads in nearly all sub-periods. This migration of larger and higher quality firms away from US bond markets to international bond markets may have created price pressure on US bond spreads. This trend is consistent with the significant decline in bond issuer quality during the September 11 crisis and post-September 11 periods and the corresponding reductions in maturities. This result indicates a migration of lower quality borrowers to domestic bond markets for shorter term bonds and suggests that borrower quality and term to maturity each are important factors in determining credit spreads.

5. Methodology-model

An important contribution of this paper is the investigation of factors contributing to credit risk in the primary debt markets. A multifactor exponential GARCH (EGARCH) model is used to evaluate credit risk spreads within a particular market. This study utilizes an EGARCH model to estimate expected spreads and their conditional variances. Our intention is to decompose spread volatility into components assessing risk aversion, liquidity, maturity, rating and credit risk using EGARCH, while controlling for other

financial shocks. The date ranges for these financial shock dummy variables are shown in Table IV.

Nelson (1991) developed an asymmetric GARCH model referred to as EGARCH to model stock returns and return volatility. A key advantage to this model is the ability to identify asymmetric influences on return volatility. Nelson includes an adjusting function $g(z)$ in the conditional variance equation.

The multifactor EGARCH-M model is:

$$R_t = a + b_1R_{t-1} + b_2lvix + b_3liquidity + b_4AvgRating + b_5TenorRating + b_6AsianCrisis + b_7PostAsian + b_8Sept11 + b_9PostSept11 + b_{10}Mexico + b_{11}Russia \tag{1}$$

$$R_t = a + b_1R_{t-1} + b_2lvix + b_3liquidity + b_4AvgRating + b_5TenorRating + b_6AsianCrisis + b_7PostAsian + b_8Sept11 + b_9PostSept11 + b_{10}Mexico + b_7b_{11}Russia$$

In the mean equation, R_t is the natural log of the credit spread in basis points. This credit risk premium is a function of the spread in the preceding period (R_{t-1}) and the level of risk aversion in the market as measured by the Chicago Board Options Exchange Market Volatility Index (VIX). Collin-Dufresne *et al.* (2001) identify the VIX as a suitable proxy for firm volatility in the absence of information regarding publically traded options for the individual firms. This study utilizes the log of the total weekly proceeds in 2005 constant dollars normalized against the standard deviation over the entire period as the liquidity proxy. We expect that bond spreads may be specifically sensitive to changes in market liquidity. The source data included rating information about each new offering. Moody's and Standard and Poor's letter ratings were converted into a numeric form with "1" indicating the best rating and "27" the worst. When both ratings were available for a single issue, the alternative ratings were evaluated for consistency. The resulting "average rating" proxy is used to assess the influence of risk change and is expected to be positively related to the credit risk premium. Following Kamin and von Kliest (1999), we include the interaction between the rating and term to maturity on a new issue is evaluated using the Tenor*Rating proxy. This measure is the log of the product of the rating and term to maturity for each new issue. The average Tenor*Rating measure was then calculated. In previous research (Morgan and Murtagh, 2009) found that lenders adjusted term to maturity and rating in response to financial crises. In riskier periods, lenders may reduce the borrowing term to mitigate increased credit risk. Dummy variables are included to capture the influence of specific crises on credit spreads.

Table IV.
Time periods for financial
shock control variables

Financial shock	Time period
Mexican crisis	January 1994-December 1995
Russian/LTCM crisis	August 1998-October 1998
Brazilian crisis	December 1998-February 1999
Argentine crisis	January 2001-May 2003
US recession	April 2001-November 2001

The mean has a conditional variance, σ_t^2 , estimated as:

$$\begin{aligned} \ln \sigma_t^2 &= \sigma_t^2 \\ \ln \sigma_t^2 &= \omega + \alpha_1 g(z_{t-1}) + \gamma_1 \ln(\sigma_t^{2-1}) \end{aligned} \quad (2)$$

The value of $g(z_t)$ is a function of both the magnitude and the sign of z_t and is expressed as:

$$g(z_t) = \theta_1 z_t + \theta_2 [|z_t| - E|z_t|] \quad z_t = \frac{\varepsilon_t}{\sigma_t^2} \quad (3)$$

The coefficient Θ_2 in $g(z_t)$ is set to 1. If z_t is $N(0,1)$, the expected value of z_t is $(2/\pi)^{1/2}$.

The conditional variance, σ_t^2 , is specified as a function of the unconditional volatility (ω), an adjusting factor $g(z)$, and the log of the forecast variance from the previous period, σ_{t-1}^2 . This specification allows positive and negative shocks to have a different impact on volatility and allows larger shocks to have a greater influence on volatility than the standard GARCH model. For standardized residuals less than (greater than) zero, the model overestimates (underestimates) the credit risk premium. For $\Theta_2 = 1$, larger shocks increase the adjustment factor, $g(z_t)$. For $\Theta_1 < 0$, a larger shock makes the adjustment factor larger. Engle and Bollerslev (1986) show that the persistence of shocks to volatility can be evaluated using the sum of the Autoregressive and Moving Average components of the conditional variance, $\alpha_1 + \gamma_1$. A sum less than 1.0 suggests that the volatility response will decay over time while a total greater than 1 indicates a continuing effect on the volatility over time.

6. EGARCH-M results

6.1 Results for the period January 1992 through December 2005

The results of the EGARCH models covering the entire sample period are shown in Table V. The intercept estimate is significant and consistent. Market risk aversion, represented by the VIX is negative for US and international loans and international bonds, but positive for US bonds. Sometimes referred to as the “fear index”, the VIX represents an expectation of stock market volatility. A negative coefficient for this factor may indicate that higher quality borrowers shift to the debt market as a shelter against higher equity risk.

The liquidity measure used is the log of the total proceeds in constant 2005 dollars where the long-term linear trend is removed. With this liquidity proxy, US region loans, international loans and international bonds have significant and negative coefficients, indicating that credit risk spreads declined as liquidity increased in these markets. In contrast, US bonds exhibit the opposite sign during this period.

An increase in the average rating for new issues in a period indicates a decrease in quality. Consequently, we expect a positive relationship between the credit spread and the average rating. This relationship is seen with the international bonds, but not with the other series evaluated. The coefficients for international loans, US region loans and US region bonds are negative and statistically significant. One possible explanation for these results would be that as the borrower ratings decline, lenders in the loan market and US bond market exact other protections reflected in this model. For bank loans, these protections may include more frequent financial reporting, active monitoring or stronger collateral agreements. Identifying these qualitative measures is outside the

	US region loans	Intl loans	US region bonds	Intl bonds
Total R^2	0.4504	0.1416	0.6151	0.3838
Log likelihood	444.353	-79.912	195.831	-224.959
MAPE	1.853	4.614	3.391	4.584
AIC	-848.71	199.82	-351.66	489.92
Intercept (a)	0.393 *	5.885 *	5.000 *	8.055 *
Risk aversion (b2)	-0.0501 *	-0.0887 *	0.1180 ***	-0.0347 *
ATP (b3)	-0.0300 *	-0.0798 *	0.0178 ***	-0.0202 **
Average rating (b4)	-0.1018 *	-0.0689 *	-0.2757 *	0.2061 *
Tenor*Rating (b5)	0.4415 *	-0.0039 *	0.1934 *	0.0452 *
D_Asian crisis (b6)	0.0119 *	0.3835 *	0.1032	0.4831 *
D_post-Asian crisis (b7)	-0.0079	0.5401 *	0.4710 *	0.3562 *
D_September 11 crisis (b8)	-0.0073 *	0.3846 *	0.3865 *	0.1883 ***
D_post-September 11 (b9)	-0.1420 *	0.2447 *	0.2262 **	0.0770 *
D_Mexico (b10)	-0.1841 *	0.0217	-0.1996 **	-0.0546
D_Russia/TCM (b11)	0.0616 *	0.1378	-0.0330	0.3162 ***
D_Brazil (b12)	0.0832	-0.0523	-0.0283	-0.0651
D_Argentina (b13)	0.0951 *	0.0128 *	-0.0044	-0.2629 **
D_US Recession (b14)	-0.0589	0.0801 *	-0.0670	-0.2723 **
R_{t-1} (b1)	-1.1208 *	-0.0453 *	-0.0206 *	-0.6337 *
EGARCH0 (ω)	0.0395 *	0.1948 *	0.0049 *	0.0324 *
EGARCH1 (α_1)	0.7235 *	0.9823 *	0.9939	0.7126 *
EGARCH1 (γ)	2.9924 *	0.0664 *	15.6853 *	-3.0703 *
THETA (θ)	-0.6454 *	0.0982 *	0.4980	1.5842 *
DELTA (Δ)	0.4504	5.885 *	5.000 *	8.055 *

Notes: Significance at: *0.01, **0.05, ***0.10 levels; this table summarizes the coefficients and significance of the EGARCH (1,1) estimates for US and international loan spreads; US and international bond spreads

Table V.
EGARCH estimates

scope of this analysis, but may provide an opportunity for additional research. Helwege and Turner (1999) suggest that variations in creditworthiness are not fully captured in the ratings, creating conditions in which poorly rated firms could issue debt with longer maturities when ratings had not kept pace with improved conditions in the firm.

The interaction term, Tenor*Rating, is statistically significant with a positive sign for US and international bonds and US region loans. The coefficient for international loans, in contrast, is negative and significant. Diamond (1993) finds banks shorten maturity on riskier borrowers during crises. Additionally, in response to loan behavior in the pre-Asian period, banks would shorten maturity, therefore the interaction of Tenor*Rating provides insight on the slope of the spread. Average tenor US loans (47 months) was significantly shorter than international loans (109 months) for the total period.

The EGARCH models include dummy variables to control for the influences of other financial crises during the period studied. The dates for these events are shown in Table IV. In periods of economic crisis, we expect that credit risk spreads would increase to reflect the increased uncertainty. As a result, a positive sign is expected for the financial crisis dummy variables. Coefficients for the period dummies b_6 through b_9 correspond to the Asian crisis through the post-September 11 periods. These coefficients are generally positive and significant for each of the periods for international loans, international bonds and US region bonds. US loans exhibit a different result.

The D_Asian crisis (b_6) coefficient is positive and significant as expected. Increased risk from the crisis is shown to increase credit spreads in the US loans during this period. However, the opposite effect is seen during the September 11 crisis and post-September 11 periods. In both these periods, the negative coefficients indicate a reduction in credit spreads. Since the September 11 crisis occurred in the middle of the US recession and was unexpected, US Federal Reserve actions to stimulate the economy with lower interest rates and increased liquidity have some effect on our results.

The influence of the Mexican crisis is seen in the US region loans and bonds with negative coefficients for each. Coefficients representing the Brazil crises are not statistically significant for any of the series. During the Russia/LTCM crisis, the coefficients are positive and significant for US loans and international bonds. During the period of the Argentine crisis, the coefficient for US and international bonds is negative but US and international loans are positive. This contrasting response may indicate a shifting of borrowers between these markets during this crisis.

The US recession in mid-2001 exhibits negative coefficients except for international loans. This result may reflect a shift in borrower quality as the US economy slowed. A further component of the mean equation is the one period lag of the credit spread. In all models, the coefficients are significant and negative indicating that higher credit spreads in the previous period will decrease spreads in the current period. Finally, the EGARCH-M model includes the conditional variance as an explanatory variable in the mean equation. As seen in Table V, the coefficient (Δ) for the conditional variance is positive for all spreads and significant for all but US loans. In this case, increased variance contributes to higher credit risk spreads.

The EGARCH estimates for the conditional variances also are shown in Table V. The unconditional volatility (ω) shows significant positive coefficients for all four series. The coefficients of the EGARCH adjusting factors (α_1) are significant and positive for US region and international loans and US region bonds. The coefficient for the forecast variance of the previous period (γ_1) is significant and positive for both loan markets and US bonds, but negative for international bonds. Theta is significant and negative for US loans, indicating a dampening effect on the adjustment factor. Theta is positive for international loans and both bond spreads.

6.2 Results by sub-period and market

Table VI shows the EGARCH estimates by market and time period. In the spread equation, the lagged spread from the previous period (R_{t-1}) has a consistently negative coefficient (b_1) indicating that the spreads in the preceding period reduce the current spread. The only exception to this pattern is seen during the September 11 crisis period. As expected, increases in the market liquidity (ATP) decreased spreads in three of the four markets; the US bond market is the exception. However, during the September 11 crisis period both bond markets exhibit positive coefficients indicating that increased proceeds also increased spreads. Similarly, coefficients for the Tenor*Rating interaction variable are mostly positive suggesting that spreads increase as lenders increase the average risk and/or term to maturity of the offering. If the VIX is an appropriate proxy for market volatility or “fear”, we expect positive coefficients reflecting increasing spreads as risk increase. This is the case for US region bonds and loans being positive but the opposite is seen for International bonds and loans. Coefficients in the separate time periods do not follow a discernable pattern. One possible explanation for this

	Pre-Asian	Asian crisis	Post-Asian	September 11	Post-September 11
<i>Panel A: US region Loans</i>					
Total R^2	0.4523	0.5077	0.4863	0.3563	0.3801
Log likelihood	112.83	88.73	99.86	76.66	113.65
Intercept (a)	3.3023 *	2.5546 *	2.6585 **	3.2580 *	1.6529 **
Risk aversion (b2)	-0.2623	-0.0299 *	-0.0796	0.0177 *	0.3804 *
Proceeds (b3)	-0.0441 **	-0.0049	-0.0403 ***	-0.0634 *	-0.0354 ***
Average rating (b4)	0.2150	-0.5931 *	-0.4692 **	-0.1238 *	0.1760 *
Tenor*Rating (b5)	0.3502	0.8119 *	0.5151 *	0.3888 *	0.4315 *
D_Mexico (b6)	-0.2265 *				
D_RussiaLTCM (b7)		0.0390 *			
D_Brazil (b8)		0.1613 *	0.1336 **		
D_Argentina (b9)			0.0505	0.0590 *	
D_US recession (b10)			-0.0277	-0.1342 *	
AR1 (b1)	-0.2141 *	-0.2417 *	-0.4803 *	0.1201 *	-0.5832 *
EARCH0 (ω)	-3.6783 *	-4.4485 *	-4.9520 **	-4.1543 *	-4.7805 *
EARCH1 (α 1)	-0.0127	0.3267	0.0141	-0.7028	0.0004
EGARCH1 (γ)	0.0074	0.0139	-0.1642	0.0515	-0.0237
THETA (θ)	-0.0015	0.0019	11.4294	-0.4089 *	-478.3712
DELTA (Δ)	0.0113	0.1566	-0.2505	0.0045	0.1559
<i>Panel B: international loans</i>					
Total R^2	0.1820	0.2374	0.1375	0.1996	0.3663
Log likelihood	-126.27	-9.17	26.60	51.92	56.09
Intercept (a)	6.3810 *	8.6722 *	5.8575 *	6.3780 *	3.4722 *
Risk aversion (b2)	-0.1381	0.5097 *	0.1340 *	-0.1412 *	0.1776
Proceeds (b3)	-0.0578 ***	0.0122	0.0342 *	-0.0459	-0.1573
Average rating (b4)	-0.3382 **	-1.0090 *	-0.0290 *	-0.2847 *	0.3594 *
Tenor*Rating (b5)	-0.0945	-0.2095 *	0.0734 *	0.0757 *	-0.0440 *
D_Mexico (b6)	-0.0389				
D_RussiaLTCM (b7)		-0.0874			
D_Brazil (b8)		-0.1539	-0.0502		
D_Argentina (b9)			0.1876 *	-0.0251 *	
D_US recession (b10)			-0.0666 ***	0.1789 *	
AR1 (b1)	0.0152	0.0157	-0.0296 *	0.2823	-0.2382
EARCH0 (ω)	-0.0491	-3.6254	-3.0915 *	-2.4503 *	-4.0082
EARCH1 (α 1)	0.0185	-0.6915	0.4446 *	0.2816 *	0.3858 *
EGARCH1 (γ)	0.9759 *	-0.3608	0.0326	0.3686	-0.0880 *
THETA (θ)	-4.6686	-0.1504	-0.1322	0.9203	0.3793
DELTA (Δ)	-0.4538 *	0.0566	0.3635	0.0414	-0.1599
<i>Panel C: US region bonds</i>					
Total R^2	0.2572	0.7269	0.6817	0.5214	0.2540
Log likelihood	-33.89	48.49	81.99	76.11	70.67
Intercept (a)	5.4922 *	8.9160 *	4.4128 *	4.1678 *	4.7854 *
Risk aversion (b2)	-0.6300 *	0.5777 *	0.0095 *	0.1371 *	-0.0926
Proceeds (b3)	0.0035	0.0519	0.0379	0.0515 *	-0.0215
Average rating (b4)	-0.3032 *	-0.1889 *	-0.2089 *	-0.4026 *	-0.6703
Tenor*Rating (b5)	0.2471 *	0.0958 *	0.2679 *	0.0884 *	0.2524 *
D_Mexico (b6)	-0.2177 *				
D_RussiaLTCM (b7)		-0.2290 **			
D_Brazil (b8)		0.0666	0.0398		
D_Argentina (b9)			-0.3022 *	0.1450 *	

Table VI.
EGARCH estimates for
each time period

(continued)

	Pre-Asian	Asian crisis	Post-Asian	September 11	Post-September 11
D_US recession (b10)			-0.0429	0.1300*	
AR1 (b1)	-0.1992**	-0.8644*	-0.6706*	-0.5510*	-0.0945
EARCH0 (ω)	-4.2619*	-4.8157*	-6.6624*	-4.1589	-1.6634
EARCH1 (α_1)	0.1679	-0.0095	0.1544	-1.0214*	0.4943*
EGARCH1 (γ)	-0.6598*	-0.2678	-0.6938	0.0450*	0.5762
THETA (θ)	-1.0497***	1.0295*	-0.0174	-0.5917*	0.0773
DELTA (Δ)	0.0593	1.7463	0.2532	-0.0261	0.0251
<i>Panel D: international bonds</i>					
Total R^2	0.2122	0.2479	0.4848	0.2091	0.3869
Log likelihood	-35.92	-33.65	-43.84	7.85	-27.66
Intercept (a)	5.0821	10.0797*	2.6099*	4.0455*	9.4296*
Risk aversion (b2)	0.3924*	-1.6223*	0.1454*	0.0648*	-0.6419*
Proceeds (b3)	0.1101*	-0.1748*	-0.1515*	0.0248*	0.1292
Average rating (b4)	0.4009*	-0.2463*	0.3171*	0.3889*	0.5798*
Tenor*Rating (b5)	-0.2680*	0.1961*	0.1706*	0.1696*	0.0203*
D_Mexico (b6)	-0.0491				
D_RussiaLTCM (b7)		0.5921*			
D_Brazil (b8)		-0.5194*	0.0895		
D_Argentina (b9)			-0.0319	-0.1965*	
D_US recession (b10)			-0.4742*	-0.0075	
AR1 (b1)	-0.3030	-0.3082*	-0.0715*	0.4038*	-0.3976*
EARCH0 (ω)	-0.4630*	-0.4380	-2.6239*	-2.4734*	-3.1405*
EARCH1 (α_1)	0.3720*	0.9972	0.0451	0.4864	0.0712*
EGARCH1 (γ)	0.8062	0.8040	-0.1865*	0.1611	-0.2939
THETA (θ)	0.3925***	0.1916	-2.3186*	0.7773*	-0.5519
DELTA (Δ)	0.0326	0.0287	-0.2632	0.3025	1.5949

Notes: Significance at: *0.01, **0.05, ***0.10; this table summarizes the coefficients and significance of the EGARCH-M (1,1) estimates for US and international loan spreads; US and international bond spreads for each time period

Table VI.

behavior could be that the VIX is a more useful risk proxy for US markets and a more internationally focused variable would be appropriate for the international markets. The coefficients for the conditional variance in the spread Default (Δ) are not significant in the majority of the sub-periods, but are negative and significant for US bonds, US loans and International loans. Similar to the lagged spread, this result indicates that the conditional variance reduces spreads in these markets. The opposite is seen in international bonds.

In the conditional variance equation, ω is consistently negative and α_1 is positive indicating that larger shocks ($g(z_t)$) increase the conditional variance. The only exception to this result is seen for the US bond market during the September 11 crisis period. Federal Reserve actions before and during this crisis may have reduced the impact of this shock on the US bond market. The EGARCH coefficients, γ , are positive for each of the markets for the full period, indicating that higher values for the lagged variance contribute to increased variance in the current period. For the adjustment factor, $g(z_t)$, θ_1 is positive and greater than 1.0 for both US debt markets. This outcome coupled with positive α_1 indicates that larger shocks, as measured by the standardized residual in the previous period, will increase the conditional variance. The opposite effect is seen for the US markets during the September 11 crisis period and for the international markets in general.

7. Conclusions

This paper extends the literature on debt market risk through a unique and extensive dataset and two distinct shocks to the global financial system. One innovation of this study is the focus on primary market debt issues and the comparison to newly issued bank loans. The findings are consistent with previous research and extend the understanding of credit risk to primary market issues.

We find that US and international loan borrowers are lower quality than their bond counterparts as measured by average ratings. Credit spreads are related to market liquidity, best represented by total proceeds, ratings and the interaction between maturity and rating. We control for various crisis periods, including regional financial crises. We find that spreads generally increased in response to the Asian crisis with the international markets exhibiting the larger increases. In the remaining periods, post-Asian through post-September 11, spreads increased for US bonds and both international markets with greater sensitivity to these shocks seen in the international markets. However, negative coefficients are seen for these time-period dummies in the US loan market indicating declining spreads. Another notable finding is the larger coefficients for the US bond market compared to the International bond market during the September 11 crisis period and thereafter. There is mixed evidence of asymmetric effects of shocks. In the US loan markets, the adjustment factor reduces forecast variance ($\Theta_1 < 0$). In contrast, the adjustment factor is not significant for US bonds, possibly indicating a more rapid adjustment and greater efficiency in this market. The opposite effect is seen in the international loan and bond markets with $\Theta_1 > 0$, indicating a persistent increase in spread volatility.

Opportunities for further research include extending the dataset through 2010 to evaluate the impact of the recent financial crisis on debt market spreads.

Note

1. The US region includes US and Canadian new issues.

References

- Amato, J. and Remolona, E. (2003), "The credit spread puzzle", *BIS Quarterly Review*, December, pp. 51-63.
- Carey, M. and Nini, G. (2007), "Is the corporate loan market globally integrated? A pricing puzzle", *Journal of Finance*, Vol. 2 No. 6, pp. 2969-3007.
- Chatterjee, A., Ayadi, O. and Maniam, B. (2003), "Asian financial crisis: the pre and post-crisis analysis of Asian equity markets", *Managerial Finance*, Vol. 29 No. 4, pp. 62-86.
- Clare, A.D., Maras, M. and Thomas, S. (1995), "The integration and efficiency of international bond markets", *Journal of Business Finance & Accounting*, Vol. 22 No. 2, pp. 313-22.
- Codogno, L., Favero, C. and Missale, A. (2003), "Yield spreads on EMU government bonds", *Economic Policy*, Vol. 18, pp. 503-32.
- Collin-Dufresne, P., Goldstein, R. and Martin, S. (2001), "The determinants of credit spread changes", *Journal of Finance*, Vol. 56 No. 6, pp. 2177-206.
- Corsetti, G., Presenti, P. and Roubini, N. (1999), "What caused the Asian currency and financial crisis?", *Japan and the World Economy*, Vol. 11 No. 3, pp. 305-73.

-
- Davies, A. (2007), "International bond market cointegration using regime switching techniques", *Journal of Fixed Income*, Vol. 16 No. 4, pp. 69-80.
- Diamond, D. (1993), "Seniority and maturity of debt contracts", *Journal of Financial Economics*, Vol. 33, pp. 341-68.
- Domowitz, I., Glen, J. and Madhaven, A. (1998), "Country and currency risk premia in an emerging market", *Journal of Financial and Quantitative Analysis*, Vol. 33 No. 2, pp. 189-216.
- Dungey, M., Fry, R., Gonzalez-Hermosillo, B. and Martin, V. (2006), "Contagion in international bond markets during the Russian and the LTCM crises", *Journal of Financial Stability*, Vol. 2, pp. 1-27.
- Edwards, S. (1998), "Interest volatility, capital controls, and contagion", Working Paper No. 6756, NBER, Cambridge, MA.
- Engle, R. and Bollerslev, T. (1986), "Modeling the persistence of conditional variances", *Econometric Reviews*, Vol. 5 No. 1, pp. 1-50.
- Friewald, N., Jankowitsch, R. and Subrahmanyam, M. (2011), "Illiquidity or credit deterioration: a study in the US corporate bond market during financial crises", working paper, Stern School of Business, New York University, New York, NY, 9 August.
- Gonzalez-Rozada, M. and Yeyati, E. (2008), "Global factors and emerging market spreads", *Economic Journal*, Vol. 118, pp. 1917-36.
- Helwege, J. and Turner, C. (1999), "The slope of the credit yield curve for speculative-grade issuers", *Journal of Finance*, Vol. 54, pp. 1869-84.
- Kamin, S.B. and von Kliest, K. (1999), "The evolution and determinants of emerging market credit spreads in the 1990s", Working Paper No. 68, Bank for International Settlements.
- Kashiwase, K. and Kodres, L. (2008), "Emerging market spread compression: is it real or is it liquidity?", Working Paper 08/10, International Monetary Fund, Washington, DC.
- Kim, S.J., Lucey, B. and Wu, E. (2006), "Dynamics of bond market integration between established and accession European countries", *Journal of International Financial Markets, Institutions and Money*, Vol. 16, pp. 41-56.
- Morgan, I.W. Jr and Murtagh, J.P. (2009), "The impact of 9/11 on debt markets", in Morgan, M.J. (Ed.), *The Impact of 9/11 on Business and Economics: The Business of Terror*, Palgrave Macmillan, New York, NY, pp. 227-38.
- Nelson, D.B. (1991), "Conditional heteroskedasticity in asset returns: a new approach", *Econometrica*, Vol. 59, pp. 347-70.
- Remolona, E., Scatigna, M. and Wu, E. (2007), "A ratings-based approach to measuring sovereign risk", *International Journal of Finance & Economics*, Vol. 13 No. 1, pp. 26-39.
- Remolona, E., Scatigna, M. and Wu, E. (2008), "The dynamic pricing of sovereign risk in emerging markets: fundamentals and risk aversion", *Journal of Fixed Income*, pp. 57-71.
- Sander, H. and Kleimeier, S. (2003), "Contagion and causality: an empirical investigation of four Asian crisis episodes", *Journal of International Financial Markets, Institutions and Money*, Vol. 13, pp. 171-86.
- Santos, J. and Tsatsaronis, K. (2003), "The cost of barriers to entry: evidence from the market for corporate euro bond underwriting", Working Paper No. 134, Bank for International Settlements, Basel.

- Smith, K. (2002), "Government bond market seasonality, diversification, and contagion: international evidence", *Journal of Financial Research*, Vol. 25 No. 2, pp. 203-21.
- Yang, J. (2005), "Government bond market linkages: evidence from Europe", *Applied Financial Economics*, Vol. 15, pp. 599-610.
- Zhu, H. (2006), "An empirical comparison of credit spreads between the bond market and the credit default swap market", *Journal of Financial Services Research*, Vol. 29, pp. 211-35.

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