Credit Derivatives and Loan Pricing

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Abstract

We examine the impact of credit default swaps (CDS) on the pricing of bank loans to U.S. corporates. We find that changes in CDS spreads have a significantly positive coefficient and explain nearly 25% of the monthly changes in aggregate spreads on new loans during 2000-2005. Moreover, CDS spreads are the dominant factor driving loan spreads, rendering traditional determinants like the credit spreads of bonds insignificant. Furthermore, over time, loan spreads have become significantly more responsive to the price of risk in the CDS market (but not to other measures of credit risk) and that information from the CDS markets is faster incorporated into credit decisions. This has led to a substantial increase in the extent to which loan spread changes can be explained by market risk factors. We conclude that the new markets for credit derivatives have an important impact on actual financing decisions and have contributed to a more market-based (and less relationship based) loan pricing.

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JEL classification: G10; G21

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1. Introduction

Banks have traditionally priced loans based on relationship arguments. Due to the information obtained by a bank in the lending process, firms cannot easily switch to other banks. This allows banks to build long-term relationship with firms. Consequently, there is less need to fully price current market conditions into loans, enabling banks to insulate firms from swings in market credit conditions. Furthermore, when a firm experiences problems, banks may continue lending at favorable rates in order to maintain the relationship. Banks have also found it difficult to price at competitive rates, simply because of a lack of appropriate benchmarks for loan pricing. Taken together, this has resulted in banks charging smooth rates over time and across borrowers.

The recent advent of credit derivatives has provided banks with a new instrument for managing and pricing credit risk. Credit derivatives, famously dubbed by Alan Greenspan as the most significant financial innovation of the recent decade, are financial instruments that provide protection on credit exposures. In their most common form, the credit default swap (CDS), they insure against the default of a credit in return for periodic payments to a protection seller.[1]

While in the past banks had only few possibilities to insure credit risk, credit derivatives now allow them to hedge a variety of exposures. Although reliable data is difficult to come by, especially large banks seem to make use of this opportunity. For example, Deutsche Bank announced in 2003 that it plans to hedge all loans with a duration of more than 180 days with credit derivatives (Walter, 2003).

Since the prices of credit derivatives represent the costs of hedging credit risk, they should have a bearing upon banks' pricing of loans. Moreover, the possibility of subsequent hedging

[1] The market for credit derivatives is developing rapidly. Only introduced ten years ago, the notional outstanding amount has reached $ 20,200bn in 2006 and is predicted to grow to $ 35,000bn in 2008 (British Bankers' Association, 2006). For the US, the notional market volume has risen from $ 287bn in December 1999 to $ 5,822bn in December 2005 (OCC Bank Derivatives Reports).

may make banks less inclined to invest into a long term relationship with firms and reduce their incentives to price loans based on relationship arguments. And even when banks cannot actually hedge a loan, credit derivatives may still affect its price. Banks have started to calculate pseudo-prices for the exposures on which credit derivatives are not traded.[2] These prices now provide loan officers with an accurate benchmark for the pricing of loans, which was absent before (e.g. Kealhofer, 2002, and The Banker, 2003).

In this paper we examine empirically the impact of credit derivatives on the pricing of loans. We study rates on new bank loans to U.S. corporates and relate them to the spreads on credit default swaps (CDS). We focus on aggregate loan data, which allows us to investigate loan pricing on a monthly basis.[3] Although credit derivatives have been traded since 1996, we consider only the period from 2000 onwards, since only then CDS had become widely used and their pricing reliable.

We find that changes in CDS prices are significant in explaining subsequent changes in loan spreads. The coefficient is near one, suggesting that a one basis point change in the CDS spread causes a one basis point change in the loan spread. Overall, CDS spread changes can explain about 25% of the variation of changes in the loan spread.[4] We also find that CDS have become the by far most important factor determining changes in loan spreads. They render conventional factors of loan pricing, such as the implied volatility in equity markets and the riskless interest rate, insignificant. Furthermore, the natural alternative pricing benchmark, the credit spread of same-rated bonds, cannot explain loan spreads.

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[2] This procedure works as follows: most of the traded references entities in the CDS market have a credit rating by one of the major rating agencies, i.e. average CDS spreads per rating grades can be calculated. By means of the probability of default, banks can map their internal ratings to agency ratings which allows to derive pseudo-CDS spreads for internal rating grades. These spreads can then be used for loan pricing purposes of non-traded but internally rated firms.

[3] For an individual firm, new loans (and thus potential changes in loan rates) occur only very infrequently.

[4] By means of comparison, firm-level studies can explain in total about 25% of bond spread changes using a wide set of explanatory factors (Collin-Dufresne et al., 2001).

We also address the question of whether the risk sensitivity of loan prices has changed over time. We find that the loan market is significantly more responsive to the price of market risk in the CDS market in the second half of our sample. Its explanatory power is more than three times the one of the first half. Interestingly, the higher responsiveness seems to be confined to credit derivative markets: the ability of both the price of risk in the bond market and a measure of physical risk to explain loan spreads has not increased.

Furthermore, we study how long it takes for information from the CDS market to be incorporated into new loans. We find that in order to explain average loan rates in a month in the first half of our example, only information generated in the CDS markets after the third week of the previous month is needed. This suggest that new information is relatively quickly reflected in actual loan decisions. In the second half of the sample, the lag even seems to shorten as then CDS information from the previous month no longer explains loan changes in the current month. Moreover, the coefficients for more contemporaneous innovations in CDS markets increase, indicating a higher weight on more timely information.

Overall, our results suggest that credit derivatives play an important role for the pricing of bank loans and thus for actual financing decisions in the economy. In particular, they seem to have contributed to loan rates reflecting more actual credit market conditions and hence less relationship arguments. We believe that this may have important implications for bank financing, and for the financial system in general.

While our study is the first to examine the impact of credit derivatives prices on the pricing in primary markets, previous literature has focused on the interaction with secondary market prices, that is equity and bond prices (e.g., Hull et al., 2004, Blanco et al., 2005, Houweling and Vorst, 2005, and Norden and Weber, 2006). These studies are based on a higher frequency (as secondary market data is available on a daily basis) and find that a substantial part of the overall price discovery takes place in CDS markets. Our evidence suggest that, with respect to primary markets, the importance of CDS markets is even more pronounced as nearly all loan-specific information is generated in the CDS markets.

Many contributions of the loan pricing literature have focused on explaining differences in loan rates across borrowers (while we consider time-series variations in loan rates). In an early study using detailed firm-level data, Strahan (1999) shows that firm risk affects the interest rate on a loan, but also its non-price terms. Carey and Nini (2004) compare spreads on European and U.S. syndicated loans. They find, after controlling for a variety of factors, European spreads to be significantly smaller than U.S. spreads, which indicates a lack of integration of loan markets.[5] Furthermore, Cook and Spellman (2005) compare prices on loans and bonds of the same borrower. They match prices at the date when a new loan is originated and find that for highly rated firms, loans rates command a premium over bonds, while for lower rated firms they are discounted. An exception from the focus on the cross section are Collin-Dufresne et al. (2001), who study changes in corporate bond spreads over time. They find that variables suggested by theory have some explanatory power but the extend is clearly limited (our results confirm this finding for loan spread changes).

Our study relates to the extensive literature stressing the special role of banks in providing financing (e.g., Leland and Pyle, 1977, Diamond, 1984, Ramakrishnan and Thakor, 1984, and Boyd and Prescott, 1986). In particular, it has been suggested that bank financing provides a benefit to firms because banks can smooth out loan pricing. The empirical evidence indicates that there is both smoothing with respect to interest rate shocks (e.g., Berger and Udell, 1992) and changes in a firm's credit risk (e.g., Petersen and Rajan, 1995, and Berlin and Mester, 1999). Our finding of loans becoming more responsive to market conditions suggests that this role of banks may have diminished in recent years.

[5] An interesting result in our study is that U.S. loan rates are driven by global CDS markets (and not the U.S. CDS market). This suggests that, while loan markets may not be integrated across continents, loan officers at least take into account global credit conditions when pricing loans.

Other recent empirical studies address different aspects of the implications of credit derivatives for bank behavior and lending. Acharya and Johnson (2005) provide evidence for insider trading in the CDS market and show that it is related to the default risk and the number of bank relationships of a traded reference entity. Minton et al. (2006) analyze the motivation of large U.S. banks to engage frequently in the credit derivatives markets. Consistent with our presumption of credit derivatives being used for hedging, they find that the probability of a bank being a net risk hedger is positively linked to the percentage of commercial and industrial loans in a bank's credit portfolio. Goderis et al. (2006) study the impact on the amount of bank lending. They find that subsequent to issuing their first Collateralized Loan Obligation (CLO), banks increase their lending by an amount that more than offsets the actual risk shed in the CLO. This is interpreted as CLOs providing a new risk management tool for banks, allowing them to operate with riskier balance sheets. Marsh (2006) considers the impact of the announcement of a new bank loan on a firm's public debt (as first studied by James, 1987). He presents evidence that the announcement effect is lessened when the lending bank actively trades in credit derivatives. This suggest that the uniqueness of bank loans is eroded through credit derivatives, consistent with our finding of a more market based pricing of loans.

The remaining part of this paper is organized as follows. Section 2 explains the data and presents summary statistics. Section 3 contains the empirical analysis. The final section summarizes and offers conclusions.

2. Description of the data

2.1. Data sources and variables

In this study we analyze time-series of aggregate loan spreads. Using firm-level data suffers from the problem that changes in loan spreads occur only very infrequently, making it difficult to analyze time-series variations. Our aggregate loan spread time series comprises only new loans and thus has the advantage that it always reflects current loan market conditions. Moreover, aggregate series can be observed at a regular frequency (monthly in our study). Studying aggregate data has the additional benefit of allowing inferences about the impact on the average loan in an economy, rather than only for a subset of firms. The obvious shortcoming is that it is more difficult to control for borrower-specific variables, which have been found important in earlier studies (e.g., Strahan, 1999). This should make it more difficult to identify a link between CDS prices and loan rates.

It should also be noted that prices of loans, bonds and CDS may differ due to a variety of institutional characteristics, such as re-negotiation rights in loan contracts, the cheapest to delivery option in some CDS spreads, and different definitions of default risk (for an excellent overview of these issues, see Cook and Spellman, 2005). These features may increase or decrease credit spreads in one market relative to those in other markets. In aggregate data we can hope for some of these differences to cancel out across firms. If the remaining differences are time varying, they are expected to further bias our results against finding a relationship between CDS prices and loans.

Specifically, our data set comprises time series of corporate loan spreads, credit default swap spreads, corporate bond spreads and macroeconomic control variables. First, loan spreads from the U.S. are provided by the rating agency Standard & Poor's for the period January 1998 to March 2006.[6] These spreads are available as monthly averages of first-lien institutional loans to firms with a credit rating of BB/BB- and B+/B. Loans refer to syndicated lending. In addition, loans are priced with floating rates, i.e. they consist of a risk-free rate (usually the swap rate) plus a credit spread. Most important, as mentioned above, loan spreads refer to new-issue loans and not to all (historical) loans outstanding. This fact is crucial

[6] We have also access to loan spread from the Loan Pricing Corporation, London (LPC). We prefer to use S&P loan spreads because these data refers to new loans and not the average of all outstanding loans. In addition, we have also run regressions with secondary market loan spreads obtained from LPC. We found that our main results continue to hold.

because we are interested in the incorporation of price information from the credit derivatives market in new loans. Our data allows us to distinguish between straight spreads (without fees) and all-in spreads (with upfront fee, hypothetically amortized over three years). We decide to consider only straight spreads because (i) credit spreads from the CDS and the bond market do neither include fees, (ii) we found fees not to vary systematically with the straight spread levels, and (iii) the importance of fees compared to total spreads is low.

Second, we use daily credit default swaps (CDS) spreads from CreditTrade (benchmark prices for more than 300 global references entities) and one large universal bank[7] for the six-year period from January 2000 to December 2005. We only consider CDS spreads that refer to senior unsecured corporate debt and have a benchmark maturity of five years. Note that constant maturity CDS spreads are quoted on a daily basis, reflecting the markets most recent assessment of credit risk. As with loans spreads, CDS are quoted above floating rates such as LIBOR or EURIBOR. We also use the information in our data set to create different types of monthly CDS spread indices. For example, we differentiate by regions (global, US, Europe), by rating grades (AAA, AA, ... BBB), and by (monthly averages, end-of-month, end-of-week etc.).

Third, corporate bond spreads are calculated from a monthly time series of Moody's corporate bond yields minus a risk-free rate. We follow previous studies and take the five year plain vanilla swap rate, available from Thomson Financial DataStream, as risk-free benchmark (e.g. Hull et al., 2004, Blanco et al., 2005, Houweling and Vorst, 2005, Norden and Weber, 2006).[8] This makes them comparable to loan and CDS spreads because these are calculated above swap rates as well. Furthermore, we construct monthly averages as well as end-of-month bond spreads. In addition to bond spreads, we consider a set of variables to

[7] The bank requests to stay anonymous. Another potential data source are CDS indices like iTraxx or DJ CDX North America. However, both indices did not exist at the beginning of our sample period and the former not for the U.S.

[8] In a preliminary analysis, we have calculated bond spreads above same-maturity yields of U.S. Treasury bonds. This alternative approach does not alter our main results.

control for the most important macroeconomic determinants of credit spreads (e.g. Collin-Dufresne et al., 2001, Elton et al., 2001). More specifically, we take into account the aggregate stock market information (the S&P 500 returns, the implied volatility index VIX for S&P 500 stock index options from the CBOE), debt markets information (the 5 year swap rate, the term premium calculated as ten-year minus one-year yield), and liquidity of CDS markets (relative bid-ask spread of CDS quotes).

The final data set results from the intersection of the above described variables, leading to monthly time series of 72 observations during the period January 2000 to December 2005.

2.2. Descriptive statistics of key variables

Subsequently, we provide descriptive information on our key variables from the loan, bond and CDS market. Figure 1 depicts the evolution of loan, bond and CDS spreads during the sampling period. We decide to rely on CDS spreads from all global reference entities in our sample because preliminary analysis showed that U.S. loan spreads are driven by global (and not U.S.) CDS spreads.[9]

Insert Figure 1 here

It can be seen that the level of loan spreads is relative high and stable during the period 2000-2002 while we can observe a decrease during the second half of the sample. CDS and bond spreads rise in the first half and decrease, similar to loan rates, in the second half. Note that CDS typically first indicate a change of direction. However, given the previously mentioned institutional differences between spreads from primary loan, CDS and bond markets, it is very interesting that they evolve so similar over time.

[9] The correlation of CDS spread levels for all reference entities and U.S. reference entities is 0.95.

Table 1 displays descriptive statistics such as the time series mean, standard deviation etc. for spread levels and for first differences of spread levels.[10] The two rightmost columns report results from two types of stationarity tests.[11]

Insert Table 1 here

In can be seen that loan spreads L^{B} exhibit a mean of 344 basis points, ranging between 358 and 511 basis points during the sample period. As expected loan spreads for the better rating grade L^{BB} display a lower mean of 277 basis points. CDS spreads, either end-of-month or monthly average, are roughly 82 basis points. Not surprisingly, all time series of spread levels are non-stationary, i.e. they are not suited as inputs for a standard regression analysis. Monthly mean changes of spread levels calculated as first differences of levels (in basis points) amount to -1.26 for L^{B}, 0.18 for B, and 0.52 for C^{eom}. Finally, both stationarity tests clearly reveal that time series of spread changes are stationary for all variables. Consequently, we consider first differences of all variables in the remainder of this paper.

3. Empirical analysis

3.1. The baseline model

The main objective of our study is to investigate whether there is an impact of credit derivatives on loan spreads. Accordingly, we start with a simple regression model to analyze whether there is a significantly positive impact of lagged CDS spread changes on contemporaneous loan spread changes.

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[10] In contrast to Figure 1, we report the actual CDS spread levels and changes (and not scaled values) since these are the spreads used in the subsequent empirical analysis.

[11] The (augmented) Dickey Fuller test refers to a null hypothesis of non-stationarity while the KPSS test refers to a null hypothesis of stationarity.

Before turning to the results some additional explanations are needed. First, note that this model aims to capture causal relationships across markets and not purely statistical associations. Second, we focus on the lowest rated loans in our sample (S&P rating: B), for which we expect the highest variations.[12] Third, we want to take advantage of the most recent information from the CDS market (while still considering causality). Therefore, instead of including changes of monthly averages, we consider lagged changes of end-of-month CDS spreads. This approach is appealing because it is reasonable to assume that loan officers take into account the most recent (and not average) information from the past month (but we will also run regressions with average CDS spreads). Fourth, as mentioned beforehand, we use global CDS spread changes since they seem to dominate the ones of U.S. reference entities.[13] Finally, we include the lagged loan spread change to control for serial correlation of this variable. Alternatively, the lagged loan spread change can be interpreted as a naive benchmark for the lagged CDS spread change. The estimation results of this baseline model are summarized in Table 2.

Insert Table 2 here

It turns out that the baseline model does a surprisingly good job. Most important, the estimated coefficient of lagged CDS spread changes is highly significant (p-val. < 0.01), correctly signed and with a magnitude of 1.15 economically meaningful. In other words, CDS spread changes from the previous month translate roughly 1:1 into loan spread changes during

[12] Our main results also hold, but are somewhat weaker, for loan spread changes of BB-rated firms.

[13] If we include lag one of the global CDS spread change and the corresponding one for U.S. reference entities the former is highly significant with a coefficient of 1.01 while the latter one is insignificant. In separate univariate regressions, both CDS variables are significant but the one for U.S. firms exhibits a smaller coefficient of 0.78.

the current month.[14] Note that this simple model leads to a relatively high R^2 of 0.33.[15] This is interesting because we expected that a model that explains loan spreads would perform worse than models for determinants of corporate bond spread changes, which usually produce R^2 values around 0.25 (e.g. Collin-Dufresne et al., 2001, Blanco et al., 2005). Moreover, the lagged loan spread changes are significantly negative at the 0.05-level but the magnitude is much smaller than the coefficient of the CDS. The negative sign is evidence for serial correlation that leads to a mean-reverting behavior of loan spreads. We re-estimate this model without the lagged dependent variable and obtain a R^2 of 0.25 and a coefficient of 1.01 for ΔC^{eom}_{t-1}.

To our knowledge, this finding represents the first empirical evidence of a significant and positive link between credit derivatives and primary loan markets. In the next section, we extend the baseline model and carry out several tests of robustness.

3.2. Model extensions and tests of robustness

The baseline model provides evidence in favor of a positive spillover effect from the credit derivatives market to loan markets. Subsequently, we check whether this link is robust to the inclusion of additional variables, alternative estimation techniques, and alternative variable definitions.

First, we consider price information from the bond market as a natural candidate that should be controlled for in our baseline model. Table 3, Panel A, reports estimation results for the baseline model augmented by lagged corporate bond spread changes.

Insert Table 3 here

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[14] Taking CDS spreads that are scaled to a rating level of BB in order to adjust for the difference in the underlying default risk does not change qualitatively the result. The corresponding coefficient is 0.38 (p-val. < 0.01).

[15] The number of observations decreases from 72 to 70 months since we lose one month to calculate first differences and another month due to the inclusion of lagged variables.

The key finding is that the relationship detected in the baseline model still holds while the coefficient of bond spread changes is not significant at all. Moreover, the inclusion of bond market information does not help to increase the R^2 of the regression model. In a next step, we take explicitly into account that CDS and bond spread levels as well as spread changes are highly correlated. For this reason, we apply a two-stage approach that is equivalent to orthogonalizing CDS and bond spreads. In the first stage, we extract the information in CDS spread changes which is not explained by bond spread changes. Accordingly, we regress lagged CDS spread changes on lagged bond spread changes. As expected, Panel B shows that there is a highly significant and positive relationship with a coefficient of 0.29. From this first stage regression we obtain residuals (E) which represent the CDS spread change component unexplained by bond market information. In the second stage, we regress contemporaneous loan spread changes on lagged bond spread changes and the unexplained CDS component E from the first stage. Panel C shows that the latter exhibits a significantly positive (p-val. < 0.01) coefficient of 1.09. This finding is very similar to results from the baseline model (we obtain the same results when we directly orthogonalize bond and CDS spread changes). We conclude that the baseline model is robust to the inclusion of bond market information.

Second, we extend the baseline model by a set of variables that have been identified as the most important macroeconomic determinants of credit spread changes in the literature (e.g. Collin-Dufresne et al., 2001). Specifically, we consider lagged changes of the implied equity volatility (ΔVIX), the S&P 500 index (R_SP500), the five year swap rate (ΔSWAP5), the term premium (ΔTERM), and the relative bid-ask spread from the CDS market as a proxy for liquidity (ΔRELS). The latter is an important variable because recent research provides evidence that CDS spreads include, in addition to a compensation for default risk, liquidity premia as well (see Longstaff et al., 2005). Table 4 displays estimations results for the models I-IV.

Insert Table 4 here

The main observation is that lagged CDS spread changes remain highly significant and that the coefficient decreases modestly, from 1.15 in the baseline model (Table 2) to 0.88 (Model I). Moreover, lagged changes of the volatility index (ΔVIX_{t-1}) are significant if we do not include the lagged CDS spread change (Model II). Adding the latter one makes the coefficient of ΔVIX_{t-1} considerably lower and insignificant while the lagged CDS spread change is, as in the baseline model, highly significant (Model III). Finally, we also include the liquidity proxy for the CDS market ($\Delta RELS_{t-1}$) and find that its coefficient is not significantly associated with loan spread changes whereas the CDS spread changes remains highly significant (Model IV). Interestingly, adding macroeconomic control variables does not increase the adjusted R^2 of the full model.

Third, one may argue that loan and CDS spread levels are cointegrated. If this is true, then information about the adjustment towards the long run equilibrium can be used to improve upon our analysis of spread changes. Hence, we estimate a vector error correction model (VECM) for loan spreads, CDS spreads, and the five year swap rate as risk-free rate (which is included in order to obtain cointegration). The results for the short-run model with the loan spread changes as dependent variable are reported in Table 5.

Insert Table 5 here

The findings from the baseline model are confirmed. The error correction term (EC) is significantly negative with a coefficient of –0.07, while the impact of CDS spread changes on loan spreads changes remains basically unchanged. The coefficient for ΔC^{eom}_{t-1} decreases to

0.99 and remains significant at the 0.01-level. Thus, accounting for a cointegration relationship between spread levels does not alter our main result.

Fourth, we conduct some additional tests to examine the sensitivity of the baseline model result to the choice of variables and the model specification. For example, taking the contemporaneous loan spread change of BB-rated firms ΔL^{BB}_{t} as dependent variable leads to the same conclusion. The only noteworthy effect is that the coefficient of the CDS spread change is slightly lower. In addition, replacing the lagged end-of-month CDS spread change ΔC^{eom}_{t-1} by the lagged monthly average CDS spread change ΔC_{t-1} confirms the baseline result in terms of statistical and economic significance (as already said earlier, we prefer the end-of-month measure as loan officers should rationally exploit only the most current information when deciding about loan rates). Furthermore, in place of first differences of spread levels, we include percentage changes as dependent and explanatory variables in the baseline model. The results support those of the baseline model. Finally, instead of running the standard OLS regression with robust standard errors we re-estimate the baseline model using the Newey-West estimator (for a lag length of 3), which also adjusts for serial correlation, and obtain highly similar results.

We conclude that the various model extensions and tests of robustness confirm the results of the baseline model.

3.3. Lag length and responsiveness of loan spread changes over time

We now ask whether the average lag length (or: response time) of loan markets to incorporate information from the CDS market and the magnitude of the CDS impact on loan rates changes over time. Practioners' statements would suggest that loan spreads both incorporate CDS information in a more timely fashion and are more responsive (or more sensitive) to CDS spreads in more recent years.

We analyze these questions with two different tests. First, we add the contemporaneous average monthly CDS spread change ΔC_t as explanatory variable to the baseline model and run separate regressions for the first (March 2000 – January 2003) and the second half of our sample (February 2003 – December 2005). We include the contemporaneous average monthly CDS spread change and not the corresponding end-of-month variable because the latter does not cover the same time interval as the dependent variable. Results are shown in Table 6, Panel A.

Insert Table 6 here

The results indicate a change of the average lag length. While in the first half of the sample the coefficient of the lagged CDS spread change is 1.21 and significant, the contemporaneous CDS spread change is insignificant. In the second half of the sample, the coefficient of the lagged CDS spread change becomes insignificant and the contemporaneous one becomes positive and significant. Taking both results together suggests a decrease of the average time the loan markets needs to incorporate information from the CDS market. Hence, loan officers seem to respond faster to CDS price information during the last three years. Note that the estimated coefficient of ΔC_t takes a value of 2.06 in the second half, supporting the hypothesis that loan spread changes have become more responsive to CDS spread changes in recent years.

The second test uses a more refined approach. We transform daily CDS spreads into end-of-week CDS spreads and calculate the corresponding monthly first differences. Using these weekly rolling monthly CDS spread changes as regressors we can then draw more differentiated conclusions about the average lag length. Specifically, we regress the contemporaneous average monthly loan spread changes on their lag, the lagged monthly bond spread changes, and the lagged monthly end-of-week CDS spread changes. Again, we split the sample in two sub-periods. For each sub-period we run eight regressions, including different end-of-week CDS spreads changes (change between last week of current month and last week of previous month, change between third week of current month and third week of previous month etc.). Results are displayed in Table 6, Panel B. For the first half of the sample, we obtain significantly positive coefficients for ΔC_w for weeks 3, 2, 1 of the current month and week 4 of the previous months. Note that the maximum coefficient of 1.40 is found for week 4 from the previous month. Moreover, all other significant coefficients monotonously decrease the more recent the CDS spread changes are. For the second half of the sample, we get only significant coefficients for weeks from the current month. In addition, all significant coefficients are equal to or larger than one. Comparing results for both sub-samples, it can be seen that the loan market now reacts more to recent CDS information. For example, while the maximum coefficient of ΔC_w is observed in the week 4 of the previous month in the first half, the same coefficient is no longer significant in the second half. Instead, CDS information from the current month becomes more important in terms of statistical and economic significance. The maximum coefficient is now observed for week 3 of the current month. Considering the R^2 values gives a similar picture.

Summarizing, our analysis provides evidence that loan spread changes reflect information from the CDS market more timely and that the loan market has become more responsive during the last years. In other words, there is a shift from a lead-lag relationship between both markets towards a contemporaneous one.

3.4. Sensitivity of loan spread changes to alternative risk measures

We now ask if alternative risk measures are useful to explain loan spread changes over time. The main idea is to analyze whether non-spread information (rather than spread information) from the CDS, bond and stock market has an impact loan spread changes. This explicitly allows to capture time-varying risk premia (see Elton et al., 2001, and Amato, 2005, for similar arguments). We first define variables reflecting the market price of risk in the CDS and bond market (MPR_C = average CDS spread for AAA-/AA-rated firms – average CDS spread for BBB-rated firms; MPR_B = average bond spread for AAA-rated firms – average bond spread for BBB rated firms). This variable captures the difference of the compensation for high and low default risk over time. It contains more information than average CDS and bond spread levels since it reflects changes in the risk premia during the sample period. In addition, we consider the implied volatility index VIX, which is a well-known stock market based measure for default risk. Figure 2 displays the time series of these alternative risk measures.

Insert Figure 2 here

It can be seen that MPR_C and MPR_B have nearly the same average.[16] However, the price of risk in the CDS market is lower (higher) than in the bond market in the beginning and end (middle) of the sample. The VIX is relatively high in the first sample and decreases similar to the other measures in the second half of the sample. Interestingly, the correlation between VIX and MPR_C is 0.70, whereas the correlation between the VIX and the bond market risk MPR_B is much smaller (0.42). This evidence is line with results from Norden and Weber (2006) who find that the co-movement of the stock and CDS market is considerably stronger than the link between the stock market and bond market.

Subsequently, we regress contemporaneous loan spread changes on ΔMPR_C_{t-1} and ΔMPR_B_{t-1} respectively during the first and second half of the sample to study whether risk premia from the CDS or bond market have an impact on the loan market. Table 7, Panel A and B report the estimations results.

[16] The time-series mean of MPR_C (MPR_B) is 75.1 (93.5) basis points. The correlation ρ_{MPR_C, MPR_B} amounts to 0.76.

Insert Table 7 here

For the CDS market, we find that the lagged price of risk is not significantly related to contemporaneous loan spread changes in the first half. In contrast, the coefficient is significantly positive and amounts to 1.64 in the second half. Moreover, the R^2 rises considerably from 0.0857 to 0.2129. Hence, the CDS price of risk has become more important for loan pricing in recent years. For the bond market, the lagged price of risk is not significant in both sub-periods, indicating that this information is not reflected in loan spreads. Finally, we examine whether information from the stock market is relevant for loan pricing. For this purpose, we test if lagged changes of the VIX, which represents a physical measure of default risk, are significantly related to contemporaneous loan spread changes. As shown in Panel C, we find that this is indeed the case. In both samples there is a significantly positive impact of lagged implied volatility changes on current loan spread changes. However, the coefficient decreases slightly from 4.48 (p-value: 0.004) in the first half to 4.39 (p-value: 0.043) in the second half. Consequently, volatility is a relevant factor as well but its importance seems to decrease slightly over time.

These results suggest that loans spreads have become more sensitive to CDS market information in recent years. By contrast, they have neither become more sensitive to information from the bond market nor to the implied volatility.

4. Conclusions

The markets for credit derivatives have provided banks with new instruments for managing and pricing credit risk. In this paper we have examined the impact on the pricing of bank loans to U.S. corporates. We found that derivatives prices, as observed in credit default swaps (CDS), have become the dominant factor explaining changes in loan spreads.

Moreover, the market risk implied by credit derivatives prices can increasingly well explain fluctuations in loan spreads, indicating that loan pricing now reflects more actual market conditions rather than relationship arguments.

A more competitive pricing of risks should of course be welcomed by leading to a more efficient allocation of resources in the financial system. However, there are also downsides (e.g. Loan Pricing Corporation, 2003). For example, it may induce more volatility into the financing costs of firms. A more market-oriented pricing also suggests that banks may be less willing to subsidize firms which experience adverse credit conditions. This may impose significant costs for firms reliant on bank financing.

There are also potential implications for financial stability. Banks have been credited with exercising a stabilizing influence over the business cycle since their loan decisions are less procyclical than market financing. An increasing dependence of loan rates on market prices may reduce this effect and may potentially amplify business cycle volatility. Further research in this field may consider our study as a starting point and could differentiate our findings by different types of financial systems, banks and borrowers.

References

Acharya, V., Johnson, T. (2005): Insider Trading in Credit Derivatives, Working Paper, September 2005, forthcoming *Journal of Financial Economics*.

Amato, J. (2005): Risk aversion and risk premia in the CDS market, *BIS Quarterly Review*, December 2005, 55-68.

Berger, A., Udell G. (1992): Some evidence on the empirical significance of credit rationing, *Journal of Political Economy*, 100, 1047-1077.

Berlin, M., Mester, L.J. (1999): Deposits and Relationship Lending, *Review of Financial Studies*, 12, 579-607.

Blanco, R., Brennan, S., Marsh, I.W. (2005): An Empirical Analysis of the Dynamic Relation between Investment-Grade bonds and Credit Default Swaps, *Journal of Finance,* 60, 2255-2281.

Boyd, J., Prescott E. (1986): Financial Intermediary Coalitions, *Journal of Economic Theory,* 38, 211-32.

British Bankers' Association (2006): Credit Derivatives Report.

Carey, M., Nini, G. (2004): Is the corporate loan market globally integrated? A pricing puzzle, Working Paper, forthcoming *Journal of Finance*.

Collin-Dufresne, P., Goldstein, R.S., Martin, J.S. (2001): The Determinants of Credit Spread Changes, *Journal of Finance*, 56, 2177-2207.

Cook, D., Spellman, L. (2005): The relative rates on a firm's bank loans and public debt: The pricing influences of loan special value vs. private information, Working Paper, January 2005.

Diamond, D. (1984): Financial Intermediation and Delegated Monitoring, *Review of Economics Studies*, 51, 393-413.

Elton, E.J., Gruber, M.J., Agrawal, D., Mann, C. (2001): Explaining the Rate Spread on Corporate Bonds, *Journal of Finance*, 56, 247-277.

Goderis, B., Marsh I, Vall Castello, J., Wagner W. (2006): Bank Behavior with Access to Credit Risk Transfer Markets, mimeo Cass Business School

Houweling, P., Vorst, T. (2005): Pricing default swaps: empirical evidence, *Journal of International Money and Finance*, 24, 1200-1225.

Hull, J.C., Predescu, M., White, A. (2004): The relationship between credit default swap spreads, bond yields, and credit rating announcements, *Journal of Banking and Finance*, 28, 2789-2811.

James, C. (1987): Some Evidence on the Uniqueness of Bank Loans, *Journal of Financial Economics*, 17, 113-134.

Kealhofer, S. (2002): The Economics of the Bank and of the Loan Book, Moody's/KMV.

Leland, H., Pyle, D. (1977): Informational Asymmetries, Financial Structure and Financial Intermediation, *Journal of Finance*, 32, 371-87.

Loan Pricing Corporation (2003): Europe counts the cost of relationship lending as alternative pricing benchmarks gather force, March 25, 2003.

Longstaff, F.A., Mithal, S., and Neis, E. (2005): Corporate yield spreads: default risk or liquidity? New evidence from the credit-default swap market, *Journal of Finance*, 60, 2213-2253.

Marsh, I. (2006): The Effect of Lenders' Credit Risk Transfer Activities on Borrowing Firms' Equity Returns, mimeo Cass Business School.

Minton, B., Stulz, R., Williamson, R. (2006): How much do banks use credit derivatives to reduce risk? Fisher College of Business, Working Paper No. 2006-03-001, June 2006.

Norden, L., Weber, M. (2006): The co-movement of credit default swap, bond and stock markets: an empirical analysis, update of CEPR Discussion Paper No. 4674, CEPR, London, revise & resubmit to *European Financial Management*.

Petersen, M., Rajan, R. (1995): The effect of credit market competition on lending relationships, *Quarterly Journal of Economics*, 110, 407-443.

Ramakrishnan, R., Thakor, A. (1984): Covenants and Collateral as Incentives to Monitor, *Review of Financial Studies,* 51, 415-32.

Strahan, P. (1999): Borrower risk and the price and nonprice terms of bank loans, *Federal Reserve Bank of New York Staff Reports*, No. 90.

The Banker (2003): Credit Derivatives' knock-on effects, June 9, 2003.

Walter, N. (2003): Ratingagenturen fordern mehr Transparenz bei Kreditderivaten, Handelsblatt, March 11, 2003, 25.

Table 1: Descriptive statistics of key variables

This table reports the mean, standard deviation (SD), minimum, median, and maximum of spread levels and first differences of spread levels (spread changes) in basis points. The column DF indicates the p-value from a Dickey-Fuller test of the null hypothesis “time series is non-stationary” while the column KPSS reports the result from a Kwiatkowski, Phillips, Schmidt, Shin-test of the null hypothesis “time series is stationary”.

Type	Description	Variable	Mean	SD	Min	Median	Max	DF p-val.	KPSS result
Levels	Loan spread B	L^{B}	344.51	61.44	235.23	358.25	511.07	0.831	No
	Loan spread BB	L^{BB}	277.38	63.55	168.54	291.62	425.00	0.798	No
	Bond spread	B	250.67	90.43	85.83	248.60	423.19	0.611	No
	CDS spread eom	C^{eom}	82.47	37.67	24.27	70.95	199.53	0.314	No
	CDS spread mean	C	82.26	37.06	27.84	71.16	187.83	0.336	No
First differences	Loan spread B change	ΔL^{B}	-1.26	29.83	-96.70	0.00	96.20	0.000	Yes
	Loan spread BB change	ΔL^{BB}	-1.59	27.60	-81.25	-2.03	80.00	0.000	Yes
	Bond spread change	ΔB	0.18	17.91	-30.17	-2.70	63.38	0.007	Yes
	CDS spread eom change	ΔC^{eom}	0.52	14.55	-35.10	-1.03	57.23	0.000	Yes
	CDS spread mean change	ΔC	0.49	11.94	-33.61	-0.39	46.77	0.000	Yes

Table 2: The baseline model

The dependent variable is the contemporaneous loan spread change ΔL^{B}_{t}, explanatory variables are the lagged dependent variable ΔL^{B}_{t-1} and the lagged end-of-month CDS spread change ΔC^{eom}_{t-1}. P-values are calculated from robust standard errors.

Dep. Var.: ΔL^{B}_{t}	Coeff.		p-val.
ΔL^{B}_{t-1}	-0.26	**	0.034
ΔC^{eom}_{t-1}	1.15	***	0.000
Const.	-1.72		0.567
Obs.	70		
R^2	0.3338		

Table 3: The baseline model including bond spread changes

Panel A: Baseline model with lagged bond spread changes

The dependent variable is the contemporaneous loan spread change ΔL^B_t, explanatory variables are the lagged dependent variable ΔL^B_{t-1}, the lagged bond spread change ΔB_{t-1}, and the lagged end-of-month CDS spread change ΔC^{eom}_{t-1}. P-values are calculated from robust standard errors.

Dep. Var.: ΔL^B_t	Coeff.		p-val.
ΔL^B_{t-1}	-0.27	**	0.039
ΔB_{t-1}	0.01		0.971
ΔC^{eom}_{t-1}	1.15	***	0.000
Const.	-1.73		0.567
Obs.	70		
R^2	0.3367		

Panel B: CDS-bond relationship (stage 1)

The dependent variable is the lagged end-of-month CDS spread change ΔC^{eom}_{t-1} and the explanatory variable is the lagged bond spread change ΔB_{t-1}. P-values are calculated from robust standard errors.

Dep. Var.: ΔC^{eom}_{t-1}	Coeff.		p-val.
ΔB_{t-1}	0.29	***	0.002
Const.	0.36		0.828
Obs.	70		
R^2	0.1312		

Panel C: Impact on loan spread changes (stage 2)

The dependent variable is the contemporaneous loan spread change ΔL^B_t, explanatory variables are the lagged bond spread change ΔB_{t-1} and the residual E from stage 1 (Panel B). The residual E represents the component of the lagged CDS spread change that is unexplained by the lagged bond spread change. P-values are calculated from robust standard errors.

Dep. Var.: ΔL^B_t	Coeff.		p-val.
ΔB_{t-1}	0.25		0.217
E	1.09	***	0.000
Const.	-0.97		0.756
Obs.	70		
R^2	0.2657		

Table 4: Alternative models with macro variables

The dependent variable is the contemporaneous loan spread change ΔL^{B}_{t}. Explanatory variables are the lagged dependent variable ΔL^{B}_{t-1}, the lagged bond spread change ΔB_{t-1}, the lagged change of the implied volatility ΔVIX_{t-1} the lagged change of the S&P 500 index return R_SP500_{t-1}, the lagged change of the five year swap rate $\Delta SWAP5_{t-1}$, the lagged change of the term premium $\Delta TERM_{t-1}$ (10 year risk-free rate – 1 year risk-free rate), the lagged relative bid-ask spread from the CDS market $\Delta RELS_{t-1}$, and the lagged end-of-month CDS spread change ΔC^{eom}_{t-1}. P-values are calculated from robust standard errors.

Dep. Var.:	Model I			Model II			Model III			Model IV		
ΔL^{B}_{t}	Coeff.		p-val.	Coeff.		p-val.	Coeff.		p-val.	Coeff.		p-val.
ΔL^{B}_{t-1}	-0.30	**	0.031	-0.24	*	0.098	-0.26	**	0.038	-0.27	**	0.031
ΔB_{t-1}	0.20		0.505	-0.06		0.782	-0.06		0.768	0.19		0.497
ΔVIX_{t-1}	0.59		0.754	4.72	***	0.001	1.53		0.320	0.31		0.874
R_SP500_{t-1}	-0.98		0.505							-1.42		0.334
$\Delta SWAP5_{t-1}$	22.29		0.278							21.69		0.289
$\Delta TERM_{t-1}$	0.02		0.894							-0.04		0.827
$\Delta RELS_{t-1}$										2.99		0.211
ΔC^{eom}_{t-1}	0.88	***	0.009				0.94	***	0.003	0.89	***	0.009
Const.	-1.02		0.726							-0.60		0.835
Obs.	70			70			70			70		
Adj. R^2	0.300			0.216			0.304			0.303		

Table 5: Vector error correction model for loan spread changes

This table shows VECM estimation results for the equation with the contemporaneous loan spread change ΔL^B_t as dependent variable. Explanatory variables are the error correction term EC which explicitly considers for cointegration of loan and CDS spreads, the lagged dependent variable ΔL^B_{t-1}, the lagged end-of-month CDS spread change ΔC^{eom}_{t-1}, and the lagged change of the five year swap rate $\Delta SWAP5_{t-1}$. P-values are calculated from robust standard errors.

Dep. Var.: ΔL^B_t	Coeff.		p-val.
EC	-0.07	*	0.095
ΔL^B_{t-1}	-0.26	***	0.008
ΔC^{eom}_{t-1}	0.99	***	0.000
$\Delta SWAP5_{t-1}$	11.43		0.297
Const.	-0.77		0.795
Obs.	70		
R^2	0.3721		

Table 6: Responsiveness of loans spread changes to CDS spread changes over time

Panel A: Results for the baseline model by sub-periods

The dependent variable is the contemporaneous loan spread change ΔL^B_t, explanatory variables are the lagged dependent variable ΔL^B_{t-1}, the contemporaneous average monthly CDS spread change ΔC_t, and the lagged end-of-month CDS spread change ΔC^{eom}_{t-1}. P-values are calculated from robust standard errors.

	First half of sample			Second half of sample		
Dep. Var.: ΔL^B_t	Coeff.		p-val.	Coeff.		p-val.
ΔL^B_{t-1}	-0.31	*	0.084	-0.00		0.983
ΔC_t	-0.01		0.965	2.06	**	0.016
ΔC^{eom}_{t-1}	1.21	***	0.001	-0.85		0.168
Const.	-1.06		0.820	-1.71		0.603
Obs.	35			35		
R^2	0.4662			0.2451		

Panel B: Average lag length and responsiveness of loan spread changes by sub-periods

The dependent variable is the contemporaneous loan spread change ΔL^B_t, explanatory variables are the lagged dependent variable ΔL^B_{t-1}, the lagged bond spread changes ΔB_{t-1}, and the lagged end-of-week CDS spread change ΔC_w from the indicated month and week respectively. P-values are calculated from robust standard errors.

Dep. Var.: ΔL^B_t		First half of the sample				Second half of the sample			
Month	Week w	Coeff. of ΔC_w		p-val.	R^2	Coeff. of ΔC_w		p-val.	R^2
Current month	4	0.17		0.659	0.1127	1.39	**	0.046	0.2031
	3	0.62	**	0.042	0.1808	1.53	***	0.003	0.3053
	2	0.81	***	0.006	0.2448	1.00	***	0.001	0.1753
	1	1.02	***	0.008	0.3036	1.04	**	0.013	0.1379
Previous month	4	1.40	***	0.000	0.4286	0.58		0.209	0.0383
	3	0.82		0.200	0.1848	0.89		0.170	0.0796
	2	-0.03		0.940	0.1072	0.92		0.240	0.1237
	1	-0.62		0.289	0.1623	0.93		0.335	0.0988

Table 7: The impact of alternative risk measures on loan spread changes over time

Panel A: Price of risk from CDS market

The dependent variable is the contemporaneous loan spread change ΔL^B_t, the explanatory variable is the lagged change of the price of risk from the CDS market ΔMPR_C_{t-1}. MPR_C is defined as the difference between CDS spreads of BBB- and AAA/AA-rated firms. P-values are calculated from robust standard errors.

	First half of sample			Second half of sample		
Dep. Var.: ΔL^B_t	Coeff.		p-val.	Coeff.		p-val.
ΔL^B_{t-1}	-0.31		0.291	-0.22		0.192
ΔMPR_C_{t-1}	0.40		0.453	1.64	**	0.040
Const.	1.36		0.797	-0.71		0.837
Obs.	35			35		
R^2	0.0857			0.2129		

Panel B: Price of risk from bond market

The dependent variable is the contemporaneous loan spread change ΔL^B_t, the explanatory variable is the lagged change of the price of risk from the bond market ΔMPR_B_{t-1}. MPR_B is defined as the difference between bond spreads of BBB- and AAA-rated firms. P-values are calculated from robust standard errors.

	First half of sample		Second half of sample	
Dep. Var.: ΔL^B_t	Coeff.	p-val.	Coeff.	p-val.
ΔL^B_{t-1}	-0.22	0.404	-0.07	0.685
ΔMPR_Bond_{t-1}	0.46	0.138	-0.29	0.673
Const.	1.45	0.810	-4.17	0.331
Obs.	35		35	
R^2	0.0739		0.0081	

Panel C: Implied volatility (VIX)

The dependent variable is the contemporaneous loan spread change ΔL^B_t, the explanatory variable is the lagged change of the implied volatility index ΔVIX_{t-1}. P-values are calculated from robust standard errors.

	First half of sample				Second half of sample	
Dep. Var.: ΔL^B_t	Coeff.		p-val.		Coeff.	p-val.
ΔL^B_{t-1}	-0.29		0.163		-0.16	0.280
ΔVIX_{t-1}	4.48	***	0.004	**	4.39	0.043
Const.	1.83		0.727		-2.27	0.532
Obs.	35				35	
R^2	0.3011				0.1371	

Figure 1: Time series of loan, bond and CDS spread levels

All spread levels are presented in basis points. Loan spreads represent monthly averages of loans to U.S. corporates with a S&P rating of B. Bond Spreads are monthly averages of U.S. corporate bonds with a Moody's rating of BBB and are calculated above the five year swap rate. CDS spreads refer to the average of end-of-month spreads from all references entities in our sample and are proportionally scaled to reflect the same average default risk as loan spreads.

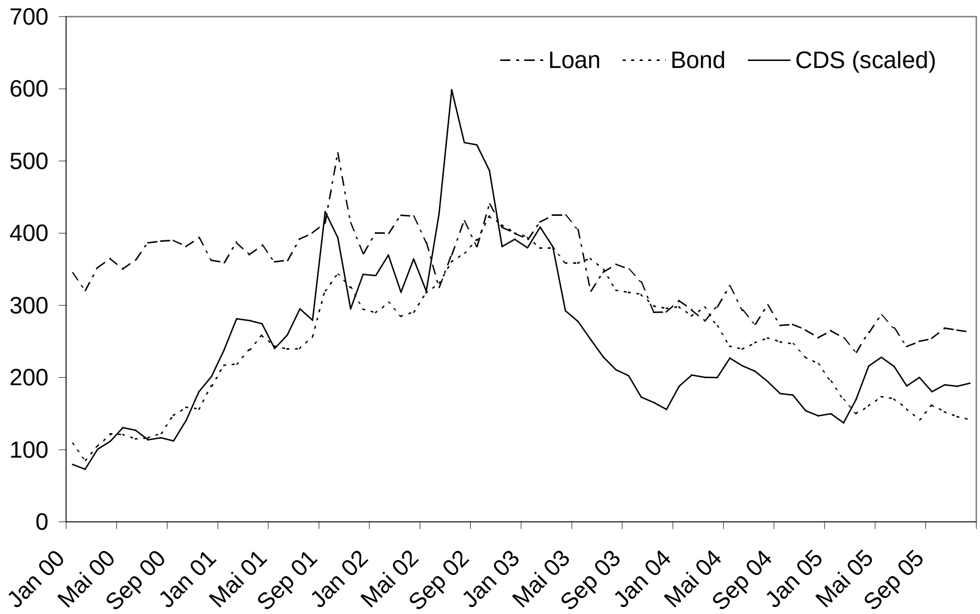

Figure 2: Market price of risk and implied volatility

This figure plots time series of the price of risk from the CDS (MPR_C) and bond market (MPR_B) during the period 2000 to 2005. MPR_C (MPR_B) is defined as the difference between CDS (bond) spreads of BBB- and AAA-rated firms. The left axis indicates the price of risk-measures and is scaled in basis points. In addition, we display the implied volatility index VIX as physical risk measure from the stock market (right axis in %).