Estimating the Exposures of Major Financial Institutions to the Global Credit Risk Transfer Market: *Are They Slicing the Risks or Dicing with Danger?*

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Rapid financial innovation has changed the landscape of risk by enabling market participants to trade credit risk across the financial and other sectors. Credit risk transfer (CRT) instruments, especially credit derivatives, offer important diversification benefits for financial institutions with large credit exposures, act as a stabilization mechanism for the financial system, and enhance efficiency in pricing and intermediation.[1] In particular, the introduction and rapid acceptance of benchmark credit derivatives indices have helped to develop a two-way market for credit derivative instruments, enabling investors to customize their exposures to credit risk. Participants in the CRT market have become more and more diverse, thus increasing the dispersion of risk across both financial and nonfinancial sectors.

That said, the exponential growth of CRT instruments may have also created some risks for financial stability. A key concern is that the pace of innovation may have exceeded the development of market infrastructure and the risk management systems of financial institutions participating in this market. Further, the interlinkages across different financial institutions—for example, between banking and other segments such as insurance and hedge funds—have increased over time.[2] Consequently, any shock to the financial system may be magnified by these interrelationships and the broader exposure of investors to these instruments, as evidenced by the recent subprime crisis in the U.S. and its repercussions for financial institutions worldwide.

Thus, the determination of risk concentration among financial institutions to credit derivative instruments has become an extremely important issue for supervisors, credit rating agencies, and private sector analysts. However, it is generally acknowledged that transactions in the CRT market are very difficult to track because of the paucity of data available to quantitatively assess the extent of risk transfers and the concentration of exposures.[3] As a result, surveillance of the opaque credit risk transfer market has proven to be quite difficult.

This article proposes a method for measuring the exposures of major global financial institutions to the CRT market by using readily available and timely financial markets data—stock prices and single-tranche CDO quotes—as a proxy. Our results reveal several important trends in the credit derivative exposures of major global financial institutions. There is evidence of a "home bias" as financial institutions appear more exposed to credit derivatives referencing issuers in their respective regions of domicile. In general, financial institutions also appear to have greater exposures to the senior and super-senior debt tranches referencing the European CDS index and to the mezzanine tranches referencing the North American CDS index. Certain financial

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institutions are perceived to have their biggest exposures to the riskiest credits—results which appear to be broadly supported by out-of-sample evidence from the recent turbulence in international credit markets.

EMPIRICAL MODEL AND DATA

We estimate the implied exposure of a firm to CDS index tranches, also known as standardized single-tranche collateralized debt obligations (STCDOs). These are synthetic CDOs based on a CDS index, with each tranche referencing a different segment of the loss distribution of that CDS index.[4] Specifically, we test for the variability of financial institutions' stock price returns to price changes in STCDOs referencing major CDS indices—the iTRAXX Europe Investment Grade (iTRAXX) and the North American CDX.NA.IG (CDX) indices—as a proxy for the perceived longer-term riskiness of their exposures to CRT instruments in general. The assumption that such a relationship exists is reasonable given that all available information about a firm's transactions and performance, and hence investors' risk perceptions, is quickly reflected in its share price in an efficient market.

Model

The empirical framework chosen is the vector autoregression (VAR) method first suggested by Hasbrouck [1991a, b]. The variables included in the VAR are the firm's daily stock price return, the return of a global stock index, and the percentage change in the spreads of STCDOs referencing European and North American CDS indices. The inclusion of a global stock index attempts to correct for systematic risk. The model and data are discussed in detail next.

Given the vector of n endogenous variables, $Y_t = (y_{1t}, y_{2t}, \ldots, y_{nt})'$, the corresponding unrestricted VAR system of order p is given by

$$Y_t = c + \Phi_1 Y_{t-1} + \ldots \Phi_p Y_{t-p} + \varepsilon_t \tag{1}$$

where c is a n-vector of constant terms, Φ_i ($i = 1, \ldots, p$) are n-by-n coefficient matrices, and e_t is a vector of uncorrelated independent and identically distributed error terms. The error terms are also serially uncorrelated. Under certain technical conditions, described in Hamilton [1994], the vector autoregression system in Equation (1) could be represented by the following vector moving average representation (VMA):

$$\begin{bmatrix} y_{1t} \\ \vdots \\ y_{it} \\ \vdots \\ y_{nt} \end{bmatrix} = \begin{bmatrix} \psi_{11}(L) & \ldots & \psi_{1i}(L) & \ldots & \psi_{1n}(L) \\ \vdots & & \vdots & & \vdots \\ \psi_{i1}(L) & \ldots & \psi_{ii}(L) & \ldots & \psi_{in}(L) \\ \vdots & & \vdots & & \vdots \\ \psi_{n1}(L) & \ldots & \psi_{ni}(L) & \ldots & \psi_{nn}(L) \end{bmatrix} \begin{bmatrix} \varepsilon_{1t} \\ \vdots \\ \varepsilon_{it} \\ \vdots \\ \varepsilon_{nt} \end{bmatrix} \tag{2}$$

where $\psi_{ij} = \Sigma_{k=1}^{\infty} \psi_{ij}^k L^k, i, j = 1, \ldots, n,$ are lag operators.

The coefficient ψ_{ij}^k measures the effect k periods ahead of a unit shock or innovation to variable y_j on variable y_i. Therefore, the long-term cumulative impact of variable y_j on variable y_i can be measured by adding the coefficients associated with the lag operator $\psi_{ij}(L)$ as follows:

$$\sum_{k=0}^{\infty} \psi_{ij}^k = \text{information of } y_j \text{ on } y_i \tag{3}$$

Equation (3) suggests that variance decomposition could be used to quantify the overall importance of innovations to variable y_j for explaining subsequent realizations of variable y_i vis-à-vis the other endogenous variables. Specifically, the overall importance of variable y_j is captured by the relative share of the variance of variable y_i it explains:

$$\frac{\left(\Sigma_{k=0}^{\infty} \psi_{ij}^k\right)^2 \sigma_{\varepsilon_j}^2}{\Sigma_{m-1}^{n} \left(\Sigma_{k=0}^{\infty} \psi_{im}^k\right)^2 \sigma_{\varepsilon_m}^2} \tag{4}$$

where $\sigma_{\varepsilon_j}^2$ is the variance of the innovation to variable y_j. Note that our VAR framework does not choose a particular ordering of the variables entering Equation (1) and, hence, is a statistical description of the dynamic interrelations between the variables analyzed. While a structural VAR may offer some advantages for interpreting the data, it requires specifying *a priori* a causal ordering of the variables. We do not deem this appropriate for our study given that there is, to our knowledge, little justification for imposing a particular ordering.

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Data

The VAR methodology was implemented using historical daily data for the period from November 14, 2003, to February 9, 2007, for a sample of the world's biggest banks, broker/dealers, insurers, and reinsurers that are active in the CRT market (Exhibit 1):

1. The stock price returns for each institution are constructed using data obtained from Bloomberg, L.P. The daily returns on the Morgan Stanley Capital International (MSCI) All-Country World Index, which are included in the model to account for common global influences on financial prices, are also obtained from the same source.
2. Daily percentage changes of STCDO spreads referencing the iTRAXX and CDX are constructed using price quotes obtained from JPMorgan Chase & Co. (Exhibit 2). The spreads quotes for STCDOs referencing CDS indices must be denominated in a common currency. For instance, if we assume that a European-domiciled institution invests in the U.S. credit derivatives market, then we would have to convert the spread of STCDOs referencing the CDX.NA.IG index from U.S. dollars to euros in order to test the relationship. For a given date, the conversion is accomplished by first computing the present value in U.S. dollars of the 5-year periodic payments of the single-tranche contract using LIBOR rates as discount factors. Subsequently, the present value of the single-tranche contract is converted to euros at the current exchange rate and the equivalent running spread is computed using EURIBOR rates as discount factors. A corresponding procedure was used to convert iTRAXX Europe IG spreads from euros to U.S. dollars when testing for the investment in European credit derivatives by U.S.-domiciled institutions.

RESULTS

Our model yields several interesting results. First, long-term stock return volatility appears to be influenced by the exposure to credit derivatives regardless of whether they reference European or U.S. issuers (Exhibit 1). Interestingly, for most institutions analyzed, the institution's past price return volatility and global stock market return volatility are not key factors in explaining the volatility in its current stock price returns.

Second, there appears to be a *home bias* effect as financial institutions appear to be more impacted by the volatility in credit derivatives of their own region. The price return volatility of financial institutions domiciled in Europe are more affected by iTRAXX tranches (Exhibit 3), while a number of U.S. banks are more affected by CDX tranches. The iTRAXX tranches are also important in explaining the volatility in stock price returns of several U.S.-domiciled financial institutions.

Third, the relationship between the domicile of a particular financial institution and the STCDOs on the regional index is especially obvious within the insurance sector. European insurance entities are more affected by volatility in the iTRAXX tranches. The U.S. insurers are more affected by CDX tranche volatility, with the exception of AIG which is influenced more by iTRAXX volatility. In the case of Japanese institutions, banks appear more exposed to volatility in the iTRAXX tranches while the sole insurance company in the sample appears to be more exposed to volatility in the CDX tranches.

In terms of risk appetite, financial institutions, especially European ones, appear more exposed to senior and super-senior iTRAXX tranches (Exhibit 4). The volatility of the senior iTRAXX tranche is the major explanatory factor for stock return volatility in two-thirds of the companies in the sample, and explains at least 40% of the stock return volatility for half the sample. Only the stock prices of a few institutions, mostly domiciled in the U.S., such as Bear Stearns, Goldman Sachs, Merrill Lynch and Morgan Stanley, have their biggest exposures to volatility in the equity and junior mezzanine iTRAXX tranches. This finding suggests that some U.S. institutions may have riskier exposures to the European credit derivatives market relative to others. Similarly, Japanese companies also appear to be exposed to the riskier iTRAXX tranches.

Financial institutions seem to be more exposed to mezzanine CDX tranches. Specifically, stock price return volatility for two-thirds of our sample institutions is explained by the CDX mezzanine tranche (Exhibit 5). However, the volatility analysis suggests that three U.S. institutions—Bear Stearns, Lehman Brothers, and Merrill Lynch—may be most exposed to the equity CDX tranche. The market's overall perceptions of the riskiness of these individual institutions' exposures to credit derivatives appear to have been broadly accurate based on reported evidence from the recent turmoil in global credit markets

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Exhibit 1

Impact of Volatility in the Major Credit Derivatives Markets on Key Participants, November 14, 2003–February 1, 2007 (In percent)

Institution	Country of Domicile	Past Returns of Dependent Variable	Global Market Factor	iTRAXX Europe Investment Grade Tranches: Equity	iTRAXX: Junior Mezzanine	iTRAXX: Senior Mezzanine	iTRAXX: Senior	iTRAXX: Super Senior	CDX.NA.IG Tranches: Equity	CDX: Junior Mezzanine	CDX: Senior Mezzanine	CDX: Senior	CDX: Super Senior
				0-3	3-6	6-9	9-12	12-22	0-3	3-7	7-10	10-15	15-30
Counterparties (Banks)													
Morgan Stanley	United States	30.5	6.6	13.5	1.3	8.4	4.6	4.9	7.7	15.6	4.0	0.8	2.1
Deutsche Bank AG	Germany	0.8	0.1	13.3	14.1	1.7	8.4	9.6	2.1	33.6	7.2	6.3	2.7
Goldman Sachs Group, Inc.	United States	3.9	0.7	11.1	0.6	1.9	0.5	0.0	24.7	15.8	38.8	1.1	0.9
JP Morgan Chase & Co.	United States	0.0	13.3	7.7	37.6	4.0	0.0	6.4	2.7	7.4	14.3	5.8	0.7
UBS AG	Switzerland	0.0	0.0	0.6	1.8	5.3	38.0	6.4	0.4	31.2	1.1	14.0	1.2
Lehman Brothers Holdings, Inc.	United States	2.4	3.2	6.8	0.2	0.9	16.8	3.9	29.0	1.4	28.2	3.3	3.9
Barclays PLC	United Kingdom	0.2	2.9	3.7	2.2	0.2	34.8	8.2	0.2	8.9	23.5	0.4	14.8
Citigroup Inc.	United States	6.1	0.4	8.6	16.1	1.0	0.8	51.3	4.6	9.0	1.9	0.0	0.1
Credit Suisse Group	Switzerland	1.9	0.0	0.0	10.3	12.6	25.4	26.6	1.4	11.1	3.8	0.4	6.4
BNP Paribas	France	10.2	0.6	15.6	0.0	19.7	16.6	8.8	10.3	2.3	1.2	13.0	1.7
Merrill Lynch & Co., Inc.	United States	3.5	3.8	22.5	0.0	9.7	1.3	0.9	14.0	5.7	28.3	9.9	0.3
Bear Stearns Companies, Inc.	United States	10.5	10.4	12.7	0.0	0.6	0.0	3.3	42.1	1.0	7.2	1.4	10.8
Bank of America Corporation	United States	0.2	1.7	6.8	1.2	40.5	14.8	0.7	12.0	0.1	1.3	20.4	0.2
ABN Amro Holdings NV	Netherlands	0.0	0.8	0.1	1.4	2.1	23.8	3.7	1.0	28.5	16.9	16.6	5.1
HSBC Holdings PLC	United Kingdom	0.0	0.5	0.8	0.1	3.4	16.0	33.0	1.8	26.9	9.2	7.1	1.0
Societe Generale	France	16.2	0.9	11.6	0.7	2.4	40.8	11.5	0.6	0.2	0.1	5.8	9.3
Royal Bank of Scotland Group PLC	United Kingdom	0.2	4.0	0.0	0.0	4.6	37.7	17.7	0.0	19.6	11.0	1.7	3.5
Insurers and Reinsurers													
ING Groep NV	Netherlands	0.0	1.1	0.9	1.1	1.3	41.6	19.2	0.1	13.1	20.7	0.0	1.0
Fortis	Belgium	0.2	1.4	10.7	2.0	1.8	46.5	11.1	0.3	6.4	11.5	0.7	7.3
American International Group Inc.	United States	2.1	1.4	23.5	5.2	1.1	27.2	0.1	1.2	3.3	12.4	22.4	0.1
AXA SA	France	3.6	2.7	2.0	0.1	0.8	39.3	16.2	1.9	19.4	9.7	1.6	2.7
MetLife Inc.	United States	11.7	1.3	0.5	0.2	13.9	2.7	0.9	1.6	48.9	17.9	0.2	0.0
Prudential Finiancial Inc.	United States	0.5	0.0	1.4	1.5	3.4	2.4	1.7	9.2	23.6	46.1	2.4	7.8
KBC Group NV	Belgium	0.2	3.3	5.3	8.2	4.2	36.0	15.2	1.9	23.1	0.3	0.8	1.5
Aegon NV	Netherlands	0.1	0.0	1.2	9.4	1.2	25.3	31.1	1.1	7.4	16.9	0.0	6.4
Hartford Financial Services Group Inc.	United States	0.4	2.1	0.5	0.7	0.1	15.2	0.0	0.4	0.0	5.4	20.5	54.6
Munich Re Group	Germany	9.2	0.3	2.3	0.4	3.3	49.4	15.8	0.0	0.4	13.1	1.9	4.0
Asian Financial Groups													
Sompo Japan Insurance Inc.	Japan	3.3	5.5	6.6	15.8	0.1	0.2	15.3	30.6	0.0	4.7	16.8	1.0
Sumitomo Mitsui Financial Group, Inc.	Japan	0.4	0.5	11.9	21.8	18.2	11.1	0.2	13.8	13.3	6.8	0.0	2.0
The Sumitomo Trust and Banking Company, Ltd.	Japan	6.3	0.0	27.9	9.4	1.8	2.6	10.9	17.2	2.3	6.8	8.4	6.5

Sources: Bloomberg L.P., JP Morgan Chase & Co., and authors' calculations.

Note: For each institution, in each index, we highlight both the tranche contributing the highest volatility and those contributing 10% or more to the volatility of the respective stock price returns.

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EXHIBIT 2

Standardized Single-Tranche CDO Contracts: Summary Statistics, November 14, 2003–February 1, 2007

Index and Tranche	Attachment and Detachment Points (In percent)	Tranche Prices (In basis points)			
		Average	Minimum	Maximum	Standard deviation
iTRAXX Europe IG					
Equity	0-3	2,688	1,292	4,928	523
Junior mezzanine	3-6	150	70	330	66
Senior mezzanine	6-9	56	19	153	31
Senior	9-12	31	10	83	17
Super senior	12-22	15	5	39	7
CDX.NA.IG					
Equity	0-3	3,971	2,670	6,275	554
Junior mezzanine	3-7	231	100	457	100
Senior mezzanine	7-10	78	23	160	41
Senior	10-15	32	11	69	16
Super senior	15-30	10	5	19	3

Sources: JP Morgan Chase & Co. and authors' calculations.

Note: The equity tranche is quoted as upfront premium plus 500 bps running spread.

(Exhibit 6). Japanese institutions also appear to have large exposures to volatility in the equity CDX tranche. Interestingly, the results also suggest that almost all insurers/reinsurers prefer the riskiest CDX tranches, notwithstanding the fact that the equity and mezzanine tranches of this index have been more volatile than the corresponding ones referencing the iTRAXX Europe IG.

Intuitively, the extent to which tranche volatility explains innovations in the stock price return volatility of our sample financial institutions may seem rather extreme. In some cases, the former appears to account for more than 60% of the volatility in the latter. One possible explanation is that the data may also be capturing the riskiness of banks' loan books or the riskiness of insurers' debt portfolios. If so, our results are even more attractive in that they reveal financial institutions' broader exposures to credit risk.

CONCLUSION

The ability to trade credit risk in financial markets has facilitated the diversification of risk across financial and other sectors, and has changed risk management practices. Theoretically, the increasing availability of CRT instruments and techniques should be positive for overall financial stability and efficiency of intermediation. However, increased interlinkages among financial institutions across the different financial segments—sometimes through these very risk transfer instruments—means that an otherwise isolated major shock in the credit markets could potentially result in substantial and widespread losses. For instance, the recent losses incurred worldwide by financial institutions in the aftermath of the subprime crisis in the U.S. in mid-2007 suggest that this is a very valid concern.

The rapid growth of CRT markets poses significant challenges for both national authorities and market participants. In this quickly expanding and innovating market, national authorities are hard pressed to ensure adequate regulation, supervision, and surveillance, while encouraging further growth and development. Issues such as the capacity of infrastructure, adequacy of reporting standards, and risk management capabilities of participating institutions are foremost considerations in these areas. For private sector participants, assessing counterparty risk remains a challenge, because it is impossible to measure the extent of an institution's CRT operations, especially in the credit derivatives market.

This article proposes a vector autoregression (VAR) framework for estimating the relative riskiness of credit derivative exposures of the major global banks and insurers using daily stock price and standardized STCDO spread data. The framework is applied to a worldwide sample of some of the largest financial institutions involved in the CRT market. We find several key trends in the global credit derivatives market. There is a clear home bias effect in that financial institutions appear to be more exposed to credit derivatives referencing firms in their own region of domicile. Financial institutions tend to have their biggest exposures to senior and super-senior tranches referencing the iTRAXX Europe IG index, but they are most exposed to the mezzanine tranches referencing the CDX.NA.IG index. Certain institutions appear to be more exposed to the riskier tranches on both indices. Given that our results broadly are supported by out-of-sample evidence from the recent turmoil in global credit markets, we suggest that our framework may be useful as a surveillance tool in capturing the riskiness of overall credit exposures of financial institutions.

ENDNOTES

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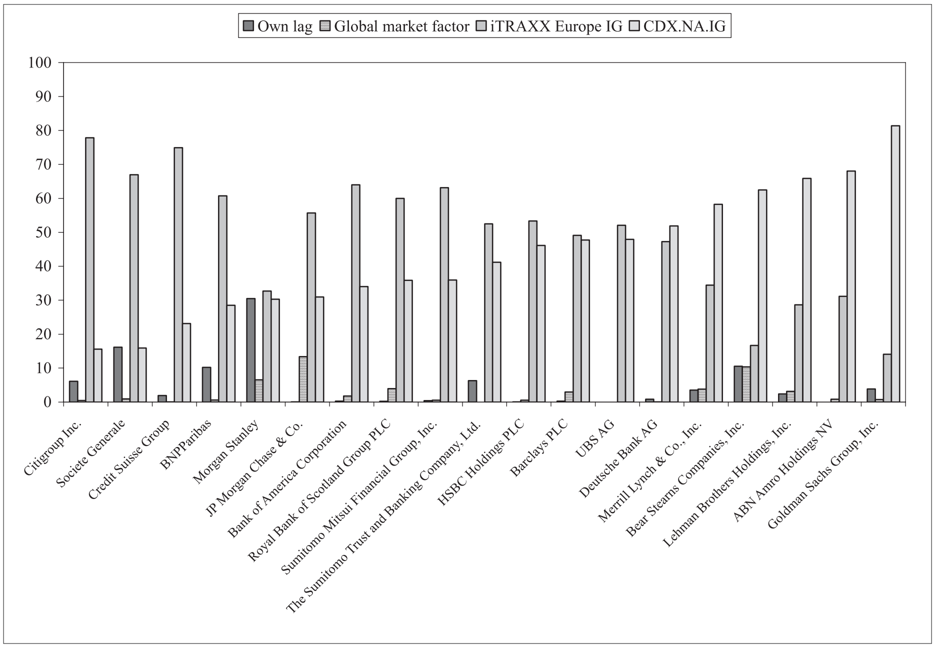
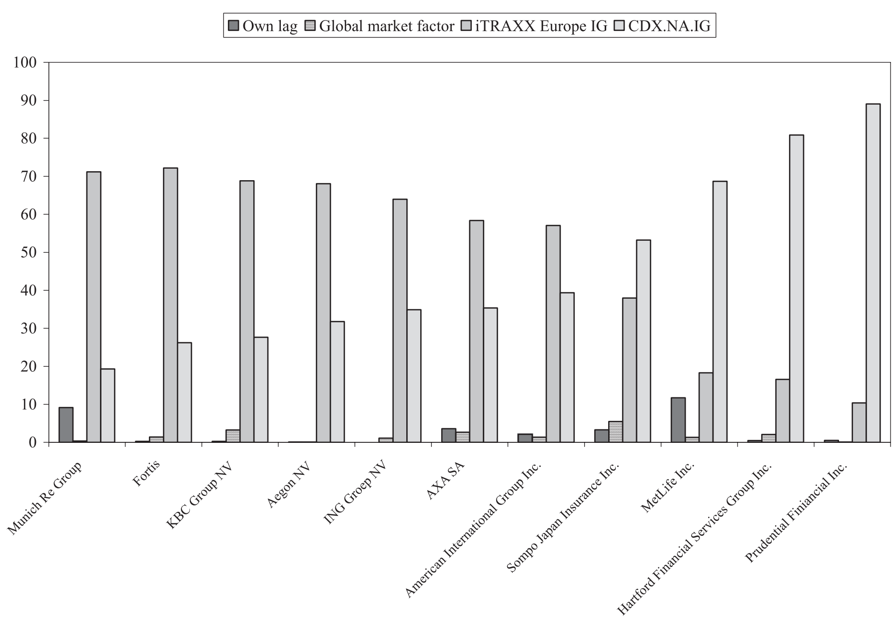
E X H I B I T   3
Variance Decomposition by Market

(a) Banks/Counterparties



(b) Insurers and Reinsurers



Sources: Bloomberg L.P., JP Morgan Chase & Co., and authors' calculations.

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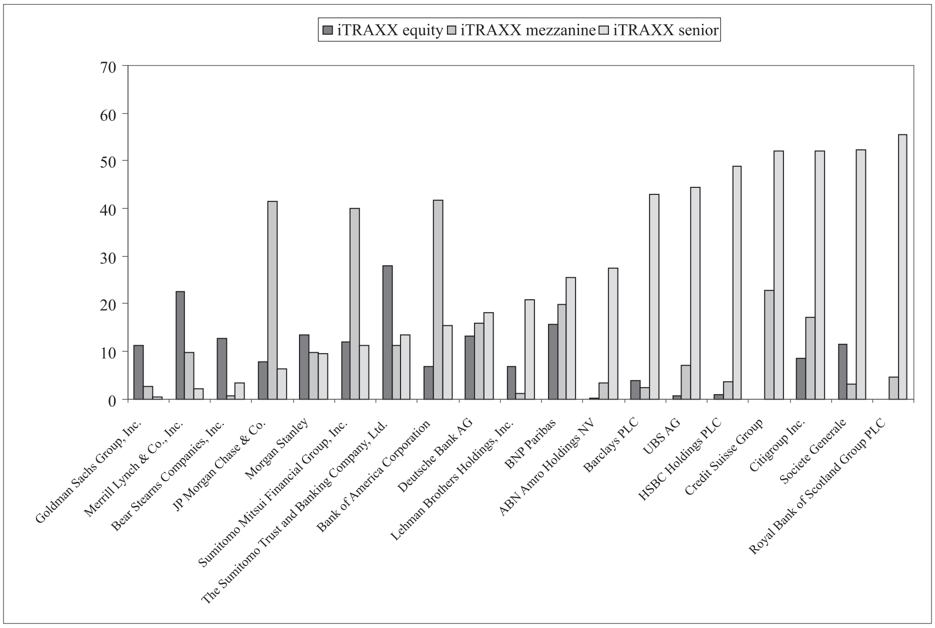
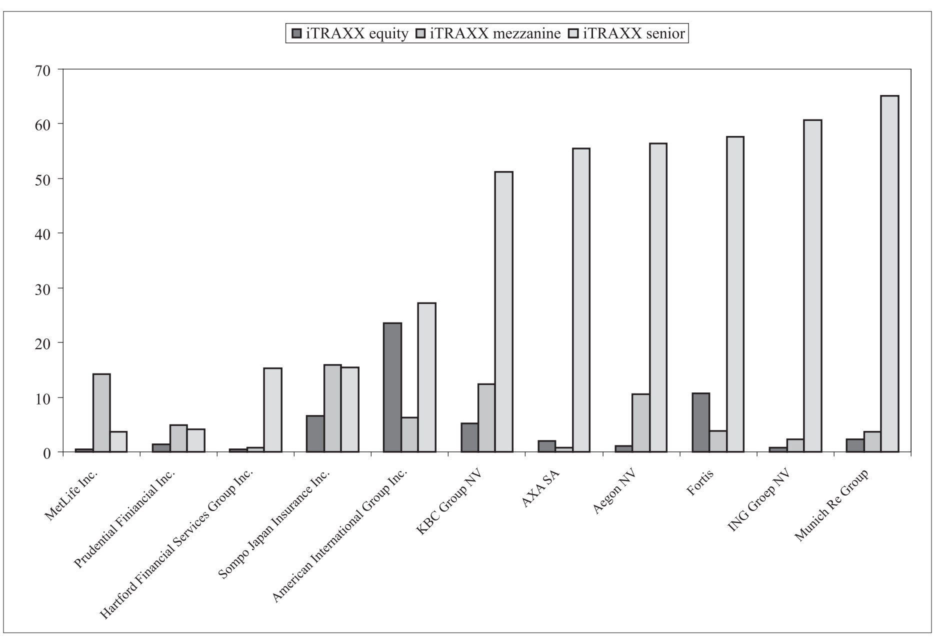
EXHIBIT 4

Variance Decomposition Seniority of Tranches Referencing the iTRAXX Europe IG Index

(a) Banks/Counterparties



(b) Insurers and Reinsurers



Sources: Bloomberg L.P., JP Morgan Chase & Co., and authors' calculations.

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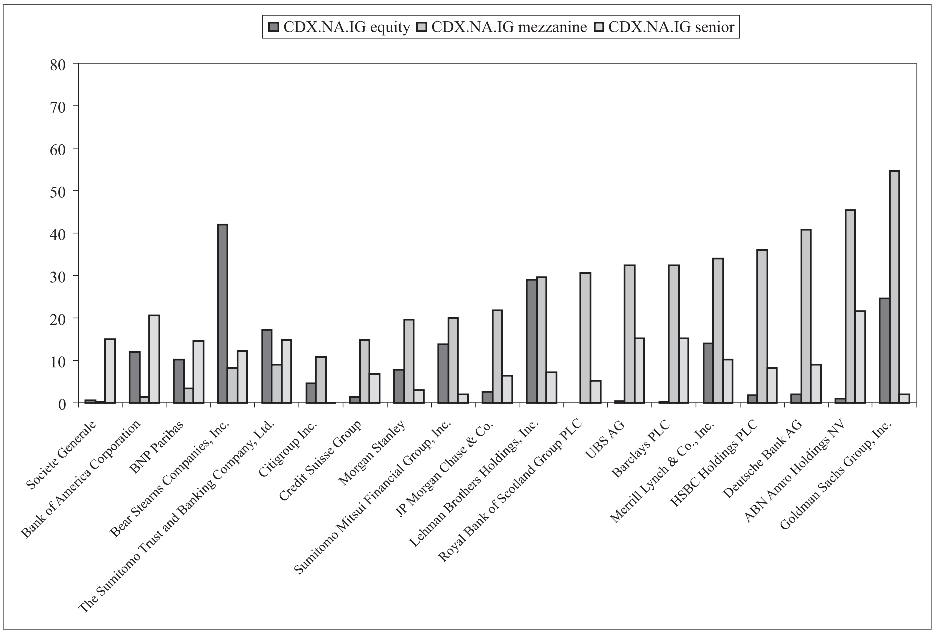
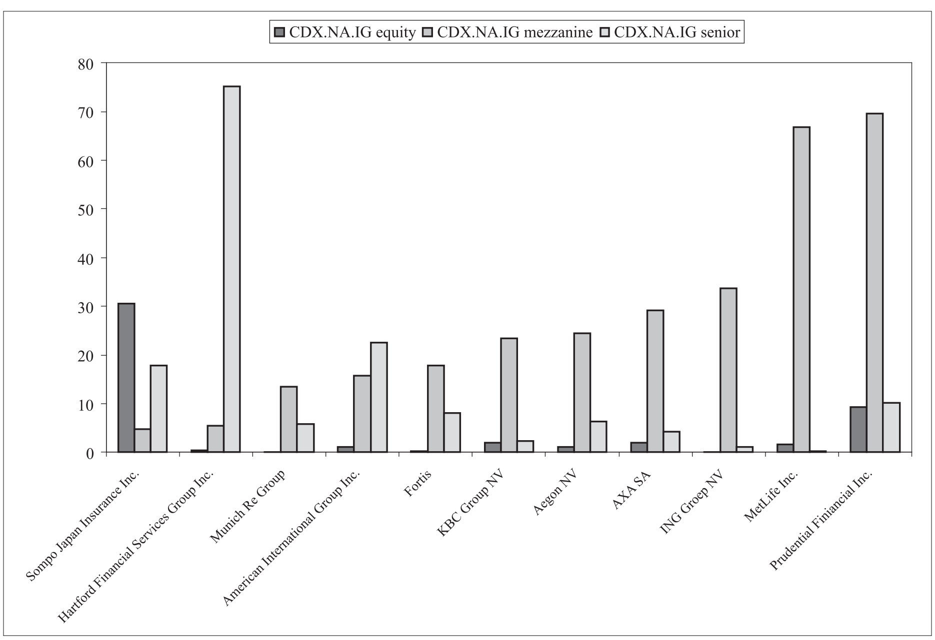
EXHIBIT 5

Variance Decomposition by Seniority of Tranches Referencing the CDX.NA.IG. Index

(a) Banks/Counterparties



(b) Insurers and Reinsurers



Sources: Bloomberg L.P., JP Morgan Chase & Co., and authors' calculations.

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EXHIBIT 6

Actual Trading Losses and Asset Writedowns at Major Global Financial Institutions from Debt Market Crisis, Q3 2007

Financial Institution	Impact	
	In billions of U.S. dollars	As a percentage of market capitalization
Merrill Lynch & Co., Inc.	8.4	13.7
Bear Stearns Companies, Inc.	0.7	5.4
Deutsche Bank AG	3.1	4.6
Morgan Stanley	2.4	3.6
UBS AG	3.4	3.0
Goldman Sachs Group, Inc.	1.7	2.4
Lehman Brothers Holdings, Inc.	0.7	2.4
Citigroup Inc.	3.5	1.5
JP Morgan Chase & Co.	1.6	1.1
Bank of America Corporation	1.6	0.7

Source: The Wall Street Journal.

Note: Market capitalization is as at the end of the quarter in which the firm reports.

[1]See Clementi [2001], Cousseran and Rahmouni [2005], and Wagner and Marsh [2004].

[2]See Rule (2001).

[3]See IMF (2006).

[4]For details on CDS index tranches, see Amato and Gyntelberg [2005].

REFERENCES

Amato, Jeffrey D., and Jacob Gyntelberg. "CDS Index Tranches and the Pricing of Credit Risk Correlations." *BIS Quarterly Review* (March 2005), pp. 73–87.

Clementi, David. "Recent Developments in Securities Markets and the Implications for Financial Stability." Euromoney International Bond Congress, London, 2001.

Cousseran, Olivier, and Imene Rahmouni. "The CDO Market: Functioning and Implications in Terms of Financial Stability." *Financial Stability Review*, Banque de France, 2005.

Hamilton, James D. *Time Series Analysis*. Princeton, NJ: Princeton University Press, 1994.

Hasbrouck, Joel. "Measuring the Information Content of Stock Trades." *Journal of Finance*, 46 (1991a), pp. 179–207.

——. "The Summary Informativeness of Stock Trades: An Econometric Analysis." *Review of Financial Studies*, 4 (1991b), pp. 571–595.

International Monetary Fund. *Global Financial Stability Report*, World Economic and Financial Surveys, Washington, D.C., April 2006.

Rule, David. "The Credit Derivatives Market: Its Development and Possible Implications for Financial Stability." *Financial Stability Review*, Bank of England, June 2001, pp. 117–40.

Wagner, Wolf, and Ian W. Marsh. "Credit Risk Transfer and Financial Sector Performance." Discussion Paper No. 4265, Center for Economic Policy Research, 2004.

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