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Is Systematic Default Risk Priced in Equity Returns? A Cross-Sectional Analysis Using Credit Derivatives Prices

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Is Systematic Default Risk Priced in Equity Returns? A Cross-Sectional Analysis Using Credit Derivatives Prices

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Abstract

This paper finds that systematic default risk, or the event of widespread defaults in the corporate sector, is an important determinant of equity returns. Moreover, the market price of systematic default risk is one order of magnitude higher than the market price of other risk factors. In contrast to studies by Fama and French (1993, 1996) and Vassalou and Xing (2004), this paper uses a market-based measure of systematic default risk. The measure is constructed using price information from credit derivatives prices, namely the spreads of standardized single-tranche collateralized debt obligations on credit derivatives indices.

JEL Classification Numbers: G10, G12, G14

Keywords: Equity returns, default risk, credit derivatives, credit derivatives indices, collateralized debt obligations

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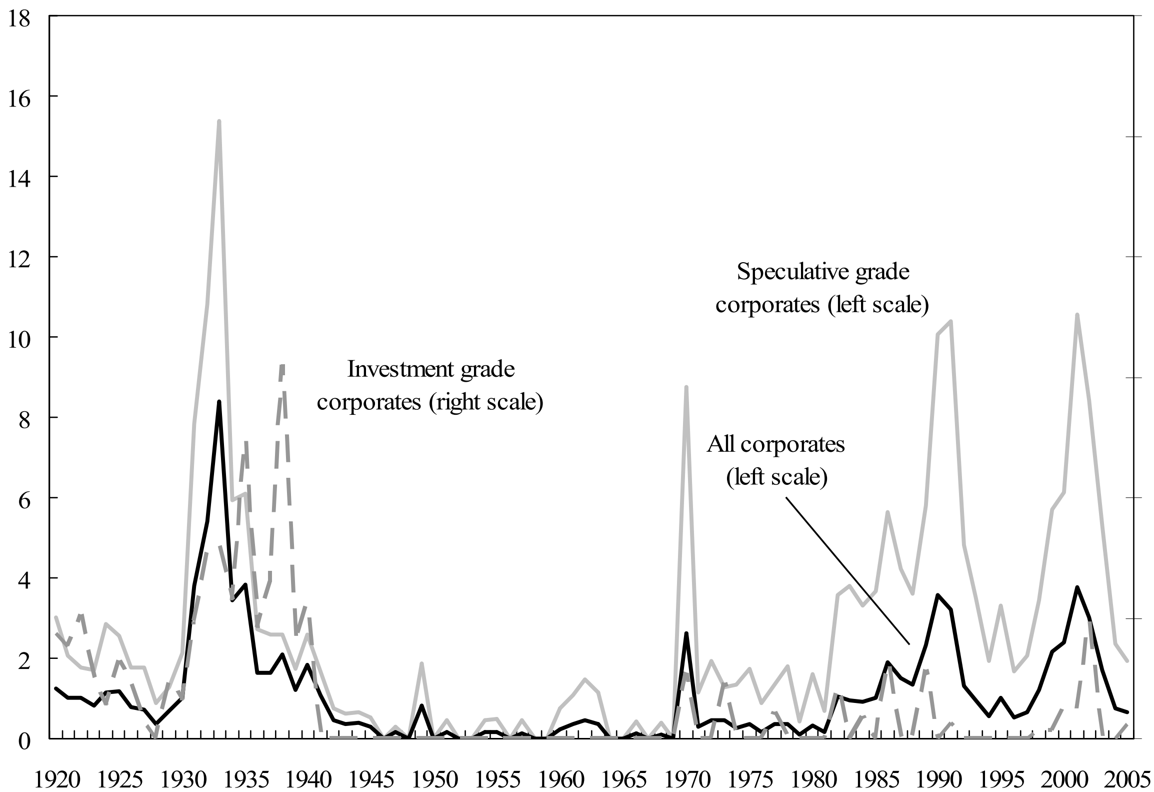
I. Introduction

A quick glance at the headlines of major business newspapers reminds us constantly that corporate defaults remain a major source of potential large losses to equity investors, as stock shares are the most junior claims on the assets of a defaulted firm. For instance, the ratings agency Moody's Investor Services reported that, in 2005, 34 corporate bond issuers defaulted on a total of $38 billion of debt, with around one third of the defaults concentrated in the transportation and automobile sectors (Hamilton, Varma, Ou, and Cantor, 2006). Historical data shows that 2005, however, was a relatively benign year, as default rates tend to peak during recession years (Figure 1).

Figure 1. Annual Issuer-Weighted Global Corporate Default Rates, 1920–2005.

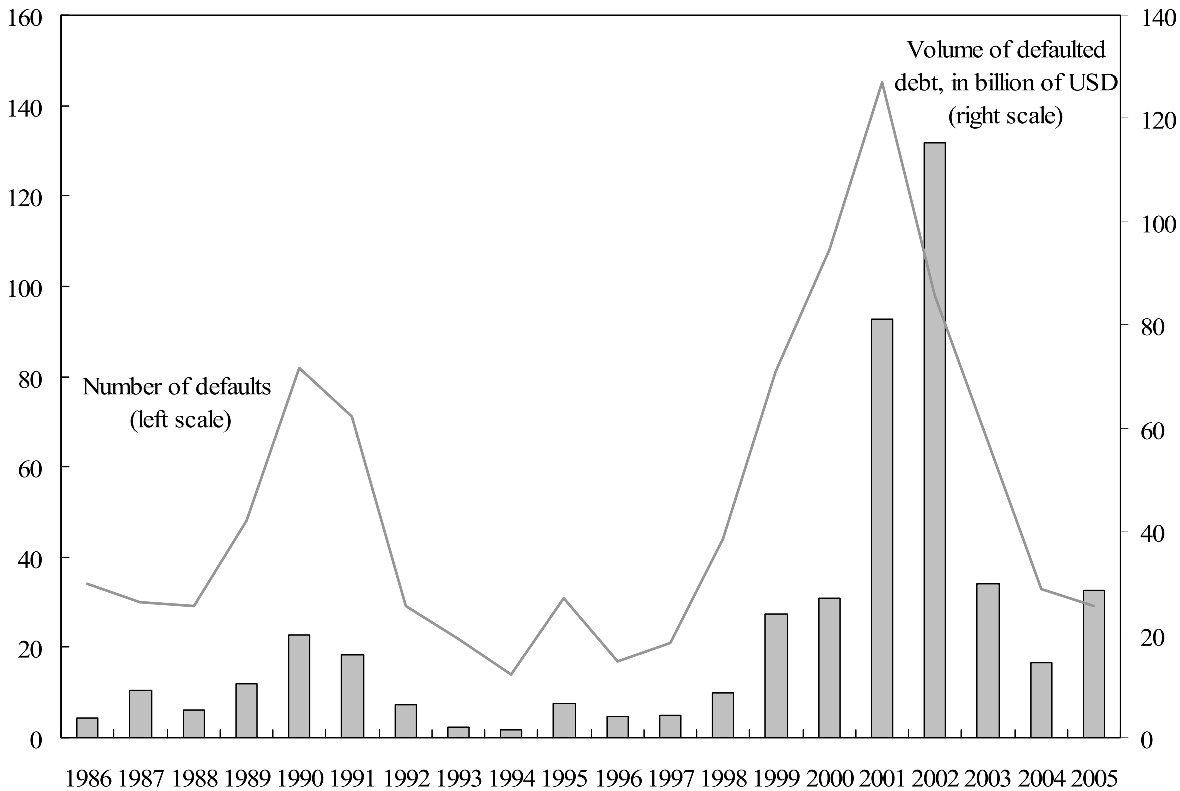


Source: Moody's Investor Services

Among speculative grade rated corporates the average default rate has been 2.7 percent during the 1920–2005 period. The low value of the average default rate fails to capture the large swings in corporate defaults experienced since the early 20th century. For instance, default rates accelerated rapidly during the Great Depression years and reached a record high of 15 percent in 1933. More recently, default rates hovered around 10 percent during the short-lived recessions experienced by the United States in 1990–91 and 2001. The pattern observed for default rates among investment grade rated corporates follows closely that of speculative grade rated corporates. However, default rates among investment grade rated corporates have been one order of magnitude lower, standing at an average level of 0.15 percent from 1920 to 2005.

Should equity investors be compensated for being exposed to default risk? As first explained by Sharpe (1964), Lintner (1965), and Mossin (1966), investors should be compensated only for bearing systematic or unavoidable risk and not for bearing firm-specific default risk. Figure 1 suggests that default risk, as measured by default rates, are highly dependent on the stage of the business cycle. Figure 2 reinforces this observation: the number of defaults and the total volume of defaulted debt in the United States increased sharply during the 1990–91 and 2001 recessions. This casual analysis of the historical data suggests that there is an important systematic component of default risk in the corporate sector that must be priced in equity returns.

Figure 2. Number of Defaults and Volume of Defaulted Corporate Debt in the United States, 1986–2005



Source: Moody’s Investor Services.

How can we identify systematic default risk in the corporate sector and test its relevance for explaining observed equity returns? This study proposes extracting a systematic default risk measure from the information conveyed by the prices of credit derivatives instruments traded in secondary markets. Specifically, the contract characteristics of single-tranche collateralized debt obligations referring standardized credit derivatives indices can be exploited to separate the systematic component from the idiosyncratic component of default risk in the United States corporate sector. The study then shows that the proposed systematic default risk measure can help explaining the cross-section of returns for the firms included in the Standard and Poor’s 500 Index several Fama-French portfolios formed on size and book-to-market value.

The rest of this paper is structured as follows. Section II reviews the related academic literature on default risk and equity returns, focusing especially on the choice of proxies for systematic default risk. Section III describes briefly what single-tranche collateralized debt obligations are, explains how to use their prices for extracting systematic default risk, and constructs a systematic default risk measure for the corporate sector in the United States. Section IV examines whether systematic default risk is priced in the cross-section of equity returns in the United States. Section V concludes.

II. Equity Returns and Systematic Default Risk

The link between equity returns and default risk has not gone unnoticed among researchers. The number of studies addressing this link is still relatively sparse though. Rietz (1988) is probably the first author to propose that, in the United States, the observed excess return of equities over Treasury bills (or equity premium) is the compensation demanded by investors for bearing the risk of extreme losses in the case of an unlikely stock market crash. Barro (2006) has extended Rietz arguments to include other rare events that have adverse consequences for equity returns such as wars and economic recessions. On the grounds of Rietz and Barro's arguments, it could be argued that systematic default risk should be a major determinant of equity returns since economic recessions are usually characterized by an increase in the number of corporate failures.

Five years elapsed from the publication of Rietz work until the publication of the seminal paper by Fama and French (1993). This paper is the first to quantify the impact of systematic default risk on the cross-section of equity returns in the United States. While the paper original motivation was to explain the size and value effect puzzles, Fama and French introduced two explanatory factors (or Fama-French factors) for individual firms' equity returns that are somehow associated with systematic default risk.

The first Fama-French factor, known as SMB or size factor, is the return differential between a small-firm portfolio and big-firm portfolio. Because small firms are more likely to default than large firms during recession periods, as illustrated in Figure 1, they should offer a higher equity return than large firms. Hence, large positive changes of the SMB factor must be associated to increases in systematic default risk. The second Fama-French factor, known as HML or book-market factor, is the return differential between two portfolios comprising high and low book-to-market value firms respectively. Since firms with high book-to-market value tend to have persistent low earnings they are less creditworthy than low book-to-market value firms. The HML factor, hence, can also be interpreted as a default risk factor.

Fama and French (1993) find that both the SMB and HML factors are significant for explaining the cross-section of equity returns in the United States, as well as other asset pricing anomalies (Fama and French, 1996). While these findings suggest that systematic default risk matters for explaining equity returns, the conclusion could be contested on the basis that there is at best only indirect empirical evidence suggesting that the Fama-French factors are associated to systematic default risk.[1]

Vassalou and Xing (2004) address this shortcoming by constructing individual default risk measures, or "distance-to-default" measures, for a large sample of corporates in the United States. The default risk measures are obtained by calibrating Merton (1974) corporate debt pricing model with equity prices and balance sheet data. One of their findings is that the return of stock portfolios are a negative function of the stocks' distance-to-default. Thus, riskiest stocks offer a higher return, suggesting the existence of a default risk premium. Another finding is that the Fama-French factors may capture effects other than default risk: an aggregate survival factor constructed using individual distance-to-default measures is statistically significant when added to the Fama-French three-factor model.

An alternative to constructing portfolio-based default risk measures is to use market-based default risk measures. Such measures have become available in light of the rapid development of the credit derivatives market and increased availability of secondary market prices of credit derivatives. The next section explains how to extract systematic default risk measures from credit derivatives prices.

III. Extracting Systematic Default Risk Measures From Credit Derivatives Prices

The most simple proxy for systemic default risk is the spread of a credit derivaties index, as long as the index comprises a relatively large cross section of firms. The spread of a credit derivatives index is the simple average of the spread of a number of credit default swap contracts referencing individual issuers. For instance, in the case of the 5-year North America investment grade credit default swap index (CDX.IG.NA), the spread is the average of the 125 most liquid 5-year credit default swaps contracts referencing investment grade corporates in the United States. The spread of a credit default swap is the price paid for insuring against potential losses in case the reference issuer defaults on its bonds or loans.[2] Hence, higher spreads correspond to higher default risk. Since credit default swaps isolate default risk from other risk factors, it could be argued that they are a cleaner measure of default risk than other measures previously proposed in the literature.

The use of the spread of a credit derivatives index as a measure of systematic default risk avoids the complexity associated with the construction of the Fama-French factors. It also avoids potential pitfalls arising from the use of accounting data and the simplifying assumptions about the capital structure of a firm needed for constructing distance-to-default measures. The appropriateness of using the spread credit derivative index, however, depends on whether credit derivatives markets are efficient. While liquidity in credit markets is lower

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[1] See Cochrane (2001), Chapter 20, and references therein.

[2] See Duffie (1999) and Hull (2002), Chapter 27, for a comprehensive discussion of credit default swaps.

than in equity markets, credit market participants are rather sophisticated relative to those in equity markets since the participation of retail investors is almost nonexistent. This fact may guarantee a certain degree of market efficiency in credit markets. Some empirical support for the efficiency of credit derivatives markets vis-à-vis the bond and equity markets is found in the studies by Blanco, Brennan, and Marsh (2005), Hull, Predescu, and White (2004) and Longstaff, Mandel, and Neiss (2005) for mature markets, and Chan-Lau and Kim (2005) for emerging markets.

A more serious objection to the use of the spread of a credit derivatives index as a measure of systematic default risk is that the spread also reacts to changes in idiosyncratic default risk. The credit derivatives index, hence, is not a completely clean measure of systematic default risk. Therefore, this paper proposes constructing a systematic default risk measure using price information on single-tranche collateralized debt obligations (STCDOs). As explained in Chan-Lau and Lu (2006), it is possible to separate systematic default risk from idiosyncratic default risk using the fact that the price sensitivity of STCDOs to these two factors depends on the STCDO subordination level. A non-technical description of the method is presented below but the interested reader may want to refer the above mentioned paper for further details.

A STCDO is a structured credit product through which an investor can sell protection on a specific loss tranche for an underlying portfolio of credit default swaps in exchange for a periodic payment or tranche spread.[3] The loss tranche is characterized by an attachment point and a detachment point. The attachment point sets the level of portfolio losses at which the investor starts bearing losses. The detachment point caps the participation of the investor on the portfolio losses. For instance, an investor in a 4-7 percent STCDO would start bearing losses only when losses exceed 4 percent of the portfolio notional amount but will stop making payments once the portfolio losses reach 7 percent. Thus, the total potential loss faced by the STCDO investor is 3 percent of the portfolio's notional amount.

Currently, there are standardized STCDO contracts referencing the major credit derivatives indices in Asia, Europe, and the United States. In the case of the United States, the attachment and detachment points of the standardized STCDO contracts referencing the North America investment grade credit derivatives index (CDX.IG.NA), in increasing order of loss seniority, are 0-3 percent for the more junior tranche, or equity tranche, 3-7 percent and 7-10 percent for what are referred to as mezzanine tranches, 10-15 percent for the senior tranche, and 15-30 percent for the super senior tranche.

The price of the tranches react differently to idiosyncratic default risk, or changes in the credit default swap spread of a single issuer or subset of issuers referenced by STCDO, and changes in systematic default risk, or changes in the correlation of default among the

[3] See, for instance, Kakodkar, Galliani, Jonson, and Gallo (2006) for a comprehensive description of STCDOs. For a nontechnical introduction to collateralized debt obligations, see Tavakoli (2003), and for a discussion of the risks and pricing of these instruments, Duffie and Garleanu (2001).

referenced issuers.[4] An increase in idiosyncratic risk causes the price of all tranches to increase. An increase in default correlation or systematic default risk leads to a widening of the loss distribution of the portfolio. The probability of experiencing very high losses increases, which has a negative effect on the price of the super senior tranche. In contrast, the risk to the equity tranche decreases since now the probability of experiencing few defaults is higher.

Therefore, a change in the idiosyncratic component of default risk should have the same directional impact on the spreads of the equity and the super senior tranche. A change in the systematic risk component of default risk should have opposite effects on the spreads of the equity and super senior tranches. Based on these stylized facts related to the spreads of equity and super senior tranches, principal component analysis can be used to extract the idiosyncratic and systematic components of default risk. Essentially, the aggregate systematic default risk measure should be the principal component such that the coefficient associated with the equity tranche has the opposite sign than the coefficient associated to the super senior tranche.

Systematic and idiosyncratic default risk measures for the corporate sector in the United States are constructed using daily changes of tranche prices quotes for the period November 13, 2003 – February 9, 2006. The daily tranche prices correspond to the continuous, on-the-run standardized single tranche contracts on the Dow Jones investment grade credit derivative index CDX.NA.IG and are obtained from JPMorgan Chase. The index comprises the most liquid 125 credit default swap contracts on investment grade corporations in North America. Table 1 presents the summary statistics of the single tranche contracts.

Table 1. CDX.IG.NA Tranches: Summary Statistics, November 13, 2003 – February 9, 2006

	Attachment points (in percent)	Tranche prices, in basis points Average	Minimum	Maximum	Standard deviation
Tranches					
Equity	0 - 3	1374	1095	1892	121
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: Bloomberg LLP, JPMorgan Chase, and author's calculations.

The equity tranche prices are reported as spreads rather than as an upfront premium plus a running spread of 500 bps, which is the usual market convention. Because the risk of

[4] The impact of idiosyncratic and systematic default risk on mezzanine tranches is not clear cut. See Gibson (2004), among others, for details.

incurring losses is very high for the equity tranche, protections sellers prefer to receive an upfront premium equivalent to a percentage of the notional amount of the tranche. The running spread for the equity tranche is calculated as the spread with the same present value as the upfront premium after discounting by the Libor rates. Daily Libor rates are obtained from Bloomberg LLP.

The mechanics underlying the extraction of the principal components is relatively simple and is explained in detail in Timm (2002) among others. A simple description of the method follows. The single tranche prices are ordered in a matrix $Y_{n\times k}$, where n is the number of observations and k is the number of variables analyzed. The principal components correspond to the columns of the matrix $P_{k\times k}$ such that the variance of the transformed data $Z = P'Y$ is maximized subject to the constraint that $P'P=I$, where I is the identity matrix. Simple linear algebra arguments show that the principal components correspond to the eigenvectors associated to the characteristic vector λ which solves the eigenequation $| \sum - \lambda I| = 0$, where $\sum$ is the variance-covariance matrix of Z.

Table 2 presents the results corresponding to the principal component analysis. Clearly, the first principal component can be identified as the idiosyncratic default risk component since a positive change is associated to positive changes of all the tranches. There are two possible candidates for the systematic default risk component, the second and fifth principal components. The fifth component, however, is discarded on the grounds that it has opposite effects on the equity and junior mezzanine tranches which is at odds with what theory suggests. Furthermore, the percent of total variation explained by the fifth component is negligible.

Table 2. Principal Component Analysis of CDX.IG.NA Tranches, November 13, 2003 – February 9, 2006

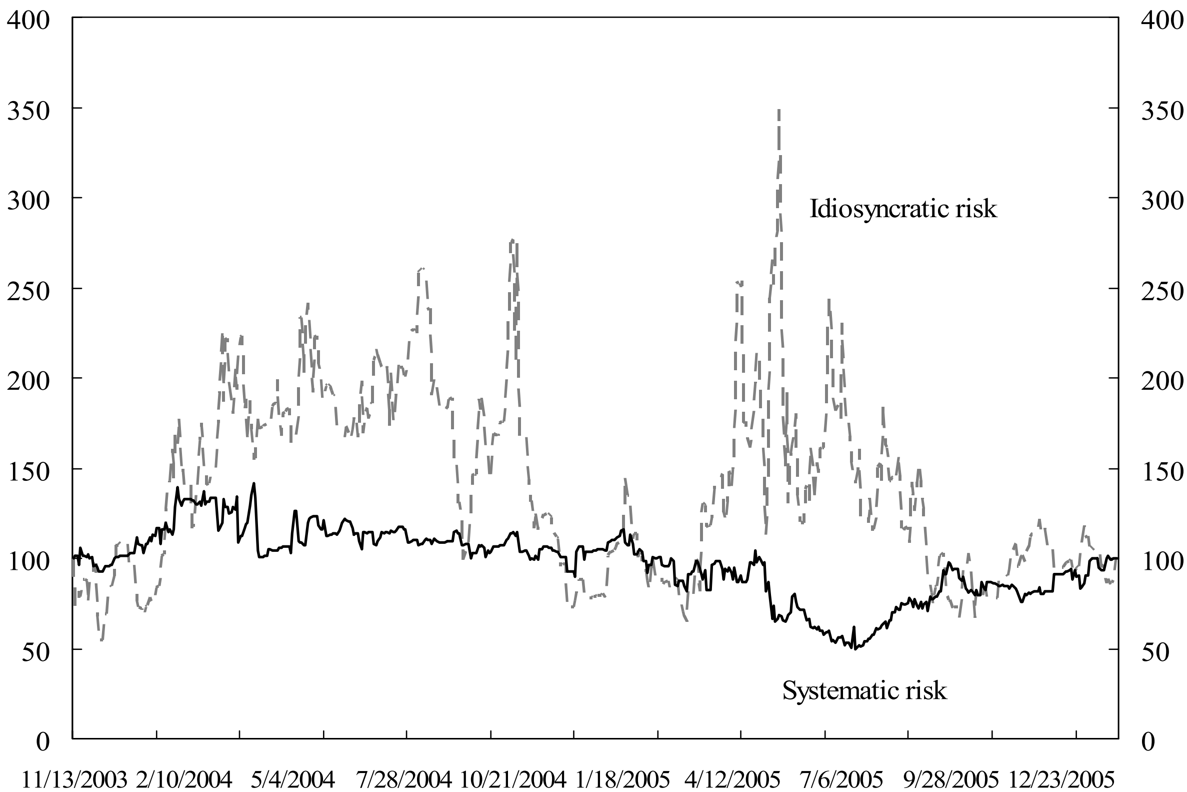
	Principal Components				
	First	Second	Third	Fourth	Fifth
Tranches					
Equity	0.102	0.051	-0.059	-0.222	-0.967
Junior Mezzanine	0.370	0.300	-0.509	-0.675	0.241
Senior Mezzanine	0.462	0.300	-0.448	0.701	-0.068
Senior	0.583	0.346	0.731	-0.060	0.049
Super Senior	0.547	-0.835	-0.045	-0.029	0.023
Percent of total variation explained	78.8	13.1	4.4	2.9	0.7

Sources: JPMorgan Chase, Bloomberg LLP, and author’s calculations.

The evolution of both components is illustrated in Figure 3 below. The large surge in idiosyncratic risk experienced in the first half of May 2005 corresponds to the unraveling of relative value trading positions by hedge funds in the aftermath of the ratings downgrade of

Ford and General Motors. Hedge funds had accumulated long correlation positions, that is, selling protection on equity tranches and buying protection on mezzanine tranches simultaneously, on the speculation that the downgrade of the automobile companies would lead to increased concerns about widespread defaults in the U.S. corporate sector. Such scenario did not materialize leading to a forced unwinding of the positions. As a result, the price of equity tranches rose sharply while mezzanine and senior tranches remained mostly unchanged.

Figure 3. Idiosyncratic and Systematic Default Risk in the U.S. Corporate Sector, November 2003 – February 2006



Sources: JPMorgan Chase, Bloomberg LLP, and author's calculations.

It should be noted, though, that while the analytical framework presented here emphasizes that there are only two main price drivers for STCDOs, it could be argued that the third principal component is also important since it explains around 4½ percent of the observed price variation. Furthermore, including the third principal component would be consistent with the framework presented by Duffie and Garleanu (2001): they pointed out that there were three types of default events: idiosyncratic or firm-specific defaults, industry wide defaults in a specific sector, and economywide defaults. These insights had been validated by Longstaff and Rajan (2006), who found that a three-factor model fits the prices of STCDOs better than two- and one-factor models. However, from the perspective of systematic and idiosyncratic risk, there is no clear economic interpretation of the third component.

IV. Is Systematic Default Risk Priced in Equity Returns?

To answer this question, a cross-section regression analysis is performed using the daily equity returns of the firms included Standard and Poor's 500 index during the period analyzed, November 14, 2003 – February 9, 2006. Daily returns are estimated from daily equity prices obtained from Bloomberg LLP. Additional data used in the analysis comprise daily series of the excess market return, and the Fama-French SMB and HML factors, all of them available from Kenneth French's web site.[5] In addition, the cross-section regression analysis is also performed for the 6, 25, and 100 Fama-French portfolio in order to test the significance of the default risk factor for a broader set of firms.

The analysis, which follows the standard approach for testing asset pricing models, is done in two stages.[6] The first stage consists of running a univariate regression for each firm across time. The independent variables used in the regression are excess market returns (or market factor), the Fama-French SMB and HML factors, and the systematic default risk factor constructed in the previous section. More formally, the time-regression below is estimated for all the firms in the sample:

$$R_{it} - r_t = \text{constant} + \beta_{i,MKT}(\mathrm{E}R_m - r_t) + \beta_{i,SMB}SMB_t + \beta_{HML}HML_t + \beta_{i,DR}DR_t + \varepsilon_t, \qquad (1)$$

where R is the firm stock return, r is the risk-free rate, R_m is the market return, SMB is the small-minus-big factor, HML is the high-minus-low factor, DR is the percentage change of the default risk measure, and ε is an error term. The coefficients $\beta_{i,j}$, *j=MKT, SMB, HML, DR* captures firm *i's* sensitivity to the different risk factors *j*. Equation (1) is estimated using ordinary least squares (OLS), and the Newey-West variance-covariance estimator is used to correct for serial correlation and heteroskedasticity.

Once the coefficients $\beta_{i,j}$ are estimated, a cross-section regression is performed in the second stage. In order to do that, the coefficients $\beta_{i,j}$ are regarded as observations and organized in a cross-section panel. Then, the average excess returns of the firms during the period analyzed are regressed on the coefficients $\beta_{i,j}$:

$$\overline{R}_i = \lambda_0 + \lambda_{MKT}\beta_{i,MKT} + \lambda_{SMB}\beta_{i,SMB} + \lambda_{HML}\beta_{i,HML} + \lambda_{DR}\beta_{i,DR} + \upsilon_i, \qquad (2)$$

where $\overline{R}_i$ is the average excess return of firm *i* during the sample period, and the coefficients λ_i, *i=MKT, SMB, HML, DR* are the risk premia associated to each risk factor. Because the risk factor coefficients are estimated rather than measured, there exists an errors-in-variable

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[5] http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/index.html.

[6] See Campbell, Lo, and McKinlay (1997); Cochrane (2001); or Cuthberson and Nitzche (2004) for details.

problem that is corrected using the procedure suggested by Shanken (1992). The results of the cross-section regression analysis are reported in Table 3.

Table 3. Cross-Section Regression Results

The Table reports the coefficients and t-statistics, computed using Shanken (1992) procedure, corresponding to the market, Fama-French, and systematic default risk factors obtained from the regression equation:

$$\overline{R}_i = \lambda_0 + \lambda_{MKT}\beta_{i,MKT} + \lambda_{SMB}\beta_{i,SMB} + \lambda_{HML}\beta_{i,HML} + \lambda_{DR}\beta_{i,DR} + \upsilon_i,$$

where $\overline{R}_i$ is the average excess return of firm *i* or portfolio *i* during the sample period, and the coefficients λ_i, *i=MKT, SMB, HML, DR* are the risk premia associated to each risk factor.

Risk factors	S&P 500	Fama-French Portfolios		
		6	25	100
Market	0.034	0.039	0.042	0.043
	(2.929)	(33.56)	(9.923)	(6.836)
SMB	0.007	0.010	0.011	0.007
	(0.443)	(0.431)	(0.583)	(0.375)
HML	0.041	0.035	0.033	0.034
	(1.191)	(1.848)	(1.978)	(1.951)
Default risk	0.359	-3.159	0.067	-0.582
	(-601.9)	(-68314)	(586.1)	(-3055.7)

Sources: Bloomberg LLP, JP Morgan Chase, Kenneth French's database, and author's calculations.

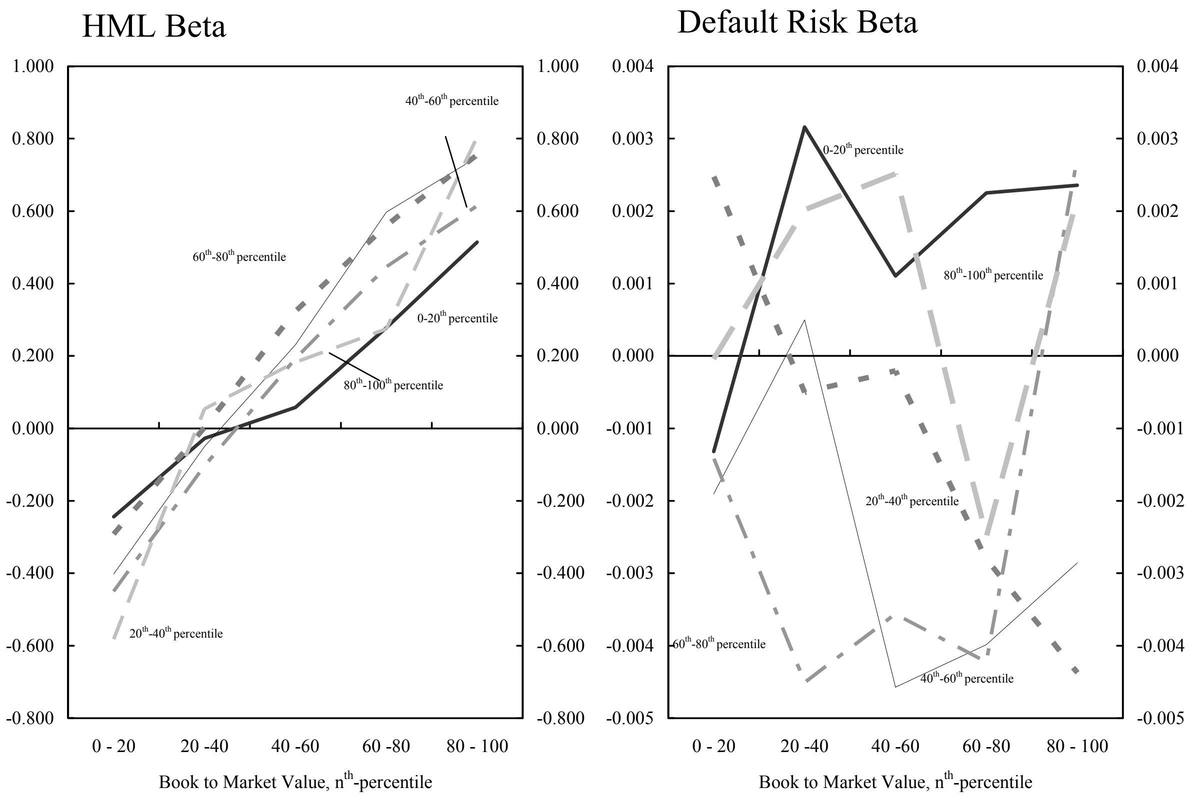
The results support previous empirical findings: systematic default risk is priced in equity returns, and the Fama-French factors capture effects other than default risk, provided that the credit derivatives-based measure captures correctly default risk. In particular, the SMB or size factor does not appear to be important for explaining equity returns either for the firms included in the Standard and Poors' 500 Index nor the Fama-French portfolios.

In general, the premium associated to default risk is one order of magnitude higher than the premium associated to market risk. This finding supports those of Saita (2006) who found that default risk were more important than equity-return risk for explaining both equity and credit portfolio returns.

However, one shortcoming of the default risk measure proposed here is that its risk premium is not stable across different portfolios or cross-section of firms. Contrary to the risk premium associated to the market risk and Fama-French factors, the risk premium changes values depending on what cross-section is used.

Figure 4 illustrates this shortcoming using the HML and default risk betas corresponding to the 25 Fama-French portfolios, sorted by size percentile. If as postulated by Fama and French (1993, 1996), default risk is increasing in book-to-market value, the betas for each risk factor should exhibit a positive slope. This is the case for the HML factor but not for the default risk factor. This absence of a clear defined slope for the default risk factor is also present in the case of the 100 Fama-French portfolios.

Figure 4. HML and Default Risk Betas for the 25 Fama-French Portfolios, Sorted by Size Percentile



Source: Bloomberg LLP, JPMorgan Chase, and author's calculations.

One possible explanation for this result is that the principal components decomposition of default risk may not capture well the systematic risk component. Testing whether this explanation is valid requires assessing the robustness of the decomposition presented here to alternative latent factor decomposition models. Another possible explanation is that the study assumes only two factors for explaining STCDO prices. The results by Longstaff and Rajan (2006), however, suggest that three factors are needed to explain the behavior of STCDOs prices satisfactorily.

V. Conclusions

This paper attempts to answer whether systematic default risk is priced in equity returns. In contrast to previous studies, the systematic default risk measure used in the analysis is derived from the prices of credit derivatives instruments. Specifically, the measure is constructed from the prices of single-tranche standardized collateralized debt obligations contracts on standardized credit derivatives indices. The measure, hence, captures the market views on systematic default correlation in the corporate sector.

The results show that systematic default risk is priced in equity returns, and that the Fama-French factors may capture effects other than default risk, validating earlier results by Vassalou and Xing (2005).The study also supports results by Saita (2006) showing that default risk was more important than equity-return risk for explaining the returns of equity and credit portfolios.

REFERENCES

Barro, Robert J., 2005, "Rare Events and the Equity Premium" (unpublished ; Cambridge, Massachussets: Harvard University).

Blanco, Roberto, Simon Brennan, and Ian W. Marsh, 2005, "An Empirical Analysis of the Dynamic Relation Between Investment-Grade Bonds and Credit Default Swaps," *Journal of Finance*, Vol. 60, pp. 2255–81.

Campbell, John Y., Andrew W. Lo, and Craig McKinlay, 1997, *The Econometrics of Financial Markets* (Princeton: Princeton University Press).

Chan-Lau, Jorge A, and Yoon-Sook Kim, 2005, "Equity Prices, Credit Default Swaps and Bond Spreads in Emerging Markets," *ICFAI Journal of Derivatives Markets*, Vol. 2, pp. 26–48.

Chan-Lau, Jorge A., and Yinqiu Lu, 2006, "Idiosyncratic and Systematic Risk in the European Corporate Sector: A CDO Perspective," IMF Working Paper 06/107 (Washington: International Monetary Fund).

Cochrane, John H., 2001, *Asset Pricing* (Princeton: Princeton University Press).

Cuthberson, Keith, and Dirk Nitzsche, 2004, *Quantitative Financial Economics*, 2nd Edition (New York: John Wiley and Sons).

Duffie, Darrell, and Nicolae Garleanu, 2001, "Risk and Valuation of Collateralized Debt Obligations," *Financial Analysts Journal*, Vol. 57, pp. 41–59.

Fama, Eugene F., and Kenneth R. French, 1993, "Common Risk Factors in the Returns on Stocks and Bonds," *Journal of Financial Economics*, Vol. 33, pp. 3–56.

______, 1996, "Multifactor Explanations of Asset Pricing Anomalies," *Journal of Finance*, Vol. 36, pp. 55–84.

Gibson, Michael, 2004, "Understanding the Risk of Synthetic CDOs," Finance and Economics Discussion Paper 2004-36 (Washington: Board of Governors of the Federal Reserve).

Hamilton, David T., Praveen Varma, Sharon Ou, and Richard Cantor, 2006, "Default and Recovery Rates of Corporate Bond Issuers, 1920–2005," *Special Comment* (New York: Moody's Investor Service).

Hull, John, 2003, *Options, Futures, and Other Derivatives*, 5th Edition (Englewood Cliffs: Prentice Hall).

Hull, John, Mirela Predescu, and Alan White, 2004, “The Relationship Between Credit Default Swap Spreads, Bond Yields, and Credit Ratings Announcements, *Journal of Banking and Finance*, Vol. 28, pp. 2789–811.

Kakodkar, Atish, Stefano Galliani, Jon Jonsson, and Alberto Gallo, 2006, *Credit Derivatives Handbook 2006*, Vol. 2 (New York: Merrill Lynch).

Lettau, Martin, and Sidney Ludvigson, “Consumption, Aggregate Wealth, and Expected Stock Returns,” *Journal of Finance*, Vol. 56, pp. 815–49.

Lintner, John, 1965, “Security Prices, Risk and Maximal Gains from Diversification,” *Journal of Finance,* Vol. 20, pp. 587–615.

Longstaff, Francis A., Sanjay Mithal, and Eric Neiss, 2005, “Corporate Yield Spreads: Default Risk or Liquidity? New Evidence from the Credit Default Swap Market,” *Journal of Finance*, Vol. 60, pp. 2213–53.

Longstaff, Francis A., and Arvind Rajan, 2006, “An Empirical Analysis of the Pricing of Collateralized Debt Obligations” (unpublished; Los Angeles: University of California).

Mossin, Jan, 1966, “Equilibrium in a Capital Asset Market,” *Econometrica* Vol. 34, pp. 768–83.

Rietz, Thomas A., 1988, “The Equity Risk Premium, A Solution,” *Journal of Monetary Economics*, Vol. 22, pp. 117–31.

Saita, Leandro, 2006, “The Puzzling Price of Corporate Default Risk” (unpublished; Palo Alto: Stanford University).

Sharpe, William, 1964, “Capital Asset Prices: A Theory of Market Equilibrium Under Conditions of Risk,” *Journal of Finance* Vol. 19, pp. 425–42.

Tavakoli, Janet, 2003, *Collateralized Debt Obligations and Structured Finance: New Developments in Cash and Synthetic Securitizations* (New York: John Wiley and Sons).

Timm, Neil H., 2002, *Applied Multivariate Analysis* (New York: Springer-Verlag).

Vassalou, Maria, and Yuhang Xing, 2004, “Default Risk in Equity Returns,” *Journal of Finance*, Vol. 59, pp. 831–68.