Another Look at the Relation Between Credit Spreads and Interest Rates

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Empirical research until now has mostly documented a significant negative correlation between movements in interest rates and credit spreads (e.g., Cornell and Green [1991]; Fridson and Kenny [1994]; Longstaff and Schwartz [1995]). However, some researchers and practitioners find it counterintuitive. According to economic theory, when the central bank raises the target rate to curb inflation, it hurts the growth of the economy. Therefore, by intuition, it should be harder for companies to survive and credit spreads should widen. This should imply a positive correlation between credit spreads and interest rate movements. Unfortunately there is insufficient empirical evidence to indicate such a positive relation. Neal, Rolph, and Morris [2001] represent almost the only attempt to support a positive relation. They use a cointegration approach and propose that a rise in interest rate will eventually widen the credit spreads after an initial narrowing effect. The statistical significance and robustness of their results are, however, not convincing enough to us.

Theoretical models, on the other hand, are quite divergent on this point. For example, the bond-pricing models of Merton [1974]; Kim, Ramaswamy, and Sundaresan [1993]; and Longstaff and Schwartz [1995]; as well as the comparative statics of the capital structure models of Leland and Toft [1996] and Collin-Dufresne and Goldstein [1999] all predict that higher interest rates would narrow credit spreads. Contrarily, modifications of the Merton model like Duan [1995] and Lesseig and Stock [1998], and the dynamic capital structure models of Fischer, Heinkel, and Zechner [1989], and Goldstein, Ju, and Leland [1998] would allow higher interest rates to increase credit spreads. Since the negative relation between interest rates and credit spreads exists as a matter of fact, it has been widely utilized in testing theoretical models of default risk. Those models that are compatible with this negative relation, such as Merton's model, are in turn recognized as the explanation for this originally surprising empirical result.

In the *Negative Correlation and the Debate* section we confirm the negative correlation but question the inference on default risk models for two reasons. Firstly, swap spreads, also widely regarded as a proxy of credit risk of AA rated banks, have a slightly positive correlation with interest rates. Secondly, statistics show a non-negligible positive correlation between movements in credit spreads and target rates lagged two periods.

In the *Dissecting the Credit Spread* section, in order to resolve the first controversy noted above, we present a way to break down credit spreads into three risk components: default risk, downgrade risk, and liquidity risk. We compare two financing plans of an AA-rated bank. We show that in one plan investors are only exposed to default risk and would receive the swap rate as yield. In the other plan, investors are exposed to all three risks and would receive the swap rate plus an additional credit spread over swap. This indicates that the swap spread (the spread between swap rate and treasury yield of the same maturity) represents the default risk of AA banks, while the credit spread over swap for AA banks represents downgrade risk plus liquidity risk. This analysis of credit spreads, though not directly applicable to other sectors and ratings, has important implications for the true relationship between interest rates and the different risk components. The whole credit spread consists of two parts which may have an inverse relationship to interest rates. The overall negative correlation with interest rates may actually come from the liquidity risk component rather than the default risk component.

In the *An Econometric Model* section, we present an econometric model for credit spreads over swap to resolve the second controversy. We take into consideration both the negative correlation of credit spreads with the concurrent interest rate and the positive correlation with the target rate lagged two periods. Empirical studies until now have been counterintuitive because they ignored the latter. We incorporate these two into a new factor: the market response to monetary policies going back two months. A bullish response indicates better liquidity conditions in the economy and leads to lower credit spreads. This explanation is more straightforward and intuitive than the structural models.

In the *Long-Term Dynamics* section, we examine the long-term key drivers of credit spreads. We show that, in the long run, credit spreads do not have any narrowing or widening trend. They increase during a crisis, recession, or big event, while remaining within a much narrower band otherwise. Monetary policy varies during these events and has no direct impact on credit spreads.

NEGATIVE CORRELATION AND THE DEBATE

Data and Definition

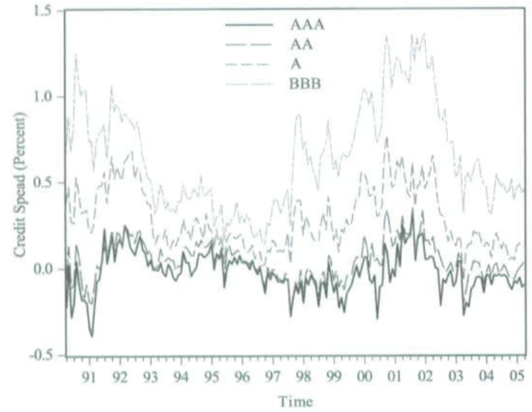
The methodology used to produce a yield or credit spread index varies across data sources. The main differences are the choice of index members and calculation methods. Latent limitations in methodology could introduce undesirable characteristics to the data and cause questionable specifications of the model. Therefore, we used three data sources in order to guarantee robustness.

The data source we finally used in order to build a regression model is taken from the Bloomberg fair value curves (BFV). Using bonds of the same rating to build a curve, Bloomberg interpolates the yield at constant maturity for a specific rating. We downloaded the industrial sector yield at a five-year constant maturity for AAA, AA, A, and BBB ratings. This data series starts from April 1991. The other two bond indices, from Moody's and Merrill Lynch respectively, served as tests for robustness throughout the article. We downloaded Moody's yield averages of 30Y U.S. corporate bonds across the ratings AAA, AA, A, BBB from Bloomberg. The advantage of this data series is it has a very long history, actually since January 1962. The credit spread over Treasuries calculated from Moody's data could only start from February 1977 when the U.S. Treasury started to provide 30Y constant maturity Treasury rate data. It is not used for the regression model for two reasons. Firstly, the 30Y tenure makes it less representative of the corporate bond market. Secondly, given the scarcity of bonds with such long maturities, each rebasing causes a large unwanted jump in the data. Though not especially suitable for regression analysis, the long history of this data series is a good representation of the general development of credit spreads over the past few decades, because credit spreads across different ratings and sectors move largely together in levels.

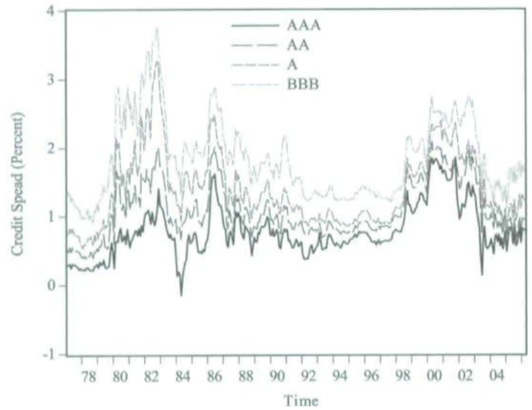
The other data source is the Merrill Lynch bond indices for the U.S. domestic market. We directly downloaded the average asset swap spread of U.S. broad market corporate bonds with maturities of five to seven years across the AAA to BBB ratings. The Merrill Lynch data go back as far as January 1997. This data series has several advantages. The methodology used to rebase the index when a bond falls out of the maturity range is the most common one. The average of the asset swap spreads is taken directly, which is more accurate and stable than taking the difference between the corporate yield average and Treasury rate. We did not use it for the final model because of the relatively shorter history. In addition, many more events of financial significance took place after 1997 than during the period 1991 to 1997. The latter period has seen the most stable credit spread levels. Therefore, both periods are representative and should ideally be included in the regression model. We will use end-of-month data for all three data sources. Exhibit 1 shows the historical data graphs for these three data sources.

EXHIBIT 1

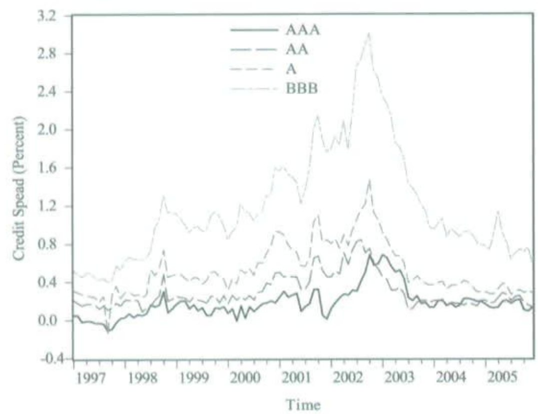
BFV 5Y Industrial Credit Spreads



Moody's 30Y Corporate Credit Spreads



Merrill Lynch 5–7Y Corporate Credit Spreads



The treasury yield history was downloaded from Bloomberg.

Exhibit 2 shows the correlation between monthly changes in credit spreads and monthly changes in Treasury yields at the respective maturity, i.e., 30Y for Moody's and 5Y for the other two. The correlation is based on the maximum available sample period for each data series. The negative correlation is indeed significant for whatever data source or time period is used.

Theoretical Models

As mentioned in the introduction, theoretical models are divergent in terms of the relation between interest rates and credit spreads. For illustration purposes, in Appendix 1 we show the relevant results of the Merton model and its modification by Lesseig and Stock [1998]. The former predicts a negative relation, and the latter predicts a positive one. The Merton model and its variations are the models most frequently cited by practitioners.

Two Controversies

The negative relation, though at first deemed counterintuitive, is becoming more and more accepted as a matter of fact. Models compatible with it are often used to explain this relation. However, we find that the two arguments below cast doubt on the inference of this negative relation for default risk models.

First, swap spreads are also widely recognized as representing the credit spread of AA-rated banks over the risk-free rate. However, as shown in Exhibit 3, monthly changes in the swap spread have a slightly positive correlation with the corresponding Treasury yield at constant maturity.

Second, theoretical models usually do not predict when an interest rate change would take effect on credit spreads. The negative correlation documented in other studies to date is based on interest rate changes and credit spread changes for the same period, so it seems that the effect is immediate. But when we look at lagged periods, we can identify a non-negligible positive correlation between credit spread changes with the changes in the 3-month LIBOR rate lagged two months, as shown in Exhibit 4. This is not captured in the theoretical models, and a consistent explanation needs to be found.

EXHIBIT 2

Correlation between Credit Spreads and Treasury Rate in Monthly Changes

Bloomberg Fair Value 5Y Industrial/Sample Period: 04/1991–04/2006.

	AAA	AA	A	BBB
Gt5	-0.16	-0.12	-0.20	-0.23

Moody's 30Y Corporate. Sample Period: 01/1981-04/2006

	AAA	AA	A	BBB
Gt30	-0.39	-0.51	-0.56	-0.53

Merrill Lynch 5-7Y Corporate. Sample Period: 01/1997-04/2006

	AAA	AA	A	BBB
Gt5	-0.34	-0.40	-0.38	-0.50

DISSECTING THE CREDIT SPREAD

A Case Study for AA Banks

In the following sections, we use CSP1 to denote the spread between the corporate bond yield and Treasury yield at the corresponding constant maturity, CSP2 to denote the asset swap spread of a corporate bond, and SSP to denote swap spread. Approximately, the following relation holds:

$$CSP1 = SSP + CSP2 \tag{1}$$

Of the two controversies mentioned above, the first one is perhaps the more perplexing. Practitioners usually view swap spreads as a measure of credit risk of AA-rated banks. They consciously or unconsciously reason that credit spreads of AA-rated banks over Treasuries should be similar to swap spreads and that AAA-rated bank bonds should trade below the swap rate. A concrete example is documented in Tuckmann [2004], p. 387. The asset swap spread of the FNMA 6.25s of May 15, 2029, at 15bp, reflects market conditions in late August 2001. But most market participants reasoned that the asset swap spread should be below zero because of this FNMA agency's very close ties to the government. They argued that it was an excellent trading opportunity. Many entered positions at that time, pushing the asset swap spread below zero. However, the asset swap spread started to widen again afterwards, forcing these investors to liquidate their positions to stop loss, which in turn pushed the asset swap

EXHIBIT 3

Correlation between Swap Spreads and Treasury Yield at Constant Maturity in Monthly Changes

Sample period: 05/1994–04/2006.

	Swap spreads			
	2y	5y	10y	30y
2Y Treasury	0.27	0.16	0.28	0.29
5Y Treasury	0.24	0.16	0.26	0.29
10Y Treasury	0.22	0.16	0.2	0.25
30Y Treasury	0.24	0.22	0.18	0.11

EXHIBIT 4

Correlation between Credit Spreads and LIBOR3m lagged 2 months in Monthly Changes

Bloomberg Fair Value 5Y Industrial/Sample Period: 04/1991–04/2006.

	AAA	AA	A	BBB
Δ_{-2} LIBOR3m	0.20	0.18	0.18	0.16

Moody's 30Y Corporate. Sample Period: 12/1984 - 04/2006

	AAA	AA	A	BBB
Δ_{-2} LIBOR3m	0.16	0.16	0.17	0.16

Merrill Lynch 5-7Y Corporate. Sample Period: 01/1997 - 04/2006

	AAA	AA	A	BBB
Δ_{-2} LIBOR3m	0.19	0.11	0.17	0.05

spread even wider, to 30 bp. It is worth noting that almost no one in the market advanced the argument that the cheapening of the bonds resulted from a perception that FNMA's credit had weakened.

In fact, the FNMA example is not just a single anomaly. Looking at the BFV data in Exhibit 1, one can see that the asset swap spread for AAA industrial bonds can be positive as well as negative. The highest AAA 5Y industrial asset swap spread could be as much as 30 bp. The situation described in the last paragraph points to liquidity as the cause. We support this hypothesis based on an analysis of the risks and risk premiums involved in two borrowing plans of an AA-rated bank. We ignore the day count convention here for convenience, and swap frequencies are taken to be semiannual for the fixed versus quarterly for the floating leg.

Consider the following example. An average AA-rated bank would like to borrow \$100 million today for five years. An average AA-rated bank is defined here to be a bank that could borrow for three months at exactly the 3-month LIBOR rate. It has the following two ways to borrow for five years.

Plan A: The bank can issue a five-year bond. To simplify the comparison, suppose this bond is issued at par. For a par bond, the effective yield is just equal to the coupon rate. Thus, with this method, the bank would pay a coupon of the swap rate plus an additional credit spread over swap (denoted by CSP2). As can be seen from the BFV data in Exhibit 1, the additional spread over the swap rate is usually larger than zero for AA industrials. The cash flows are summarized as follows:

Initial Amount Received: 100m
Semiannual Coupon Payment:
100m*(Swap Rate + CSP2)/2
Payment at Redemption: 100m

Plan B: The bank can pay fixed in a five-year swap from the beginning and borrow recurrently at the three-month rate available. That is, at the end of each three-month period, the bank has to pay interest and principal back to the lenders and seek new financing. We denote the LIBOR rate for the ith quarter as LIBOR_i. The actual borrowing rate available for the bank for quarter i usually deviates from LIBOR_i due to slight or large changes from an exact AA rating. We denote this deviation for period i as δ_i. The cash flows are summarized as follows:

Initial Amount Received: 100m
Quarterly interest payment
at the end of the ith quarter: 100m* $(\text{LIBOR}_i + \delta_i)/4$
Quarterly amount received from swap partner:
100m* $\text{LIBOR}_i/4$
Semiannual payment to swap partner:
100m* Swap Rate/2
Payment at Redemption: 100m

At the end of each quarter, the payment of the principal amount to the old investors and the collection of new funds cancel out. Thus, these two cash flows are not listed. Since we assume that our bank starts with an exact AA rating, it can borrow at the exact 3-month LIBOR rate for the first period. That is,

$$\delta_1 = 0 \tag{2}$$

For the period thereafter, however, a LIBOR rate is not guaranteed. We assume that

$$E(\delta_i) = 0 \tag{3}$$

This assumption is intuitively reasonable. It implies that, with only the information with which we started, the expected borrowing rates for an AA-rated bank for all subsequent periods are equal to LIBOR. A strict test, however, would require considerable effort. There are two major difficulties. First, in the real world, ratings can only take distinct values, while we would also like to measure slight deviations from the exact rating. Secondly, a three-month borrowing rate is not available for companies with ratings below AA–, as discussed below. Here we only provide a rough test based on a similar situation. We examine how much the credit spread of a five-year bond of a company rated AA this year would deviate from the average AA credit spread in the following year. Only discrete ratings are considered. Exhibit 5 shows the Moody's year-to-year transition rates between ratings for the period 1983 to 2005. On average, over 92.3% of AA-rated companies in one year maintained their AA rating the following year. At the same time, about 4.43% of the AA companies were upgraded to AAA and 1.38% were downgraded to A, while 1.9% of the AA companies withdrew. Exhibit 6 shows the mean value of BFV 5Y Industrial Credit Spreads. It can be seen that bonds of AAA companies on average traded 6.77 bp below bonds of AA companies. In turn, bonds of AA companies traded 24.44 bp

EXHIBIT 5

Moody's Average One-Year Whole Letter Rating Transitions Rates

Sample Period: 1983–2005.

Beginning of Year Rating	End of Year Rating								
	Aaa	Aa	A	Baa	Ba	B	Caa-C	Default	WR
Aaa	94.7	5.21	0	0	0	0	0	0	0.15
Aa	4.43	92.3	1.38	0	0	0	0	0	1.9
A	0	2.9	91.7	3.19	0.52	0	0	0	1.66
Baa	0	0	8.88	79	6.85	0.85	0	0	4.4
Ba	0	0	0	4.28	85.9	8.29	0.73	0.62	0.15
B	0	0	0	0	3.5	87.2	2.09	3.89	3.34
Caa-C	0	0	0	0	0.52	28.2	53.1	18.2	0

below those of A companies. Therefore, on average, 5Y bonds of an AA company in one year would trade at

$$\frac{4.43}{98.1}\times(-6.77)+\frac{1.38}{98.1}\times 24.44=0.038$$

basis points above an average AA bond in the following year. This is very close to zero compared to the general level of credit spreads. Under assumption (3), the bank will be expected to pay an annual interest rate equal to the swap rate.

Obviously there is a difference in the amount of CSP2 in the yield the bank has to pay in these two plans, but why? The following is a comparison of the different types of risks involved in the two plans. We will see in the end that the CSP2 is to compensate for the additional risk for the investor in Plan A.

Curve risk: In both plans, investors are subject to the general curve risk. In Plan A, when the general interest rate level rises, the investor will suffer a capital loss on the bond. In Plan B, the investor would take a loss reversing the swap when he decides to stop lending.

Default risk: In both plans, when the bank defaults, investors will lose the principal and wait a long time before a recovery amount is paid.

Downgrade risk: On the other hand, if there is a slight or even sizeable change of credit worthiness of the bank according to market opinion, the investor in Plan A would immediately endure a capital loss because of a price drop in the market. In Plan B, the investor only has to wait until the end of the three-month period and he will get back the original principal plus interest.

Liquidity risk: In addition, there is nearly no liquidity risk for the investor in Plan B. Liquidity risk is by definition the risk of significantly changing the price of a security by selling or buying it. This risk is usually most evident in small cap securities where it is difficult for a seller or buyer to find a counterparty. In Plan A, if an investor wanted to sell a relatively large amount of the bond, he would push the price lower. This capital loss is not related to the credit rating. On the contrary, in Plan B, regardless of the amount the investor wants to sell, he could always wait until the end of a three-month period, and he would get the full amount back.

The conclusion is that, in Plan A, the investor takes two more risks than in Plan B: the downgrade risk and liquidity risk. As mentioned before, in Plan A the bank pays swap rate plus CSP2, while in Plan B it pays only the swap rate. Therefore, the investor in plan A is compensated by an additional amount of yield equal to CSP2 of the bank for the downgrade risk and liquidity risk. The

EXHIBIT 6

Mean Bloomberg Fair Value 5Y Industrial Credit Spreads

Sample Period: 04/1991–04/2006.

	AAA	AA	A	BBB
Mean (bp)	-2.40	4.37	28.81	65.17

spread of the Plan B yield over the risk-free yield, swap spread (SSP), accounts for the default risk of the bank.

This has an important implication for the evaluation of default risk models. Using the common credit spread over the Treasury yield may distort the true relationship between default risk and interest rate. In the case of AA-rated banks, a rise in the risk-free rate increases its default risk (represented by SSP) while decreasing the credit spread over Treasuries (to be denoted by CSP1). Since downgrading is just another sign that the default risk has increased, it could be reasonably assumed that the relation between the downgrade risk and the Treasury yield is similar to that between default risk and the Treasury yield. Therefore, the dynamics of the liquidity risk premium should be responsible for the negative relation between credit spreads and interest rates in this case. When testing default risk models, the default risk components of the credit spread should ideally be used to make any meaningful conclusions.

The Generalization to Issuers of Other Ratings

In the case of a general corporate bond, however, the allocation of risks to CSP2 and SSP is not so clear-cut. There are scarcely any data available for conducting the same analysis. Below we discuss the possibility of a generalization.

Firstly, support for this possibility lies in finding the short-term borrowing rate and a swap rate for corporates of a specific rating, which are comparable to LIBOR and the swap rate in the case of AA banks.

For the short-term rate, the interest on short-term bank loans could have been used, provided it was collected and presented as an index according to rating and industry. In fact, what is clearly available is the prime rate, the lending rate of commercial banks to their most steady, creditworthy customers, usually large, conservatively financed businesses. The prime rate is the same for almost all major banks. In the United States, it is set at 3% above the Federal Reserve target rate. Interest rates on other loans are based on the prime rate and internal criteria of respective banks. Presumably, banks do not change their models and parameters for lending rates so frequently; therefore, if observable, the short-term borrowing rate of a specific rating class is most probably at a fixed margin over target rate. An alternative could be yields of corporate bonds to mature in a few months. The problem is that corporate bonds become very illiquid once their maturities fall below one year. Exhibit 7 shows the BFV yield for 3-month BBB U.S. industrial bonds and 3-month AA US bank bonds against LIBOR, respectively. One can see that the yield index for 3-month BBB industrial bonds sometimes falls below the 3-month LIBOR rate, which casts doubts on the feasibility of using these data.

On the other hand, it is even more difficult to find the swap rate for corporates of other ratings. Swaps between companies are tailored to individual cases, and no single reference rate is available.

However, there is still a chance that, in the future, more reliable data will become available or new financial instruments will appear that would serve the purpose of separating different risk components.

Without using actual data, one could also make assumptions to get more conclusions. For example, one could reasonably assume that the relation between the default risk component of other ratings and interest rates are similar to that in the AA bank case. Then the negative relation between the whole credit spread and the interest rate observed for other ratings should also be attributed to liquidity risk.

It is worth mentioning that whether to use CSP1 or CSP2 for analysis is usually an unconscious choice for practitioners, but it may make a material difference. If the default risk components of all rating categories are highly correlated, the default risk information is largely reduced by using CSP2 instead of CSP1, while the liquidity risk information is emphasized.

AN ECONOMETRIC MODEL

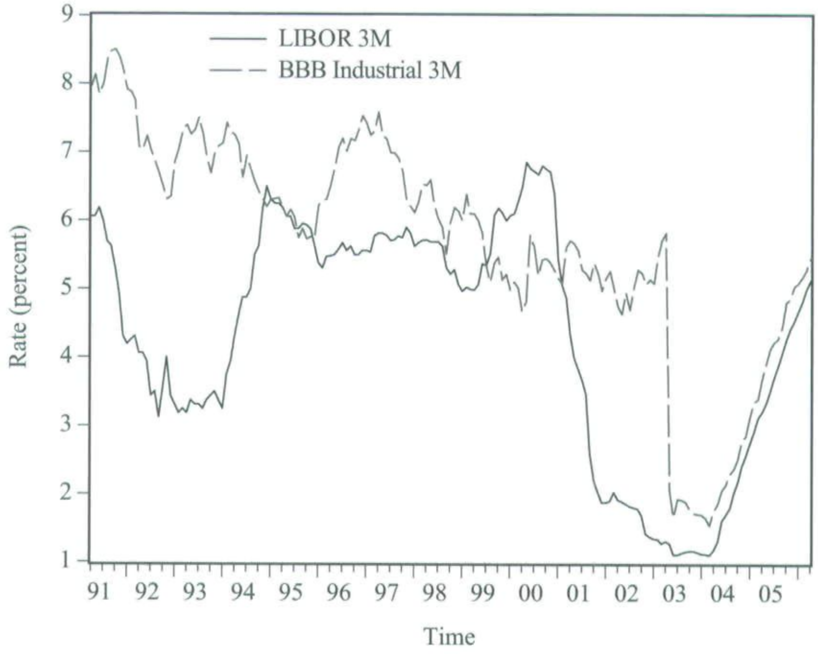
Now that the negative relation is found to be attributed to liquidity risk, it is still interesting to look for a more intuitive explanation of this relation. In this light, we present the following statistical model.

We find that the factors that affect credit spread over swap vary from sector to sector. However, the sector effect is not the focus of our study. Therefore, below we provide a regression model only for the industrial sector data from the Bloomberg fair value curve. The three factors we use are swap spread, global stock index performance over the past quarter, and response of the long-term interest rate to monetary policies.

The second factor, global stock index performance over the past quarter, is defined as follows: We use the

EXHIBIT 7

BFV 3 Month BBB Industrial Bond Yield vs. 3 Month LIBOR Rate



S&P 500 index (SPX) to represent the U.S. domestic market, the Dax index (DAX) to represent the European market, and the Nikkei index (NKY) to represent the Asian market. The definition of the global stock index is

$$STOCK_t = L(1+\alpha L+\alpha^2 L^2)(r_t^{SPX} + \beta r_t^{DAX} + \gamma r_t^{NKY}) \quad (4)$$

where L is the lag operator

$$Lx_t \equiv x_{t-1} \quad (5)$$

The actual coefficients used in the regression are $\alpha = 0.7$, $\beta = 0.9$, $\gamma = 0.9$ which reflect a larger weighting for the U.S. domestic stock market performance compared to foreign ones and a larger weighting for stock index performances during the last month than for earlier periods.

The third factor is composed of two data series. The first is the 3-month LIBOR rate movement lagged two periods. The 3-month LIBOR rate is used here as a proxy for the target rate. The target rate is a series that remains constant over periods between jumps and is therefore not ideal for regression. The 3-month LIBOR is closely linked to the target rate while reflecting the market estimation of coming Fed actions. The second series is the 5-year Treasury yield movement in the current period, representing the market response after the actual or expected monetary policy change going back two months.

With the three factors described above, we test the regression model in Equation (6). The coefficients and test statistics are shown in Exhibit 8.

$$\begin{aligned}\Delta_t CSP2 = \beta_1 \Delta_t SSP + \beta_2 \Delta_{t-1} SSP + \beta_3 STOCK \\ + \beta_4 \Delta_t gt5 + \beta_5 \Delta_{t-2} Libor3m\end{aligned} \quad (6)$$

Our results indicate that the BFV credit spread over swap is significantly negatively correlated with the swap spread. There is still a positive correlation with the swap spread lagged one period. This shows that the BFV data series is slightly self-correcting.

There is a negative impact from the global stock monthly return. Intuitively speaking, when stock indices perform well in the last quarter, market conditions tend to improve. The market is usually more liquid when it is in an upswing; therefore, credit spreads over swap, as an indicator of liquidity risk, narrow.

As mentioned in the previous section, credit spread movements are negatively correlated with the long-term interest rate movements of the same period but positively

EXHIBIT 8

Regression Model for BFV 5Y Industrial Credit Spread over Swap

$\Delta_t CSP2 = \beta_1 \Delta_t SSP + \beta_2 \Delta_{t-1} SSP + \beta_3 STOCK + \beta_4 \Delta_t gt5 + \beta_5 \Delta_{t-2} Libor3m.$

Sample Period: 04/1991–04/2006, t statistic in brackets.

	AAA		AA		A		BBB	
ΔSSP	-0.78	(-12.11)	-0.61	(-10.07)	-0.58	(-8.50)	-0.61	(-6.93)
Δ_1SSP	0.20	(3.10)	0.13	(2.08)	0.29	(4.29)	0.26	(3.00)
Stock	0.02	(0.65)	-0.04	(-1.22)	-0.10	(-3.03)	-0.17	(-4.06)
Δgt5	-0.06	(-3.44)	-0.03	(-1.98)	-0.05	(-2.89)	-0.06	(-2.87)
Δ_1LIBOR	0.05	(2.26)	0.05	(2.12)	0.06	(2.32)	0.07	(2.24)
R^2	0.54		0.45		0.47		0.41	

correlated with the LIBOR3m rate lagged two months. These two effects can be clearly seen in Exhibit 8. Without including the lagged LIBOR3m rate, one would have reasoned, for example, that a rise in the 5-year Treasury yield of 25 bp this month would cause the BBB credit spread over swap to narrow by 1.5 bp. But this alone does not capture the mechanism shown in our regression. It is well known that the Treasury yield curve is affected by the Fed target rate movements. The short end of the curve is largely subject to the impact of the Fed target rate changes, while the longer end is affected by both the Fed target rate and the market dynamics. If the 3-month LIBOR rate remains stable and the 25 bp rise in the 5-year Treasury yield is solely due to market dynamics, then the BBB credit spread would narrow by 1.5 bp. But, on the other hand, if, for example, this 25 bp rise in the Treasury yield comes after a 25 bp rise in the 3-month LIBOR rate two months ago, then the credit spread would hardly have changed. More intuitively speaking, the two factors can be viewed together as one factor: the market response to a move in the Fed target rate. If the target rate rises (or is expected to rise) and the longer end rises even more in response, the curve becomes steeper, which is usually viewed as a sign of a bullish economic outlook. The credit spreads would narrow in this case because the market expectation for the future is very optimistic despite efforts by the Fed to curb inflation and dampen excessive growth. If the target rate rises, but the longer end stays at its original level, the curve flattens, which indicates a bearish economic outlook and, worse, liquidity condition. Credit spreads would widen because the market tends to view the target rate rise as restrictive to the economy. To clearly reflect this reasoning, we rewrite our regression model as Equation (7). This does not change the regression results.

$$\begin{aligned} \Delta_t CSP2 = {} & \beta_1 \Delta_t SSP + \beta_2 \Delta_{t-1} SSP + \beta_3 \Delta_t STOCK \\ & + \beta_4 (\Delta_t gt5 - \lambda \Delta_{t-2} Libor3m) \end{aligned} \tag{7}$$

LONG-TERM DYNAMICS

Neal, Rolph, and Morris [2001] represent the first attempt to deduce a positive relationship between credit spreads and interest rate. They argued, among other things, that Merton's model, after adjusting to modifications in Duan [1995] and Lesseig and Stock[1998], would support this positive relation. They used Moody's 10Y yield average of several rating categories and tried to deduce a cointegration between the yield of corporate bonds and interest rate. Then they used the vector error correction model and impulse response function to show that the impact of interest on credit spreads ultimately becomes positive. Their results are questionable, however, in two respects. First, the lower bound of their confidence interval for the impulse responses touches zero, indicating that the slight positive long-term response is not significant at all. And second, the results depend highly on the time period of the data used. This article is closely related to Duffee [1998], who finds no clear long-term relationship between interest rate and credit spreads. The reason for the different conclusions is that Neal, Rolph, and Morris [2001] use the whole history of Moody's credit spread since 1962, while Duffee [1998] only uses roughly one-third of that history. To illustrate this difference, we present a scatter plot of Moody's 30Y BBB Corporate Credit Spread versus the 30Y Treasury yield at a constant maturity in levels in Exhibit 9.

Our analysis until now has been carried out based on monthly changes of the data to capture the short-run dynamics and avoid spurious regressions. Using data series in levels instead of changes is suitable for the analysis of long-run relationship and is the basis of cointegration. The graph on the left uses the sample period of 02/1977 to 04/2006; a weak positive relation between the two series can be seen. The graph on the right uses the sample period of 01/1984 to 04/2006, but no significant relation can be inferred between the two series. This shows that there is no stable long-run relationship between interest rate and credit spread.

It comes down to two interesting questions. In the long run, are credit spreads affected by monetary policy, if not the interest rate? What is the key driver of credit spreads in the long run?

We suggest that credit spread hikes are event-driven and credit spreads remain within a much narrower band when there are no significant financial events. Exhibit 10 shows the historical development of the 30Y credit spread and federal target rate. Vertical lines are added for most of the renowned crises or economically important events, and shading marks the official recession periods announced by NBER. The movement of the Fed target rate and credit spread after each event is recorded in one table in Exhibit 10. It is very interesting to note that the credit spread rises in almost all events and recessions. The Fed cut target rates during each recession, while the rises and falls in the target rate during the events turn out to be 50–50.

We looked more closely at these events and found the reason to be that the monetary policy was adjusted differently during three different categories of events. Type I events are those that can cause inflation or an over-heated economy, like an oil crisis or dot-com bubble. Type II events are those that can increase unemployment or damage growth, typically an S&L crisis or LTCM default. Type III are those that are not critical enough for the Fed to react, for example, those stemming from foreign countries. The typical Fed response would be to raise rates in the first case, cut rates in the second, and remain neutral in the third. In the long run, it is not surprising that there is no correlation at all.

CONCLUSION

This article sheds new light on the relationship between the credit spread and Treasury yield curve. We point out that different risk components in the credit spreads may have different relations with the interest rate. In addition, we present a statistical model that captures the short-term dynamics of credit spreads. In particular, it points out that whether credit spreads widen when the Fed raises its target rate depends on the lagged response of the yield curve. However, in the long run, the focus should be on three things: latent crisis, big events, and recession. They will cause hikes that are not captured in short-term statistical models.

This article proposes various interesting directions for future studies. Due to the limited availability of data, the credit spreads could be clearly analyzed only in the case of AA banks at the moment. A generalization would be

EXHIBIT 9
Scatter Plot: Moody's 30Y BBB Corporate Credit Spread vs. 30Y Treasury Yield at Constant Maturity

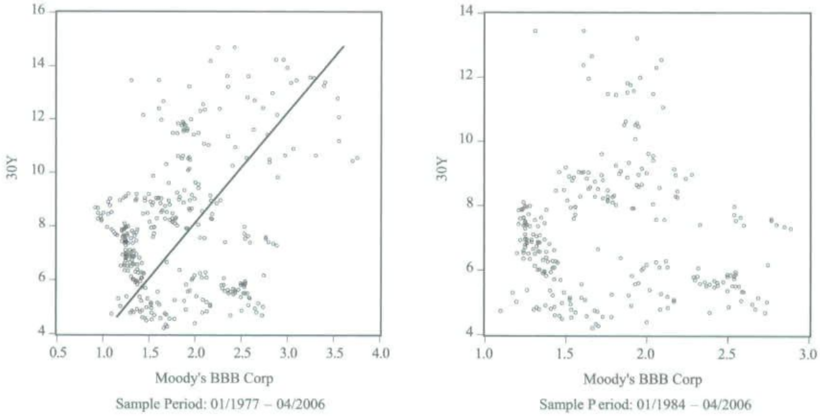
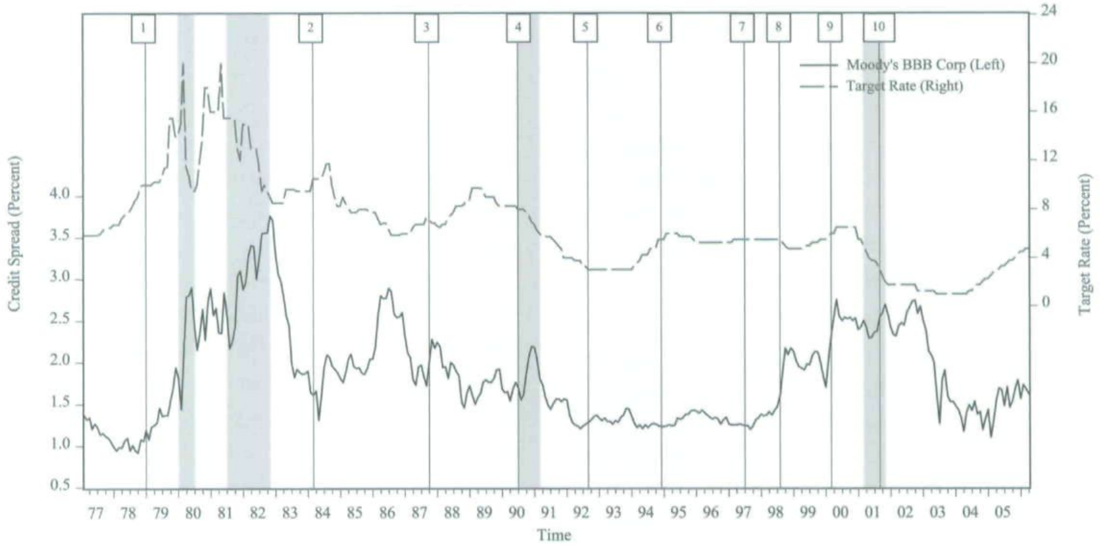


EXHIBIT 10

Moody's 30Y BBB Corporate Credit Spread vs. Federal Target Rate with Events of Financial Significance (Vertical Lines) and Recessions Highlighted (Shades)

Sample Period: 02/1977–04/2006.



Description of Events and Movements of Target Rate and Credit Spread during These Events

	Event	Start	Fed target	Credit spread
1	Second oil crisis	1979m01	↑	↑
2	S&L crisis	1984m03	↓	↑
3	Black Monday stock market crash	1987m10	↑	↑
4	First Gulf War results in third oil crisis	1990m07	↓	↑
5	Black Wednesday, Britain withdrawal from ERM	1992m09	↓	↑
6	Mexico peso economic crisis	1994m12	↑	—
7	Asia financial crisis	1997m07	—	↑
8	Russian default/LTCM	1998m08	↓	↑
9	Dot-com bubble burst	2000m03	↑	↑
10	September 11 terrorist attack	2001m09	↓	↑

possible if new financial instruments become available and liquid or efficient methods are developed to collect existing data. Further studies could also involve taking into account the effect of embedded options. Developing separate theoretical models for downgrade risk and liquidity risk could be useful, whereas the existing research is mostly focused on default risk. In addition, based on the long-term event-driven characteristic of the credit spreads, we suggest further studies using jump functions instead of simple statistics to model long-term behavior. Our study is conducted on U.S. market data; it also would be interesting to test European market data.

APPENDIX I

Within the Merton model, it is assumed that the firm's capital structure consists of debt with a notional amount of K and equity with total value of S(t) at time t. The debt is in the form of zero coupon bonds with maturity T. It has a market price of P(t) and a corresponding yield y(t) at time t. We define today to be time 0. The total firm value V(t) at time t is then the sum of the present value of debt and equity:

$$V(t) = S(t) + P(t) \quad 0 \le t \le T \tag{8}$$

$$\gamma(t) = \frac{\ln(K/P(t))}{T-t} \tag{9}$$

It is assumed that the firm can only default at time T and it defaults when firm value cannot cover debt. Equity holders have the claim on what is left over after the company has paid its debt. They get nothing if the company defaults. That is,

$$P(T) = \min(V(T), K) \tag{10}$$

$$S(T) = \max(V(T) - K, 0) \tag{11}$$

Therefore, stock is just equivalent to a European call option on the underlying firm value V(t) with strike K in this case. It is further assumed that the underlying firm value V(t) follows a stochastic lognormal process with constant volatility and the risk-free rate is r. In this setting, the classical Black-Scholes-Merton option pricing formula can be used to price the stock at time 0.

$$S(0) = V(0)N(d_1) - Ke^{-rT}N(d_2) \tag{12}$$

where

$$d_1 = \frac{\ln(V(0)/K) + (r + \sigma^2/2)T}{\sigma\sqrt{T}} \quad d_2 = d_1 - \sigma\sqrt{T} \tag{13}$$

N( ) is the cumulative normal distribution function. After calculating the stock price at time 0, we could infer the market price of the debt at time 0. In turn, the credit spread over the risk-free rate *csp2* can be calculated from this price and the risk-free rate r. We use the notation csp2 instead of csp1 because in Merton's model only the default risk is captured.

$$P(0) = V(0) - S(0) \tag{14}$$

$$csp2 = \gamma(0) - r = \frac{\ln(K/P(0))}{T} - r \tag{15}$$

$$\frac{\partial csp2}{\partial r} = \frac{1}{T(V(0) - S(0))}\frac{\partial S(0)}{\partial r} - 1 \tag{16}$$

The partial differentiation of S(0) to r is just one of the famous Greeks, ρ, associated with the Black-scholes formula.

$$\rho = \frac{\partial S(0)}{\partial r} = KTe^{-rT}N(d_2) \tag{17}$$

Combining (12), (16), and (17) we get

$$\begin{aligned}\frac{\partial csp2}{\partial r} &= \frac{Ke^{-rT}N(d_2)}{V(0)(1-N(d_1)) + Ke^{-rT}N(d_2)} - 1 \\ &= \frac{-V(0)(1-N(d_1))}{V(0)(1-N(d_1)) + Ke^{-rT}N(d_2)} < 0\end{aligned} \tag{18}$$

Thus, the relation between credit spread and interest rate is negative.

In the classical Merton model, V(0) is assumed to be known and independent of the risk-free rate r. This assumption is criticized in Lesseig and Stock [1998], who argue that a higher risk-free rate would cause the future cash flows to be discounted at a higher rate, thus immediately lowering the current firm value. In the simplest case, imagine that the whole asset of the firm is just a risk-free zero-coupon bond with maturity $\widetilde{T}$ and notional amount $\widetilde{K}$. Hence, the initial firm value V(0) is

$$V(0) = \widetilde{K}\,exp(-r\widetilde{T}) \tag{19}$$

The Equation (8) still holds. That is, the company still finances itself with stock and a bond of maturity T. It is obvious that a change of risk-free rate in this setting would immediately change the current price of the risk-free bond, hence the starting asset value of the company. Without giving the interim steps, we present the derivative of credit spread to interest directly below:

$$\frac{\partial csp2}{\partial r} = \frac{(\widetilde{T} - T)V(0)(1-N(d_1))}{T(V(0) - S(0))} \tag{20}$$

When the maturity of the government bond is longer than the maturity of the company's debt, the right-hand side of (20) is positive.

Thus, under the classical assumption, when interest rate rises, credit spread widens, while in the example described by (9) it works exactly the opposite way.

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