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Correlation in credit risk changes

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ABSTRACT

The current economic climate makes understanding credit risk correlation particularly important. After allowing for a comprehensive set of observable firm-specific, industry, market, and macroeconomic factors, there is an economically significant co-movement in credit default swap spreads that remains to be explained. Including a time dummy completely accounts for the remaining co-movement, confirming the existence of a systematic component that has been previously unaccounted for. Our findings suggest that it may be important to consider unobservable risk factor(s) in credit risk models.

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1. Introduction

Understanding the causes of correlated credit losses is crucial for many purposes, such as managing portfolios, setting capital requirements for banks, and pricing structured credit products that are heavily exposed to correlations in credit risk. Although it is well known that credit risks across firms are correlated, there is much ambiguity regarding determinants of credit risk correlation. This lack of understanding poses serious challenges for investors, practitioners, and regulators and may be one of the factors contributing to the latest financial crisis. This paper attempts to increase our knowledge in this area.

Our study explores the economic importance of unobservable risk factors in credit spread changes. Many credit models are based on the doubly stochastic assumption that, conditional on observable risk factors, credit events are independent of each other. Evidence in the empirical literature shows, however, that observable factors cannot fully account for the correlation in default intensity (Das et al., 2007; Duffie et al., 2009). Jorion and Zhang (2007) document strong contagious effects among firms influenced by bankruptcy. On the basis of these findings, some researchers incorporate other risk factors, such as counterparty risk or contagion, in credit models (Collin-Dufresne et al., 2003; Duffie et al., 2009; Giesecke, 2004; Jarrow and Yu, 2001; Schönbucher and Schubert, 2001). Because these other factors are difficult to measure, we refer to them in this paper with the umbrella term "unobservable factors".[1]

Although there is evidence that the doubly stochastic assumption may not hold in defaults (Das et al., 2007; Duffie et al., 2009), whether this assumption holds in the credit market is more ambiguous. Collin-Dufresne et al. (2001) find that regression residuals are largely driven by a single common systematic component that cannot be explained by the usual macroeconomic factors. In contrast, Cremers et al. (2008) and Ericsson et al. (2009) find only weak evidence of a residual common factor. We aim to add to this debate.

We focus on the correlation in *changes* in credit risk instead of correlation in the *levels* of credit risk for three reasons. First, changes in credit risk are more important for portfolio management than levels of credit risk, as fund managers or banks may self-select into a portfolio comprising high credit risk or low credit risk borrowers. While the level of credit risk can be more easily managed, portfolio values are extremely sensitive to changes in

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[1] What constitutes unobservable factors? One example is the loosening of lending standards. This loosening of standards has been a major contributor to the increases in credit risk in the past few years, and this dimension cannot be captured by the commonly used observable risk factors. Other examples that are difficult to measure include the market's time-varying appetite for credit risk or accounting quality. Failure to capture such risk factors leaves some correlations in credit risk unexplained.

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credit risk. Second, scholars have a better understanding of the level of credit risk than of changes in credit risk (Ericsson et al., 2009; Zhang et al., 2009): The R-squared in a level regression is usually above 60%; by contrast, the R-squared in a change regression rarely exceeds 30%. Third, insights from level and change analysis can be quite different, as we explain later in this paper.

We investigate the existence of a missing factor(s) using two methods. The first method, used in prior literature, is the residual principal component analysis (PCA). This method can identify the existence of missing factors, but it cannot measure the magnitude of correlation between credit risk changes. The second method is average pair-wise residual correlation. This method directly gauges the magnitude of the credit risk correlation, an important parameter for the banking industry (for instance, when setting capital requirements). Using a simulation exercise, we show that whenever a regression model misses a factor(s) from the data-generating process, neither the R-squared from the residual PCA approach nor the average pair-wise residual correlation is zero. Therefore, a non-zero residual correlation would suggest a missing factor(s).

Equipped with this insight, we find existence of an unobservable factor(s) in the correlation among credit spread changes. To reach this conclusion, we investigate a comprehensive set of observable factors used in the literature (Collin-Dufresne et al., 2001; Cremers et al., 2008; Tang and Yan, 2010) and their contributions to the correlation in changes in credit risk. On the basis of monthly changes in CDS spreads from January 2001 through December 2006, we find that changes in CDS spreads are positively correlated, with an average correlation of 19% points. Observable variables at the firm level can reduce the correlation by 6% points, resulting in a correlation of 13% points among the regression residuals. The R-squared from the residual PCA method is 14.5%. Market and macroeconomic variables are significantly associated with changes in CDS spreads, with the expected signs of the regression coefficients, and these variables can explain an additional 4% points in regression residual correlations and decrease the R-squared from the residual PCA method to 8.2%. We confirm the existence of an industry effect and find that firms in less cyclical industries have lower correlations in credit risk changes. Industry variables, however, have minimal impact on the correlation in CDS spread changes after we control for firm, market, and macroeconomic variables. Thus, much of the correlation is still unaccounted for.

In addition, once we add time dummies to the regression models, the R-squared of the regression models experiences a huge jump, and both the R-squared from the residual PCA method and the average pair-wise residual correlation fall to zero. This evidence lends further support to the existence of a time-series wise missing factor(s).

We also reconcile our findings with those in the literature (Cremers et al., 2008; Ericsson et al., 2009). We argue that one cannot conclude from a non-zero correlation about the absence of a residual factor. In addition, we have a larger sample size than Ericsson et al. (2009), and we study changes in credit spreads, which offers different insights from the level analysis in Cremers et al. (2008).

Further, we have tried many other factors that have not been used in the literature, such as market liquidity, bank lending standards,[2] and other variables, but none of them can account for the missing factor. Thus, identifying the missing factor(s) remains a task for future research.

Although our study period is short, it includes one full business cycle, and for this reason our results should have general implications. The study period does not include the recent market turmoil. If contagion is a major phenomenon during severe economic downturns, failing to include the recent period of turmoil is biased only against the finding that unobservable factors play an important role. Therefore, our evidence suggests that modeling the unobservable risk factors should be of first-order importance for future research in credit modeling.

The rest of this paper proceeds as follows. In Section 2, we review the doubly stochastic assumption. We describe our variables and data in Section 3 and discuss our methodology in Section 4. We discuss observable risk factors and their contributions to the correlation in changes in credit risk in Section 5. In the last section, we draw a brief conclusion.

2. Doubly stochastic assumption

The two branches of credit risk measurement are the reduced-form approach and the structural approach. Reduced-form models assume that a firm's credit risk varies with changes in macroeconomic conditions (see Duffie and Singleton, 1999; Hull and White, 2001; Jarrow et al., 1995; Lando, 1998). These models assume that observable risk factors are the main drivers of correlations in firm credit risk and that, after controlling for observable factors, credit events should be independent. This is the doubly stochastic assumption. Because of its mathematical tractability, most researchers and practitioners gravitate toward this approach; thus, the doubly stochastic assumption is behind many commonly used reduced-form models to assess credit risk, such as the duration models and the survival time copula models.

In contrast, the doubly stochastic assumption does not play a particular role in the structural models, the second approach, which originates from the Merton (1974) model. The key to structural modeling is to capture the stochastic asset diffusion process. The credit risk correlation between two companies is introduced by assuming that the stochastic processes followed by the assets of the two companies are correlated. Correlation in the stochastic asset diffusion processes of two firms can be caused by both observable and unobservable risk factors. Although the structural models are flexible in modeling correlation in credit risk changes, they are very difficult to implement empirically.

Not surprisingly, the doubly stochastic assumption is the key assumption behind the proprietary models. For instance, Moody's KMV Risk Advisor considers systematic risk factors using a three-level approach: a composite market risk factor, an industry and country risk factor, and regional factors and sector indicators. The factor loading for an individual firm for each of the factors is estimated using asset variances obtained from the option theoretical model. The factor loadings are then used to calculate covariances for each pair of firms. In CreditMetrics, the credit transition matrix is conditioned on a credit cycle index, which shifts down when economic conditions deteriorate. CreditMetrics obtains the credit cycle index from a regression of default rates for speculative grade bonds on the credit spread, 10-year Treasury yield, inflation rate, and growth in gross domestic product (GDP).

There is ample evidence in the literature that macroeconomic conditions influence credit risk. Theoretical models (e.g., Chen, 2010; David, 2008) argue that macroeconomic shocks affect credit spreads and that the addition of macroeconomic variables can help improve a reduced-form model (Jarrow and Turnbull (2000)). Empirical studies have also established the connection between credit risk and various macroeconomic factors. Scholars find a negative relationship between credit risk and the term spread (Estrella and Hardouvelis, 1991; Estrella and Mishkin, 1996; Fama and French (1989)), a positive association between credit risk and credit spread measures (Chen, 1991; Fama and French, 1989; Friedman and Kuttner, 1992; Stock and Watson, 1989), and a negative

[2] The Federal Reserve Board survey on lending standards can be considered one measure of tightening or loosening in lending standards. We have tried this variable among our observable factors, and it does not contribute much to reduction in the average correlation in regression residuals.