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Modeling the dependence structure between default risk premium, equity return volatility and the jump risk: Evidence from a financial crisis

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ABSTRACT

This paper investigates the dependence structure between default risk premium, equity return volatility and jump risk in the equity market before and during the subprime crisis. Using iTraxx CDS index spreads from Japanese and Australian markets, the paper models the different relationships that can exist in different ranges of behavior. We consider several Archimedean copula models with different tail dependence structures, namely, Gumbel, Clayton, Frank, AMH and Joe copulas. Although the dramatic change in the levels of the iTraxx CDS index, we find strong evidence that the dependence structure between CDS and stock market conditions is asymmetric and orienting toward the upper side. In addition, we find that the Japanese CDS market is more sensitive to the stock return volatility than the jump risk and the magnitude of this sensitivity is related to the market circumstances. However, Australian CDS market is more sensitive to the jump risk than stock return volatility before and during the financial crisis. This result has important implications for both global financial stability and default risk management. Specifically, the heterogeneity of markets, coupled with the diversity in the risk exposures cause the default risk premium and equity markets to exhibit different levels of sensitivity.

1. Introduction

The ongoing financial crisis has had dramatic effects on the global financial sector and significant default risk. Subsequently, Japanese and Australian markets face growing bank losses and a cruel market environment accompanied by a slowing economy and fluctuant equity prices. While there are many papers discussing how the subprime mortgages crisis slowdown can affect the economy, regulators, central banks, equity markets and exchange rates movements,[1] there has been little research to explain the dependence structure between default risk premium and equity market during the subprime mortgages crisis. Understanding dependence structure between default risk premium and equity market is important for financial analysts, credit risk management and financial stability.

A growing body of work has used corporate bond prices or single name credit default swap (CDS) spreads as proxy of default risk premium. However, single name CDS spreads are much less liquid than indices and the credit spreads that are inferred from corporate bond prices are affected by tax considerations and illiquidity. In June 2004, the iBoxx and Trac-x CDS indices emerged to form the Dow Jones iTraxx index family. Similar to the stock index, a CDS index is a portfolio of single-name credit default swaps. CDS indices are new instruments that provide investors with market-wide credit risk exposure. The iTraxx CDS index family consists of the most liquid single-name CDS in the Asian and European markets. The iTraxx CDS index provides liquid market prices of credit spreads of different maturities and in different economic sectors. Then, CDS index spreads have become a preferred proxy for default risk premium rather than bond spreads and single name CDS spreads.[2]

This paper examines the nonlinear relationship between stock market conditions and default risk premium before and during the financial crisis. We study the dependence structure between default risk premium (iTraxx CDS index spreads), equity volatility (estimated with GARCH (1,1)) and the jump risks (estimated with the kurtosis of equity return distribution) using copulas. The economic implication behind the kurtosis is that it measures the extreme movement in equity returns and indicates the tendency of jump events.[3] We regard kurtosis as a proxy of jump risk and study how it impacts the iTraxx CDS index.[4]

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[1] For example the works of N'Diaye et al. (2010), Zhang et al. (2010), Ackermann (2008), Dooley and Hutchison (2009) and Fratzscher (2009).

[2] E.g. BystrÖm (2006), Alexander and Kaeck (2008), Tang and Yan (2010).

[3] According to Zhang et al. (2009), skewness is often loosely associated with the existence of jumps in the financial industry, while kurtosis can be formalized as an econometric test of the jump diffusion.

[4] A number of studies connect the kurtosis with jump risk (Drost et al. (1998), Bates (1996), Andersen et al. (2002), Chen et al. (2008)).

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The fraction of the stock market for our purpose is the stock of the reference entities which are part of the iTraxx index portfolio. For that reason, we construct an equally weighted portfolio of the stocks of the reference entities which are part of the iTraxx index portfolio. In addition, we use Archimedean copula functions to explore the dependence structure between stock market conditions and default risk premium. A copula is a function that connects the marginal distributions to restore the joint distribution. Using a copula approach, we can model the different relationships that can exist in different ranges of behavior.

There are many advantages when we use copula functions in analyzing the dependence structure. First, copulas allow us to easily construct multivariate distributions with given univariate margins. Second, the copula function can provide us the degree of the dependence and also the structure of the dependence. It presents a useful tool when modeling non Gaussian data since the Pearson's correlation coefficient is adapted for linear dependence and normal distribution. Third, unlike correlation, copulas do not involve elliptically distributed random variables. As a result, they are especially useful when modeling the dependence between asset returns and default risk. Finally, copulas are invariant to increasing and continuous transformations. For example, dependence structure with copula does not change with returns or logarithm of returns. This is not the case for the correlation, which is only invariant under linear transformations.

Our paper contributes in three ways. First, we expand the very small number of related studies by providing evidence for new issues. We find that the dependence structure between equity return volatility and default risk premium is positive and asymmetric and is increased after the launch of the subprime crisis. Second, we find that the sensitivity of default risk premium to stock market conditions is related to the market circumstances. Third, our finding of significant tail dependence has important implications in credit risk management and financial stability. Tail dependence indicates the extreme co-movements and the potential of a simultaneous large loss in the equity markets and significant default risk. Furthermore, tail dependence is an appropriate measure for systematic risk in times of financial crisis and it allows investors and market participants to measure the probability of simultaneous extreme losses. Ignoring the tail dependence would under estimate default risk premium.

The rest of the paper is organized as follows: Section 2 provides an overview of the relevant literature about the relationship between CDS and equity markets. Section 3 presents copula methodology. Section 4 presents data and preliminary statistics. Section 5 presents estimation results and discussion. The article ends with a conclusion.

2. Literature review

Credit derivatives provide efficient tools of hedging and separating credit risk from other market risk. The motivation of the protection buyer is the management of credit risk. Nevertheless, credit derivatives allow for protection seller to have long positions against different debtors. There are diverse structures of credit derivatives contracts. The most widely traded product is the CDS contract in which the seller of protection receives a periodic payment (premium) from the buyer of protection and pays a one-off payment in the event of default by a reference entity.

Previous studies have empirically investigated relationships between the CDS and equity markets. Benkert (2004) study the influence of volatility of firm value on CDS spread. He finds that option implied volatility measure has the strongest effect on CDS changes; Ericsson et al. (2009) examine the impact of leverage, firm value volatility and interest rates on single-firm CDS concluding that all variables explain the CDS spreads. Cossin and Hricko (2002) find a significant relationship between CDS spreads and equity prices in a cross-section study. Abid and Naifar (2005) examine the impact of stock return volatility of reference entities on Japanese CDS spreads. They find that pairs with higher credit quality present a weaker dependence coefficient and the impact of stock returns volatility on CDS spreads is higher for the lowest credit quality. Berndt and Ostrovnaya (2007) report a significant relationship between CDS and the equity market. Acharya and Johnson (2007) find that there is information flow from the CDS markets to equity markets. This flow occurs only for negative credit news and for entities that subsequently experience adverse shocks. Carr and Wu (2007) find that CDS spreads covary with both the currency option implied volatility and the slope of the implied volatility curve in moneyness. Jorion and Zhang (2007) examine the intra-industry information transfer effect of credit events, as captured in the CDS and equity markets. They find that contagion and competition effects are reliably associated with industry characteristics. Also, contagion effects are better captured in the CDS market than the equity market. Alexander and Kaeck (2008) study the empirical influence of a set of theoretical determinants of CDS spreads on the daily changes in iTraxx Europe. They find that CDS spreads are influenced by stock volatility during periods of CDS market turbulence and are more responsive to stock returns in ordinary market circumstances. Fung et al. (2009) examine the relationship between the stock and CDS markets. They find that the stock market appears to lead both the investment-grade and high-yield CDS markets. Forte and Pena (2009) examine the dynamic relationship between CDS and stock markets, and find that stock markets play a leading role in explaining CDS spreads. Dupuis et al. (2009) provide empirical evidence that the dependence structures between CDS and stock returns can be statistically very different and sensitive to the composition of the portfolio. Norden and Weber (2009) find that CDS market is more sensitive to the equity market than the bond market and the magnitude of this sensitivity is related to the credit quality. Jorion and Zhang (2009) study the impact of a borrower's bankruptcy on its creditors and find that creditors carried significant negative abnormal stock returns and increases in CDS spreads.

As the above literature attests to, the CDS may be linked to the equity market. This paper adds to the literature by providing insight into the relationship between default risk premium, equity return volatility and jump risks before and during the financial crisis. Incorporating jumps risks should better explain the level of credit spreads and default risk premium. Duffie and Lando (2001) find that a jump component is crucial for matching short-term default probabilities and credit spreads. Leland (2006) shows that, with the addition of a jump component, traditional structural models can be made to explain better both default probabilities and credit spread. Zhang et al. (2009) explain the relationship between CDS, equity volatility and jump risk. They find that the volatility risk alone predicts 48% of the variation in CDS spread levels, whereas the jump risk alone forecasts 19%. Tang and Yan (2010) find that model-based variables such as growth rate, growth volatility, investor sentiment, and jump risk, contribute better for explaining CDS spreads.

We adopt the Kurtosis of index return distribution to proxy for the jump risk. The economic implication behind the kurtosis is that it measures the extreme movement in stock index returns and indicates the tendency of jump events. Intuitively, such a jump component has its impact mainly on the tail behavior of the equity prices. Moreover, the majority of researches on default risk premium have concentrated on the estimation of default probabilities from corporate bond data and exploring the determinants and the dynamics of the term structure of credit spreads. Earlier empirical work has been done on single-name CDS products. CDS are much less liquid than indices and the credit spreads that are inferred from corporate bond prices are affected by tax considerations and illiquidity. The iTraxx CDS index provide liquid market prices of credit spreads and depends on its corresponding maturity. The 5-year CDS indexes are commonly considered as the most liquid and are considered a much better proxy for default risk premium.