PRICE DISCOVERY OF CREDIT RISK

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To my wife Fang He and our son Andrew Fangjie Du

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ABSTRACT

PRICE DISCOVERY OF CREDIT RISK

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This study investigates financial markets' price discovery for credit risk across the stock, bond, and credit derivatives markets. This study also examined what factors affect financial market's price discovery for credit risk. Four factors are studied: liquidity, transaction cost, credit ratings and maturities. Using weekly equity, bond and credit default swap market data from January 2000 to October 2007, it is found that stock market and bond market, credit derivative market and bond market are co-integrated for long term credit risk price discovery. In short term, both stock market and credit derivatives market lead the bond market for credit risk price discovery. However, the credit risk price discovery relationship between the stock market and credit derivatives market is unclear both in short term and in long run. The price discovery contribution analysis-Gonzalo and Granger (1996) common factor component and Hasbrouck information share (1995) suggests that stock market provides above 80% of price discovery contribution for credit risk among three markets and credit derivatives market's credit risk price discovery contribution is much less than the stock market, while the bond market contributes the least. Credit ratings only affect the credit risk price discovery among equity, credit derivatives and bond market in long run, but no significant influences of ratings in short term. In long run, high yield rating segments provide more credit risk price discovery than the investment grade rating segments. Little evidence is found in this study about the influences of maturities on the

credit risk price discovery process among equity, bond and credit derivatives market. Finally, from this study it is found that liquidity factor plays a significant role in the financial market's credit risk price discovery, which is consistent with the liquidity and trading cost explanations of other previous price discovery researches.

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CHAPTER 1

INTRODUCTION

This study was developed during a time characterized by two important developments in the credit markets. The first phenomenon was the rapidly forming credit derivative markets, including the credit default swaps (CDS) (see Figure 1-1) and the structured credit market, which includes collateral debt obligations or simply CDOs (see Figure 1-2). The second phenomenon was the United States (US) sub-prime mortgage market crisis, beginning in July 2007. The sub-prime mortgage market turmoil has spread to the other credit markets and equity markets causing general economic instability (see Figure 1-3). As an example, Figure 1-4 displays deterioration of sub-prime mortgage BBB bonds, which declined from 97 in January to 39 in June 2007. The asset backed securities market index (ABX) dropped more than 100% from July and August 2007. With the rise of global credit risk concerns, the market has shifted from the excessive liquidity to credit risk re-pricing resulting in a true credit crunch and crisis.

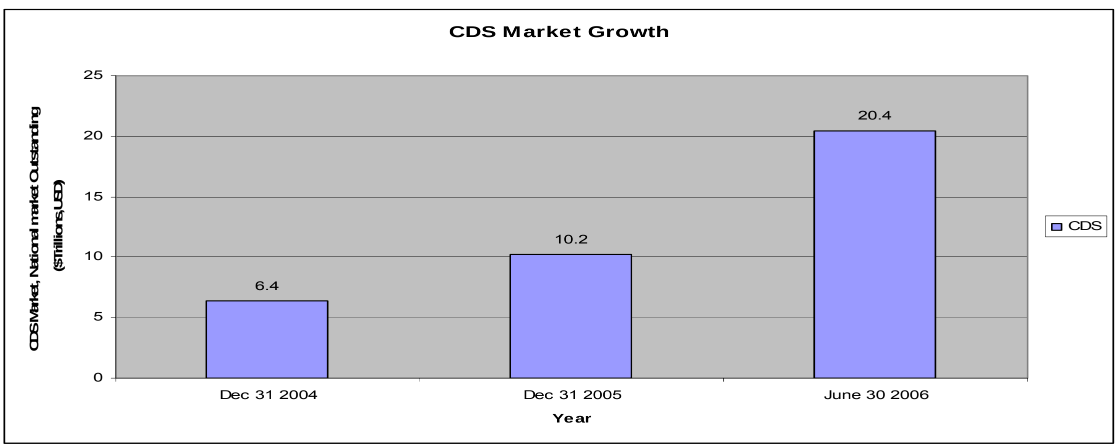


Figure 1-1 Credit Default Swap (CDS) Market Growth (Source: BIS)

The US credit market meltdown in July 2007 has triggered another round of debate on credit risk, an issue that is important but an issue that people do not full comprehend evidenced by the credit market meltdown. Two important questions on credit risk are asked: 1) “How is credit risk priced in the financial markets?” and 2) “How is the credit risk information transmitted among different financial markets?” Credit risk and the credit risk price discovery in financial markets remains an important issue worthy of future research.

Figure 1-2 Structure Credit (Collateral Debt Obligation CDOs) Market Growth (Source: SIFMA)

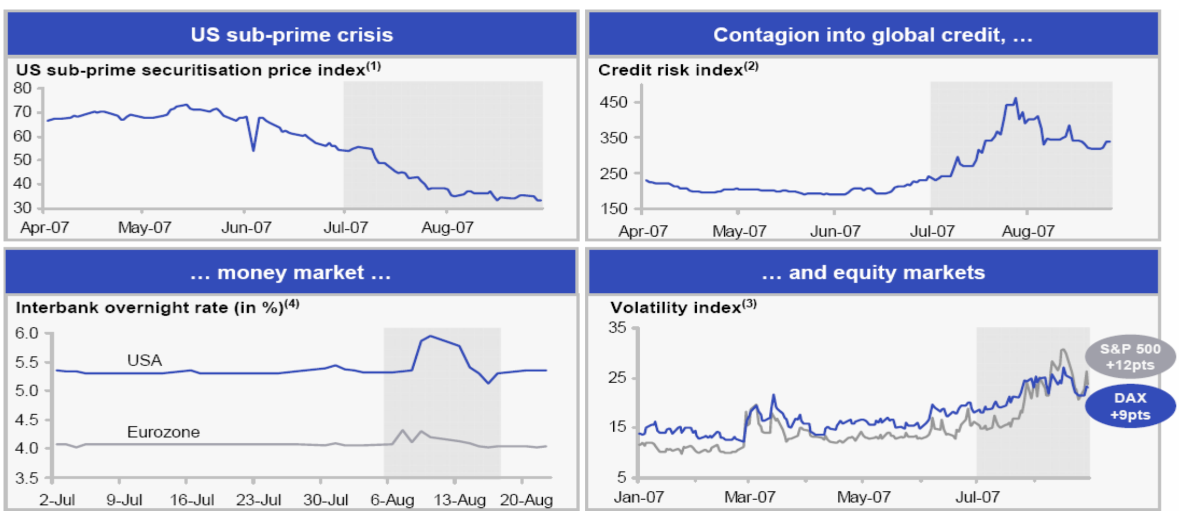


Figure 1-3 US Sub-Prime Crisis and Market Turmoil. (Source: DataStream, Thompson Financial and Deutsche Bank)

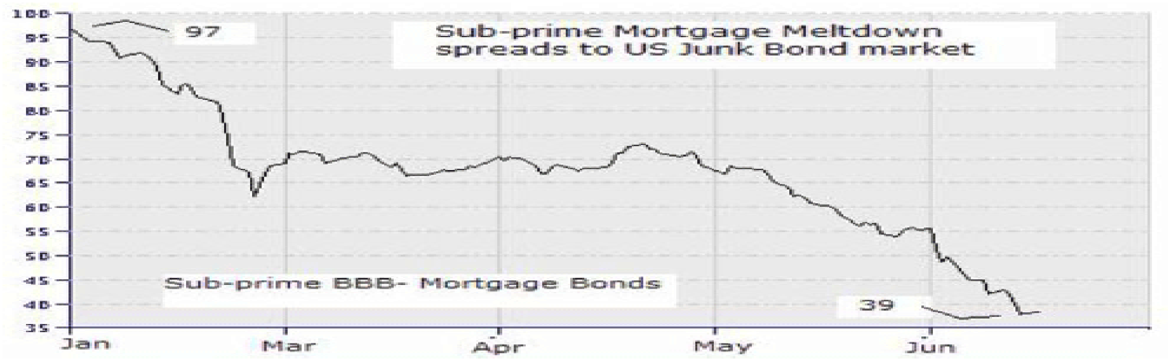


Figure 1-4 US Sub-Prime Mortgage Meltdown Spreads to US Bond Market (Source: Bloomberg)

In the past decade, credit risk research has concentrated on building a theoretical linkage between a corporate borrower's credit risk and financial market based information. Two approaches have been developed to model credit risk: the structural credit risk model and the reduced form credit risk model.

The structural credit risk model approaches to credit risk from a company's equity price by applying Black-Schole's option pricing theory (Merton, 1974), in which defaults happen when a company's asset value falls below its debt value. Instead of using equity price to derive credit risk, the reduced form credit risk model explains credit risk by linking a company's default probability to its bond price (Jarrow, Lando and Turnbull, 1997; Duffie and Singleton, 1999). However, some empirical tests show a limited ability for both the structural model approach and the reduced form models to explain observed credit risk spreads.

Empirical research has not demonstrated how credit risk is priced in different financial markets and which financial market, if any, is the leading indicator of a borrower's credit risk. If the stock market is the leading indicator of credit risk, we should pay more attention to the structural form approach to credit risk. If the bond market is the leading indicator of credit risk, we should focus on the reduced form approach. If neither the stock market nor bond market accurately prices credit risk, we should examine other financial markets, such as credit derivatives market, for credit risk price discovery capabilities.

This study addresses these issues by researching the financial market's credit risk price discovery function. The implication of this study lies in that it will provide empirical evidence of credit risk price discovery across different financial markets and credit risk information transmission across various financial markets. Price discovery refers to the process of how new information on an underlying asset is incorporated into a security price in a market when several closely linked securities are traded in multiple markets (Hasbrouck 1995). Credit risk is priced in several financial markets when the obligor issues various securities. When two or more markets do not react to new information simultaneously, one market will lead the other. When such a lead-lag relation appears, the leading market is said to provide price discovery.

This present research focuses on studying corporate borrowers' credit risk pricing and credit risk information transmission among different financial markets. The research goal is to understand each market capabilities and efficiencies in impounding and pricing a borrower's credit risk. I will address this topic from three aspects:

1) Whether an equilibrium credit risk price discovery relationship exists among different financial markets in the long-run?

2) Which financial market is leading the other markets in pricing an obligor's credit risk? In other words, which market provides price discovery for credit risk?

3) How much does a financial market contribute to overall credit risk price discovery?

This present study contributes to existing credit risk literature in several ways. First, in addition to the widely-studied credit risk research in equity and bond markets, I extend the current study to the developing credit derivatives market, especially the credit default swap (CDS) market. The influence of the burgeoning credit derivatives market on other financial markets' credit risk price discovery mechanism should be studied. Second, this study attempts to investigate what factors affect the financial markets' credit risk price discovery mechanism. Four factors are examined: liquidity, transaction cost, credit ratings, and maturities. Third, by applying Hasbrouck's (1995) information share (IS) and Gonzalo and Granger's (1995) common factor components (CFC) procedure, this study is able to investigate financial markets' credit risk price discovery from a market microstructure standpoint. The information share and common factor components tests will allow me to evaluate the degree to which each financial market contributes to credit risk price discovery. Finally this study employs a robust dataset provided by JP Morgan, which covers almost all important equity, bond, and credit derivatives market securities. To my knowledge, this is an initial comprehensive study of the price discovery of credit risk across different financial markets.

This study is organized as follows: Chapter 2 provides a literature review of credit risk and price discovery; In Chapter 3, research hypotheses are developed; Chapter 4 describes the data. The methodology and research design are described in Chapter 5. Chapter 6 to Chapter 8 reports the empirical results and analysis, and finally Chapter 9 discusses research conclusions and future research.

CHAPTER 2

LITERATURE REVIEW

Credit risk price discovery research studies the pricing of an obligor's credit risk in the financial markets and the pricing information transmitted across financial markets. Credit risk price discovery can be studied by empirically testing the long run equilibrium relationship and the lead-lag relationship of an obligor's credit risk in various financial markets. In this section, I will review the credit risk and price discovery literature. First, an overview of the credit risk literature and the development of credit risk theories are introduced, then price discovery research literature are reviewed, and finally, the current research on price discovery of credit risk is examined.

2.1 Overview of Credit Risk

Credit risk refers to the risk of loss incurred by either an obligor's unwillingness or inability to pay a debt. An obligor's credit risk can be evaluated by analyzing fundamental information, such as financial ratios, or by financial market information, such as changes in security prices. For example, Altman (1968) proposed using Z-score to capture an obligor's credit quality and default probability. An obligor's credit risk measurement, referred to as the Z score, is calculated from a discriminant regression model, in which Z-score is dependent on financial fundamental such as debt structure, financial ratios, etc. The fundamental approach to credit risk is extensively developed by Altman (1968) And Altman (1985).

Another line of credit risk research focuses on market prices of a corporate issuer's securities. Merton (1974) first applied the Black and Scholes option pricing methodology to model credit risk for debt securities. He showed that a stock could be viewed as a call option on the firm with the strike price equal to the face value of a single payment debt issue. Merton's approach is referred to as the "Structural Model" in the sense that it defines a default as the event of when the market value of assets is at or falling below the market value of liabilities, or some exogenous threshold level.

In the structural model, the stock price is the main credit risk driver because the market value of the liabilities is not as volatile as the stock price and usually remains unchanged over a specific time horizon. Building upon Merton's "Structural" framework, theoretical extensions include Leland (1994) and Longstaff and Schwartz (1995) etc. The empirical results of the structural model's ability to explain credit risk are mixed. Early studies indicated that credit yield spreads predicted by Merton (1974) model are far below the market observed corporate-treasury yield spreads. However, other studies have argued that extensions of the Merton model that incorporate certain realistic economic considerations can accurately explain the observed yield spreads. Recently direct tests of structural models conducted by Anderson and Sundaresan (2000) still show mixed results on this approach's explanatory power.

Instead of assuming equity price as a sole credit risk driver, Jarrow and Turnbull (1995) and Duffie and Singleton (1999) assume defaults are exogenous, usually a Poisson process, with a specified recovery rate that is paid upon default. This approach is labeled as the "reduced form" credit risk model since it takes default as an exogenous process rather than an endogenous event, as in the structural model.

The reduced form credit risk model utilizes the market observed credit yield (risk adjusted return) to solve for default probability, recovery rates, and risky debt price. Reduced form models do not post a causal relationship between firm value and default. They are more dependent on the quality of the bond market data and the bond market pricing mechanism. The efforts to develop reduced form models have been made by Letterman and Iben (1991), Jarrow and Turnbull (1995), Jarrow, Lando and Turnbull (1997), Duffie (1998), and Duffie and Singleton (1999). Empirical evidence concerning the effectiveness of reduced form model is also limited.

Duffie (1999) finds that these models have limitations in explaining the observed term structure of credit spreads across firms of different credit risk qualities.

Recently, research has started that evaluates credit risk through the rapidly developing credit derivatives market, the credit default swap (CDS) market in particular, rather than the equity and bond markets. Hull and White (1999) first modeled default probability from the CDS spreads. Later JP Morgan Bank developed another credit risk model from CDS market. However, the empirical evidence and back testing of these models are inconclusive.

In the past decades, credit risk research has experienced a paradigm shift from traditional fundamental approaches to focusing on credit risk pricing based on financial market information. The structural model framework assumes the equity market is efficient in impounding credit risk information, while reduced form model uses bond market prices as a main source of credit risk information. Due to its liquidity and efficiency in pricing and trading credit risk, the credit derivatives market has attracted researchers to develop credit risk models based on this rapidly developing market. However, the empirical evidence supporting these credit risk models is relatively new and results are also mixed and inconclusive. To determine the optimal approach to the study and pricing of credit risk, further empirical investigation is warranted. Presently this important question remains unanswered: which financial market is most efficient in reflecting credit risk? In short, which market provides price discovery for credit risk?

2.2 Overview of Price Discovery

Price discovery refers to the process through which financial markets converge on the equilibrium price of an underlying asset. It is the process of uncovering an asset's full information or intrinsic value. Theoretically, when two markets for the same underlying asset are faced with the new information arriving simultaneously, these markets should react simultaneously and uniformly. When both markets do not react contemporaneously, one market leads the other. With such a lead-lag relationship, the leading market is said to provide price discovery.

The importance of price discovery lies in that, first, it is a necessary feature of efficient and transparent markets. The efficient market hypothesis requires no arbitrage opportunities and market prices that quickly reflect any new information affecting fundamental values. Second, if one market is leading other markets in setting an equilibrium price, then the securities in the other markets are mispriced, at least temporarily. Security prices will eventually converge to equilibrium price set by the leading market. Finally, price discovery study should provide empirical evidence for theoretical modeling of market and credit risk.

Efficient market conditions suggest that all financial markets price the same underlying asset equally and simultaneously. However, trading cost, liquidity, market microstructure, and market imperfections, such as differing tax rates, information asymmetries, and prepayments could distort pure arbitrage relationships.

The empirical research in the area of price discovery is somewhat limited to the analysis of cash and futures markets. Garbade and Silber studied commodity futures. Stoll and Whaley examined US stock index futures. Poskitt has studied New Zealand interest rate futures. Upper and Werner (2002) examined German Bund markets and Mizarach and Neely for US government bond markets. Flemming and Ostdiek (1996) introduced the trading cost hypothesis to explain price discovery, which suggested that the market with the lowest overall trading costs will react first to new information. Booth, Lee, and Tse (1996) also suggested that higher transaction costs may reduce market information efficiency. The general consensus in the price discovery literature is that futures markets tend to lead cash markets due primarily to relatively lower transaction costs in futures markets.

The liquidity explanation of price discovery was examined by Yan and Zivot (2004) in the FX markets. They found that substantial price discovery occurred through the USD markets due to the greater liquidity of this market. The relative liquidity and lower transaction costs of the USD markets are conducive to the efficient assimilation of diverse economic information.

Price discovery is also related to market microstructure. Auction markets, inter-dealer markets, open-outcry markets, computer trading systems and absence of price limits may result in conditions conductive to greater information efficiency and price discovery. Grunbichler et al. (1994) showed that the use of an electronic trading platform in the futures market increased price discovery potential. Berkman and Steenbeek (1998) demonstrated that the absence of daily price limits resulted in greater information efficiency and a higher information share. Tse and Zabotina (2001) found that markets with open outcry have higher market quality than electronic market during volatile periods. Hasbrouck (2003) concluded that, for the S&P500 and Nasdaq-100 indices, price discovery was dominated by electronically-traded futures contracts.

Market imperfections can distort price discovery. Information imperfections and asymmetric signal qualities can decrease price adjustment speed. Taxation, prepayment, options, and different maturities lead to distortion of arbitrage relationship among closely-linked markets. Harris, McInish, and Wood (2002) found in US corporate bond market small issues and implied options often hamper corporate bond pricing.

Finally, Upper and Wener (2002) examined financial markets' price discovery during normal and volatile market conditions. They found that the share of price discovery of the spot market decreased significantly and spot trading simply followed the futures market during more stressful periods. Price discovery was associated with faster trading and wider spreads during more volatile periods.

2.3 Price Discovery of Credit Risk

Prior credit risk research has focused exclusively on testing credit risk models in individual financial markets, such as examining structural models in equity markets or reduced form models in bond markets. Credit risk price discovery research should evaluate credit risk information from all credit-linked financial markets including the bond, equity, and the developing credit derivatives markets.

Several credit risk price discovery studies have focused exclusively on information from just a single or at most two financial markets. For example, Longstaff, Mithal, and Neiss (2004) studied a sample of US bonds and found that the information in equity markets lead bond markets. Blanco, et al. (2004) found price discovery relationships between the credit default swap market and a segment of corporate credit markets by examining the credit default swaps (CDS) spread and bond corporate-treasury yields. It was found that the CDS market dominated the price discovery process while the bond market was not significant.

Blanco, Brennan, and Marsh (2005) analyzed a set of European and US credits by using CDS prices and credit spreads in bond cash market and found that the CDS market was the primary impetus for price discovery. Crouch and Marsh (2005) examined arbitrage relationship between the CDS spreads and asset swap prices. Using data for nine large auto manufacturers with diverse credit ratings, they found that CDS prices led asset swap prices for the majority of these corporations.

Campbell and Hendry (2006) studied high frequency data in the price discovery process in both Canadian and US 10-year government bond markets. They found that price discovery occurred relatively more often in futures markets than in cash markets.

In conclusion, price discovery study for credit risk information across all credit-linked financial markets, stock market, bond market (cash and futures), and credit derivatives market is left unexplored. This present study addresses this gap in the literature by investigating the price discovery of credit risk (using different credit risk measurements) across all three markets: bond, equity, and credit derivates.

CHAPTER 3

RESEARCH HYPOTHESES

Based on credit risk literature and prior price discovery theories, research hypotheses are developed for this present study. Hypothesis one tests whether the stock market or the bond market is the leading indicator of credit risk. Hypothesis two examines the credit derivative market's emerging influences on credit risk price discovery. Hypothesis three focuses on analyzing the stock market, bond market, and credit derivative market's price discovery contributions to credit risk. Hypothesis four examines financial market's credit risk price discovery function for those credits with different credit ratings; Hypothesis five investigates financial market's credit risk price discovery for those credits with different maturities (durations).

3.1 Theory

This section discusses the theoretical relationship between equity, bond market, and credit default swap market in terms of credit risk. The theoretical relationship of equity, bond, and credit default swap market in terms of credit risk is explained by Merton (1974) capital structure-based option pricing theory (OPT). A debt security can be replicated by a synthetic portfolio consisting of a put option and the equity. Merton looked at the debt security as a put option on the equity of a company. Corporate bond investors effectively write European put options to equity owners, who hold a residual claim on the firm's asset value. The trigger of the default event of a company is that the company's asset value falls below the face value (D) of its debt obligations. The face value of the debt is the exercise price of the put option of the equity.

The factors that determine the riskiness of a debt are its duration, firm leverage, and asset value volatility (See Appendix A-Merton Model). Hence, equity and debt are positively correlated. Their correlation increases with higher default risk and leverage, which imply a higher probability that the asset value of the firm may drop below the default threshold. Bond and equity prices should also be cointegrated and share an equilibrium price relationship. Figure 3-1 illustrates the relationship between equity, bond, and credit default swap price of a leveraged firm with a notional amount of outstanding debt ("default threshold"),referred to as 'D' in Figure 3-1. The firm defaults if its asset value falls below the notional amount of outstanding debt. Keeping the debt level constant, if the firm is low-rated and operates at a high risk of default, the chances of both equity holders and creditors being affected by bankruptcy are high and a high correlation between bonds and equity is expected. At a sufficiently high firm asset value, the distance to default reaches a level at which the chances of bankruptcy becomes remote and the correlation between bonds and equity decreases.

The credit default swap (CDS) could be viewed as an insurance policy bondholders might buy to protect against credit losses in the event of bankruptcy. The CDS spread is the insurance premium bondholders pay to the protection sellers, which is an additional cost of buying bonds. In Figure 3-1 the CDS cost lowers debt value from B to B' and pushes the default threshold from D to D', which makes debt holders further away from default event. The higher CDS premium paid by bond holders, the further away the bond holders are from the default event. However, the lower bond value is realized because of the additional CDS cost bond holders paid to buy credit loss protection.

The bond holder's choice of credit default swap contract is highly correlated with the bond ratings. The CDS cost is more effective for low rating bonds than for the high rating bonds since the default distance of high rating bonds is longer than that of the low rating bonds. At the same time, a bond with longer duration faces more default risk than a bond with shorter duration. So, long maturity bond holders are more likely to choose credit default swap contracts as opposed to short maturity bond holders.

3.2 Hypothesis 1

From the illustration of Merton model in Figure 3-1 the asset value (or equity price) drives a company's distance to default. The higher equity price, the further away this company is from the default. Also, from the liquidity and transaction cost explanation of price discovery,

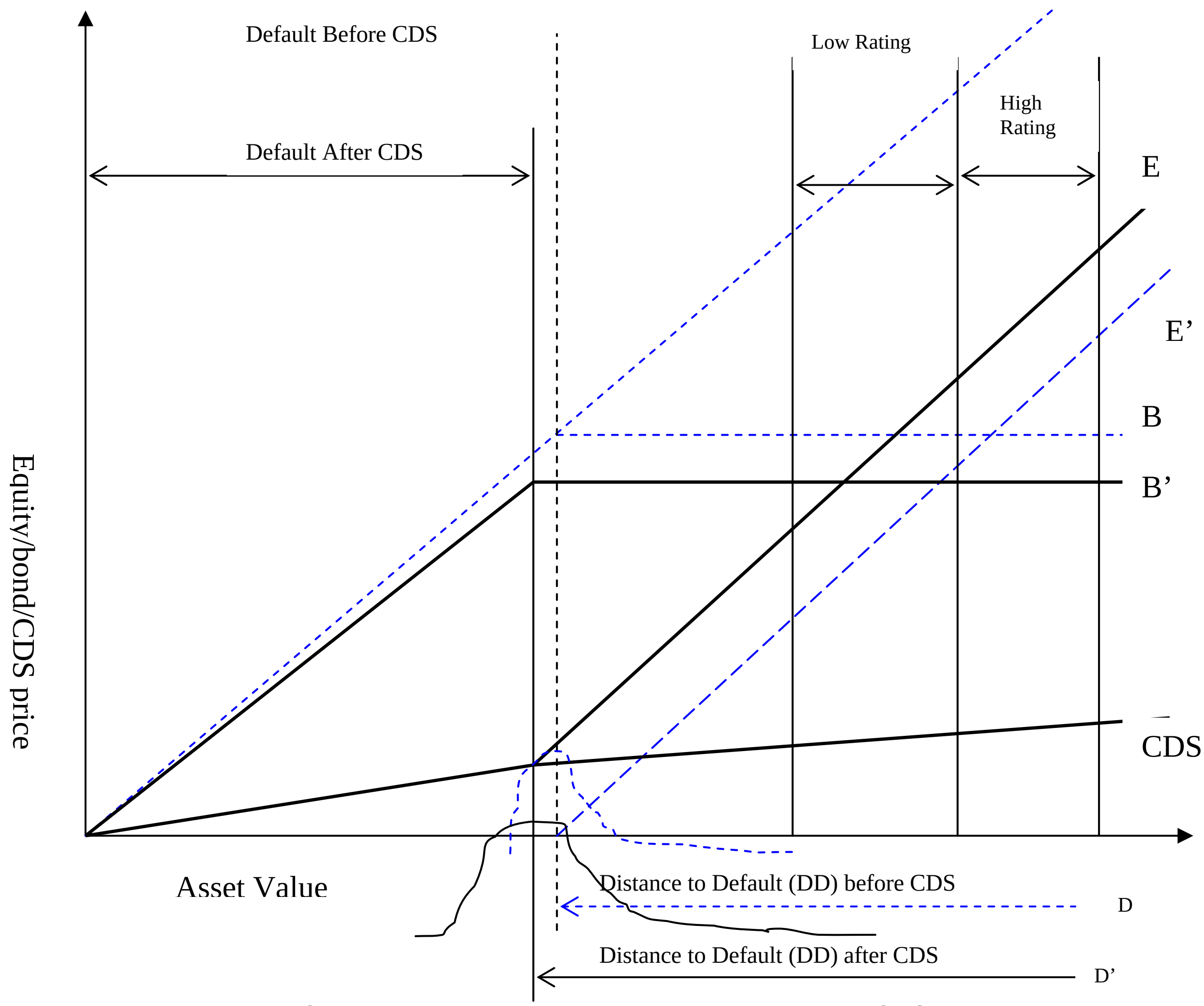


Figure 3-1 Credit risk relationship between equity, bond and CDS market

I expect stock market implied default probability will lead the bond market derived default probability because the stock market drives the default process and the stock market is a more liquid with lower transaction costs. This leads to the first research hypothesis:

H1: Stock market leads the bond market in price discovery of an obligor's credit risk.

I use distance to default (DD) as the measurement of stock market implied credit risk (Merton 1976), which is derived from the stock market transaction prices. The bond market implied credit risk is measured by several variables: option adjusted spread, i-spread, and z-spread (Duffie and Singleton, 1997), which is derived from bond prices.

Due to the different market dynamics in investment grade and high-yield bond markets, two sub-hypothesis are as follows:

H1A: Stock market leads the bond market in credit risk price discovery for an investment grade obligor;

H1B: Stock market leads the bond market in credit risk price discovery for a non-investment grade obligor;

3.3 Hypothesis 2

The second hypothesis examines the influence of the credit derivative market on credit risk price discovery. The general consensus found in the price discovery literature was that the futures (derivatives) markets tended to lead the cash market. The main reason was the relatively lower transaction costs of the futures market. Flemming, Ostdiek, and Whaley (1996) found that the market with lowest overall trading cost will react fastest to new information. Booth, Lee, and Tse (1996) also suggested that higher transaction costs may reduce market information pricing efficiency. Just as the futures market generally provides price discovery for an underlying asset, I expect the credit derivatives market to expedite financial market's price discovery function for credit risk. Similar to the futures market, the credit derivative markets has lowered trading costs due to the use of standardized contracts and electronic trading. This leads to the second research hypothesis:

H2: Credit derivatives market leads the cash bond market in price discovery of an obligor's credit risk.

This hypothesis is divided into two subsets to test both the investment grade credit market and non-investment credit markets.

H2A: Credit derivatives market leads the cash bond market in price discovery of an investment grade obligor's credit risk.

H2B: Credit derivatives market leads the cash bond market in price discovery of a non-investment grade obligor's credit risk.

3.4 Hypothesis 3

I will investigate the financial market's contribution to credit risk price discovery within the market microstructure framework. Following Hasbrouck (1995) and Gonzalo and Granger (1996) market microstructure approach methodology to price discovery, I will examine how an obligor's credit risk information is transmitted across stock, bond and credit derivatives markets by analyzing each market's credit risk information share (IS) and common factor component (CFC). The IS (Hasbrouck, 1995) and CFC (Gonzalo and Granger, 1996) procedure will be applied to measure each individual market contribution to price discovery.

This hypothesis is developed based on hypothesis 1, liquidity explanation of price discovery in stock market, and hypothesis 2, lower transaction cost explanation of price discovery in derivative market. Since the stock market drives a company's default process I expect stock market's liquidity effect plays a more important role than the credit derivative market's lower transaction cost effect on the credit risk price discovery. Thus, the third hypothesis is as described as follows:

H3: The stock market contributes most to credit risk price discovery. The credit derivative market has a second biggest contribution, and the bond market contributes least.

This hypothesis is also split into two sub-hypotheses which will test both investment grade obligors and non-investment grade obligors.

H3A: For the investment grade market segment, stock market has the biggest contribution to credit risk price discovery and credit derivatives market has a second biggest contribution, while the bond market contributes least.

H3B: For high yield market segment, stock market has the biggest contribution to credit risk price discovery and credit derivatives market has a second biggest contribution, while the bond market contributes least.

3.5 Hypothesis 4

This hypothesis examines financial market's credit risk price discovery function for credits with different ratings. According to Merton model illustrated in Figure 3-1, a low-rated firm operates at a high risk of default, the chances of both equity holders and bond holders being affected by bankruptcy are high, so we would expect a high correlation between bonds and equity as the levels of asset value is low which warrants a low credit rating. At the same time, bond holders with low credit rated bonds are more likely hedge credit risk by buying credit default swap contracts, which will push them away from initial default point D to D'. Thus, we expect a higher correlation between the bonds and credit default swaps for low rated credits than high rated credits.

H4: Financial markets provide more credit risk price discovery for low rated credits than for high rated credits.

In more detail, in hypothesis 4 we expect stock market and credit derivatives market provide more credit risk price discovery for low rated credits than for high rated credits.

3.6 Hypothesis 5

Finally I will test the influences of different durations on the financial markets' credit risk price discovery. According to Merton model (See Appendix 1), the equity implied credit risk is positively correlated to the bond's time to maturity or duration. A bond with long maturity faces more default risk than a bond with a shorter maturity, and thus long maturity bond holders are more likely to be involved in default risk hedging using credit default swap as compared to shorter maturity bond holders. As a result, I expect that financial markets provide more credit risk price discovery for long maturity credits than for short maturity credits.

H5: Financial markets provide more credit risk price discovery for credits with long maturities than for credits with short maturities.

In another word, in hypothesis 5 I expect stock and credit derivatives markets to provide more credit risk price discovery for long maturity credits than for short maturity credits.

CHAPTER 4

CREDIT RISK MEASURES AND VARIABLE DESCRIPTIONS

4.1 Credit risk measures in financial markets

In order to evaluate the financial markets' price discovery functions for credit risk, the first step is to measure the degree of credit risk in each market. Over the past several decades, several market based credit risk measures have been developed in the credit risk literature. In this study, I will use the following variables to measure implied credit risk.

4.1.1 Credit risk measures in equity market

This study employs default distance (DD) to measure the equity market implied credit risk. DD is calculated by using Merton's structure form credit risk model. Merton (1974) first applies Black-Scholes option pricing to credit risk modeling and developed the structure form credit risk model. Later research extended the Merton model to the structural model framework. These researches included Black and Cox (1976); Geske (1977); Nielsen, Saa-Requejo, and Santa Clarra (1973); Shimko, Tejima, and Van Deventer (1993); Zhou (1997), Anderson and Sundaresan (1996); and Duffie and Lando (2001). In this present study, I use the Merton (1974) formula to calculate default distance from equity price:

The value of the firm is assumed to follow a geometric Brownian motion such that

$$dV = \mu V dt + \sigma_v V dZ$$

Default occurs if the value of the debt is insufficient to repay the debt principal: $V_t<K$.

The equity price is immediately obtained as

$$S_t = V_t N(k + \sigma_V \sqrt{T-t}) - Ke^{-r(T-t)} N(k)$$

where

$$k = \frac{\log(V_t / K) + (r - 0.5\sigma_V^2)(T-t)}{\sigma_V \sqrt{T-t}}$$

In Merton model, the default distance is given as

$$DD = -\frac{[\log(V_t) - \log(X) + (\mu - \sigma_V^2 / 2)(T-t)]}{\sigma_V \sqrt{T-t}}$$

And thus probability of default could be written as the cumulative normal distribution of DD,

$$PD_t = N\left(-\frac{[\log(V_t) - \log(X) + (\mu - \sigma_V^2 / 2)(T-t)]}{\sigma_V \sqrt{T-t}} \right)$$

Where

N(.) is the cumulative Gaussian distribution

Vt is the value of the firm at time t

X is the default threshold

σ_V is the asset volatility of the firm

u is the expected return on assets

Assuming a default threshold equal to the sum of short term liability and half of long term liabilities, I calculate default distance (DD) from a stock price, stock volatility of the firm, and expected return of a stock.

4.1.2 Credit risk measures in bond market

The main source of market based82credit risk information has traditionally been the corporate bond market. Yield spread, the margin between the yield on corporate bonds and a benchmark such as government bonds, has typically been used to measure credit risk.

Assuming a zero-coupon bond paying one unit of value at maturity; the default probability of the bond is p, the fixed recovery rate is RR, the risk-free discount rate is r, and the bond yield is y. If the bond is currently valued at B, risk neutrality implies

$$B = \frac{(1-p)+pRR}{1+r} = \frac{1}{1+y}$$

Then the default probability could be solved as

$$PD = \frac{1-(1+r)B}{1-RR} = \frac{y-r}{(1+y)(1-RR)}$$

Usually the recovery rate (RR) and yield (y) of a specific bond are known, and thus the default probability is decided by the yield spread over a benchmark (y-r).

While there is not yet universal acceptance on which benchmark to use, I use three types of yield spreads, spread to US treasury, spreads to USD LIBOR, and spreads to asset swap curve, to measure credit risk in corporate bond market.

Spread to Benchmark Treasury: This is the yield of the bond minus the yield to maturity of a particular US Treasury bond or note associated with the corporate bond

Spread to Benchmark Treasury=Yield of bond – yield to maturity of US Treasury

Spread to USD LIBOR: The Spread to USD LIBOR is the yield of the bond minus the USD LIBOR with the same maturity as the bond.

Spread to USD LIBOR = Yield of bond – USD LIBOR swap rate

Spreads to asset swap curve: This is the spread of swapping a corporate bond to a same-currency LIBOR floating rate.

Asset swap spread= floating leg spread to USD LIBOR for par coupon-matched asset swap

4.1.3 Credit risk measure in credit derivative market

The most important and liquid credit derivative market is the credit default swap (CDS) market. A credit default swap (CDS) is a bilateral contract under which two counter parties agree to trade the credit risk on a reference entity or sovereign entity. The protection buyer pays the credit default swap spread (risk premium) to the protection seller in exchange of the principal protection when the reference bond defaults. The typical contract maturity is 5-years for corporate reference entities. The CDS spread is the insurance premium paid to the protection seller for credit loss, thus the CDS spread theoretically is the risk premium for pure credit risk.

The CDS spread depends on the default probability of the reference obligor (Chan-Lau, 2003, 2005, and Neftci, Santos, and Lu 2005). Assume a one-period CDS contract with a unity notional amount. The protection seller is exposed to an expected loss L equal to

$$L = p(1-RR)$$

Where p is the default probability and RR is the recovery rate.

In absence of market frictions the risk neutral CDS spread (credit risk premium) should be equal to the present value of the expected loss

$$CDS = \frac{p(1-RR)}{1+r}$$

Where r is risk free rate, RR is recovery rate and p is default probability. Obviously the default probability pp is only decided by CDS spread if recovery rate is known.

Duffie (1999) first adopted CDS spread as credit risk measure in credit derivative market. In later studies, Houweling and Vorst (2001), Hull and White (2000, 2003), Blanco, et al. (2003), and Zhou (2004) also take CDS spread as the credit risk measure for the credit derivatives markets. In this study, I also employ CDS spread to measure credit risk in credit derivatives market.

4.2 The Data

The data for this study consists of stock market data, corporate credit market data and the relatively new credit derivative market data. The data are acquired from several providers. Due to the short history of the new credit derivative market, this data is only available after

September 2003. Therefore, I will examine price discovery dynamics for credit risk from January 2000 to October 2007. The testing period is divided into two sub-samples, January 2000 to September 2003 and October 2003 to October 2007.

For the stock market the credit risk measure is Default Distance (DD) which was calculated from S&P 500 index by using Merton model, as previously described. The weekly S&P 500 Index level, volatility, and index return data from January 2000 to October 2007 were collected from DataStream. Weekly Default Distance (DD) was calculated from S&P 500 index level, volatility, and index return.

Credit risk is measured by three types of yield spreads in the corporate credit market: spread to US treasury benchmark, I-spread, Z-spread, and asset swap spread. For these yield spreads, I use JP Morgan credit market index data. JP Morgan Market provides a comprehensive corporate bond market index for these yield spreads, JULI and JULI Liquid.

The JULI indices capture the most liquid bonds in the market. Two-thirds of the all index constituent are priced on a daily basis by JP Morgan's trading desk. JULI includes the largest and most active issuers in US corporate bond market that is comprised of 1727 individual bonds from 315 different issuers, a combined market capitalization of $1.26 trillion. The universe is divided along the credit rating dimension into four investment grade rating categories of AAA, AA,A, and BBB. Further the JULI index is sub-divided into five maturity buckets: 1-3year, 3-5 year, 5-7 year, 7-10 year, and 10+ years. This allows for a detailed comparison and analysis of yield and spread term structures for corporate bonds with different ratings.

In addition to JULI indices, JP Morgan Market also provides JULI Liquid Indices. JP Morgan developed HELIQS (Hedonic Liquidity Scoring Model) to measure bond liquidity. The JULI Liquid only includes corporate bonds which are above 300 million instead of 50 million for JULI index. JULI Liquid index is more liquid than the JULI index. The same as JULI, JULI Liquid is also divided into the four, AAA, AA, A, and BBB investment rating categories and the five, 1-3y, 3-5y, 5-7y, 7-10y, and 10+y maturity buckets. The availability of JULI and JULI

Liquidity indexes makes it possible to test the influences of liquidity on credit risk price discovery on corporate bond markets.

For the non-investment grade bond market, JP Morgan Market provides the JP Morgan High Yield index, which is also divided into four, BB, B, C and D rating categories. For this study, the weekly JULI, JULI Liquid and JP Morgan High Yield data from January 2000 to October 2007 are collected.

I use the CDS spread to measure credit risk and the Dow Jones CDX index to track credit derivative market. The CDX tracks reference entities in North America and is standardized in terms of index composition procedure, premium payment, and maturity. The CDX index includes CDX NA IG (CDX North America Investment Grade), CDX NA HY (CDX North America High Yield), and CDX NA XO (CDX North America Crossover). The most actively traded index is the Dow Jones CDX NA IG index. It includes 125 North American investment-grade companies in which each company is equally weighted. The index contract matures 3-year, 5-year, 7-year and 10-year, respectively. The 5-year contract is most liquid and most often traded. The composition of reference entities included in a CDX is renewed every six-months, March and September, based on a vote of participating dealers.

CDX indexes are numbered sequentially. The index for the first basket of 125 firms are designated the CDX NA IG 1 index in 2003, the index for the second basket of 125 firms was designated the CDX NA IG 2 index, etc. and so up to CDX NA IG 9 in September 2007. Since the inception of CDX started from CDX NA IG 1 in September 2003, the credit derivative market data only covers September 2003 to October 2007. Weekly CDX NA IG and CDX NA HY clean price and CDS spread (mid) are collected from Markit, the largest credit derivatives market data provider.

CHAPTER 5

RESEARCH DESIGN AND METHODOLOGY

Schreiber and Schwartz (1986) defined price discovery as “the search for an equilibrium price.” Baillie (2002) defined price discovery as “gathering and interpreting news” and Lehmann (2002) described it as “incorporation of the information implicit in investor trading into market prices.” These interpretations suggest that price discovery is a dynamic process in search of equilibrium state which is characterized by the fast adjustment of market prices from old equilibrium to the new equilibrium with the arrival of new information. Credit risk price discovery refers to a process by which asset prices are formed and new credit risk information is impounded.

Credit risk price discovery dynamics are characterized by

1) Long term price discovery: how to identify the common efficient price and its innovation in long run? If several securities on the same underlying asset are traded in several closely related markets, we should expect the price of a security would not deviate from its equilibrium price because of the arbitrage forces keeping the price close to the long–run equilibrium price. Empirically, the common efficient price and its innovations could be tested by examining cointegration of transaction price time series. This study follows Johansen cointegration test procedure to examine financial market’s long-term equilibrium price of credit risk.

2) Short-term price discovery: how to identify the influences of the transitory price deviation from equilibrium on asset values in short-run? The short-term price discovery dynamics is represented by the transitory price deviation from equilibrium price. The short-run transitory price deviations and the incorporation of new information into market price can be

tested by examining the lead-lag relationships of different markets. This study will use Granger causality test, vector regression model (VAR), vector error correction model (VECM) and impulse response function (IRF) to investigate the short term lead-lag relationship of credit risk price discovery in financial markets.

3) Price discovery contribution: how to identify different market's contribution to credit risk pricing? Namely, how to measure each financial market's contribution to price discovery? The prices in the informationally-linked markets have a common factor innovation that links the stochastic processes in the cointegrated markets. The impact of new information on prices could be captured by the proportions of this common factor attributable to each market. The contributions could be captured by contributions of innovation in each market to the total variance. In this study, I will follow Hasbrouck (1995) information share (IS) methodology and Gonzalo and Granger (1995) common factor components (CFC) methodology to econometrically measure each financial market's contribution to credit risk price discovery.

5.1 Credit risk cointegration among stock market, bond market and credit derivatives market.

5.1.1 Unit Root Test

Financial time series are often non-stationary. Stationarity should be checked and handled before any econometric methodologies appropriately applied. A non-stationary time series has an obvious trend over time which is said to have a unit root. Consider a time series variable $\{Y_t\}$ represented by a first-order autoregressive scheme AR(1) : $Y_t = \alpha Y_t + \varepsilon_t$, if α <1, then $\{Y_t\}$ is stationary; however, if α =1 then $\{Y_t\}$ is non-stationary and has a unit root. We can remove the unit root by taking difference: $\Delta Y_t = Y_t - Y_{t-1}$. If the first difference is stationary, then we say $\{Y_t\}$ is integrated with order 1, denoted as I(1), meaning that $\{Y_t\}$ has to be difference one to make it stationary.

Considering the autocorrelations of a time series, I utilize the standard Augmented Dickey-Fuller (ADF) to the unit root in each credit risk time series. The ADF test for a unit root is estimated by the following regression equation: $\Delta Y_t = \alpha_0 + \alpha_1 t + \gamma Y_{t-1} + \sum_{i=2}^{p} \beta_i \Delta Y_{t-1+i} + \varepsilon_i$ where p is chosen lag length. Sufficient lags p should be included to ensure no autocorrelation in the error term. The hypotheses are H0: γ =1 (Unit root) and H1: γ <1.(No unit root).

5.1.2 Cointegration Test

5.1.2.1 Engle-Granger Cointegration test

Engle and Granger (1987) proposed cointegration test to examine the linear stationarity among different non-stationary time series. It will give us statistical evidence of the long run credit risk price discovery among the stock market (denoted by S), bond market (denoted by B), and credit derivatives market (denoted by D).

The linear long run credit risk price equilibrium among the above markets could be written as $\beta_1 S_t + \beta_2 B_t + \beta_3 D_t$ namely, $\beta(S,B,D)'$

If long run equilibrium exists, then $\beta_1 S_t + \beta_2 B_t + \beta_3 D_t = 0$. The deviation from long equilibrium, called equilibrium error $e_t = \beta(S,B,D)'$, should be stationary.

The Engle Granger cointegration test examines whether the residuals from a two dimension equilibrium regression is stationary.

$$\Delta S_t = \alpha_1 + \alpha_s e_{t-1} + \sum_{i=1} \alpha_{11}(i) \Delta S_{t-i} + \sum_{i=1} \alpha_{12}(i) \Delta B_{t-i} + \varepsilon_{st}$$

$$\Delta B_t = \alpha_2 + \alpha_B e_{t-1} + \sum_{i=1} \alpha_{21}(i) \Delta S_{t-i} + \sum_{i=1} \alpha_{22}(i) \Delta B_{t-i} + \varepsilon_{Bt}$$

A pair-wise Engle-Granger cointegration tests are conducted among the stock market, bond market and credit derivatives market.

5.1.2.2 Johansen Cointegration test

However, there are some limitations for Engle-Grange cointegration test. First, Engle-Granger cointegration could not test three or more variables when there may be more than one cointegration vector, second, Engle-Granger method relies on a two-step estimator in which the second stationary test is based on the regression residuals from first step. Any errors introduced from first-step regression residual estimation will carry into the second-step estimation of cointegration coefficient α .

To avoid these problems, this study also adopted Johansen (1988) maximum likelihood estimators circumvent the use of two step estimators, which can also estimate and test multiple cointegration vectors.

The cointegration rank test by Johansen investigates the existence of a stationary linear combination of the first order integrated time series on the basis of the following vector based system. Consider

$$x_t = A_1 x_{t-1} + A_2 x_{t-2} + \dots A_p x_{t-p} + \varepsilon_t$$

Where x_t = the (n×1) vectors (x1t,x2t,…xnt)', ε_t = the (n×1) vector with zero mean and variance matrix $\sum \varepsilon$, A_i is a (n×n) matrix of parameters. The parameter matrix is estimated by using maxim likelihood estimation.

The system could be written as

$$\Delta x_i = \sum_{i=1}^{p-1} \pi_i \Delta x_{t-i} + \pi x_{t-p} + \varepsilon_t$$

$$where$$

$$\pi = -\left(I - \sum_{i=1}^{p} A_i \right)$$

$$\pi_i = -\left(I - \sum_{j=1}^{i} A_j \right)$$

I is an (n×n) identity matrix. Information on the rank of π gives us an indication of the number of cointegrating vectors. The rank of π is equal to the independent cointegration vectors. The rank of π is equal to the number of its characteristic roots that differ from zero. The test for the number of characteristic roots that are insignificantly different from unity could be conducted using the following two test statistics

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^{n} \ln(1-\hat{\lambda}_i)$$

$$\lambda_{\max}(r, r+1) = -T \ln(1-\hat{\lambda}_i)$$

Where $\hat{\lambda}$ is the estimated value of characteristic roots (Eigenvalue) obtained from the estimated π matrix and T is the number of observations.

5.2 Lead-lag relationship among stock market, bond market and credit derivative market.

Short-term credit risk price discovery involves testing the lead-lag relationship among these markets. The Granger causality test and impulse response analysis are two econometrical techniques to examine the lead-lag relationship among time series. Both Granger causality test and impulse response analysis could be conducted in Vector Autoregressive Model and Vector Error Correction Model (VECM) depending on the stationarity and cointegration trend among testing time series.

5.2.1 Vector Autoregressive Model (VAR)

Weak stationarity is the sufficient and necessary condition for the use of VAR models. If the credit risk measures in stock market, bond market and credit derivative market all show weak stationarity, the lead-lag relationship among each variable could be tested in following VAR system

$$
\begin{bmatrix} \Delta S_t \\ \Delta B_t \\ \Delta D_t \end{bmatrix} = \begin{bmatrix} c_1 \\ c_2 \\ c_3 \end{bmatrix} + \begin{bmatrix} \sum_{j=1}^{p} \varphi_{1,j} \Delta S_{t-j} \\ \sum_{j=1}^{p} \varphi_{2,j} \Delta S_{t-j} \\ \sum_{j=1}^{p} \varphi_{3,j} \Delta S_{t-j} \end{bmatrix} + \begin{bmatrix} \sum_{j=1}^{p} \varphi_{1,j} \Delta B_{t-j} \\ \sum_{j=1}^{p} \varphi_{2,j} \Delta B_{t-j} \\ \sum_{j=1}^{p} \varphi_{3,j} \Delta B_{t-j} \end{bmatrix} + \begin{bmatrix} \sum_{j=1}^{p} \varphi_{1,j} \Delta D_{t-j} \\ \sum_{j=1}^{p} \varphi_{2,j} \Delta D_{t-j} \\ \sum_{j=1}^{p} \varphi_{3,j} \Delta D_{t-j} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1,t} \\ \varepsilon_{2,t} \\ \varepsilon_{3,t} \end{bmatrix}
$$

where S is credit risk measures in stock market, B is credit risk measures in bond market and D is credit risk measures in credit derivatives market. After the VAR model estimation, lead-lag relationship could be tested using Granger causality test or impulse response analysis.

Granger (1969) causality tests the empirical relationship among time series without imposing limitations on the long-run consistency of price dynamics. The bivariate autoregressive specification of Granger causality with intercept between stock market credit risk and bond market credit risk could be written as

$$
\Delta S_t = c_1 + \sum_{j=1}^{q} \alpha_{1,j} \Delta S_{t-j} + \sum_{j=1}^{q} \beta_{1,j} \Delta B_{t-j} + v_{1,t}
$$

$$
\Delta B_t = c_2 + \sum_{j=1}^{q} \alpha_{2,j} \Delta S_{t-j} + \sum_{j=1}^{q} \beta_{1,j} \Delta B_{t-j} + v_{2,t}
$$

The joint rejection of $H_0 : \beta_{1,t-1} = \beta_{1,t-j} = ... = \beta_{1,t-q} = 0$ implies that ΔB strictly Granger causes ΔS. Similar statistical significance of $\alpha_{2,t-j}$ across all lagged endogenous variables indicates a similar feedback effect of ΔS on ΔB. When ΔB strictly Granger causes ΔS, we also say that the change of bond market credit risk leads the change of stock market changes.

Another way to test the lead-lag relationship is analyzing the impulse response of each time series on the shocks. The moving average representation could be written as

$$\begin{bmatrix} S_t \\ B_t \\ D_t \end{bmatrix} = \begin{bmatrix} \overline{S} \\ \overline{B} \\ \overline{D} \end{bmatrix} + \sum_{i=0}^{\infty} \begin{bmatrix} \phi_{11}(i), \phi_{12}(i), \phi 3(i) \\ \phi_{21}(i), \phi_{22}(i), \phi_{23}(i) \\ \phi_{31}(i), \phi_{32}(i), \phi_{33}(i) \end{bmatrix} \begin{bmatrix} \varepsilon_{St-i} \\ \varepsilon_{Bt-i} \\ \varepsilon_{Dt-i} \end{bmatrix}$$

$$or \quad \mathrm{X_t} = \mu + \sum_{i=0}^{\infty} \phi_i \varepsilon_{t-i}$$

The coefficients $\phi_{jk}(i)$ are called impulse response function. After VAR parameters estimation, the impulse response function could be plotted to identify the response of each time series to the shocks. This study will use both Granger causality test and impulse response function to test the short-term credit risk price discovery among the three markets.

5.2.2 Vector Error Correction Model (VECM)

Vector Error Correction Model (VECM) is a constrained VAR model. Once the vector variables is found non-stationary and cointegrated at order one, the VECM model should could be used to explore the dynamic of co-movement among the time series at levels. VECM restricts the long-run behavior of endogenous variables to converge to their cointegration relationships (through price adjustments) while allowing a wide range of short run dynamics of past price movements as random disturbances on joint price dynamics within a linear system of simultaneous equations. The degree of cointegration is reflected in the specification of error correction term, which gradually corrects past deviations from long-run equilibrium through a series of partial short-run price adjustments.

A VECM(p) is written as

$$\begin{bmatrix} \Delta S_t \\ \Delta B_t \end{bmatrix} = \begin{bmatrix} \delta_{1t} \\ \delta_{2t} \end{bmatrix} + \Pi \begin{bmatrix} S_{t-1} \\ B_{t-1} \end{bmatrix} + \sum_{i=1}^{p-1} \Phi_i \begin{bmatrix} \Delta S_{t-i} \\ \Delta B_{t-i} \end{bmatrix} + + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{bmatrix}$$

$$where$$

$$\Pi = \begin{bmatrix} \alpha_1 \\ \alpha_2 \end{bmatrix} [1, -\beta]$$

The model can also be written as

$$\begin{bmatrix} \Delta S_t \\ \Delta B_t \end{bmatrix} = \begin{bmatrix} \alpha_1 \\ \alpha_2 \end{bmatrix} (S_{t-1} - \lambda - \beta B_{t-1}) + \sum_{i=1}^{p-1} \Phi_i \begin{bmatrix} \Delta S_{t-i} \\ \Delta B_{t-i} \end{bmatrix} + + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{bmatrix}$$

The lagged difference between both level series denotes the "error correction term" (or "cointegration term") as an additional endogenous variable of possible long-term consistency (with complete cointegration $\lambda = 0$ and β=1). A significant negative α_1 means stock market react to the price changes in bond market which implies that bond market is leading market. And a positive α_2 shows that a change in stock market results in price adjustment in bond market and indicates that stock market leads the bond market. If both adjustment coefficients are significant with the correct signs, the relative magnitude of the two coefficients will reveal the leading market. The same as in VAR model Granger causality test and impulse response analysis could be applied to test the lead-lag relationship among these markets after VECM estimation.

5.3 Credit risk price discovery contribution

Finally, I examine each financial market's contribution to credit risk price discovery by following Hasbrouck (1995) information share (IS) procedure and Gonzalo and Granger (1996) common factor component (CFC) method. Hasbrouck's model extracts the price discovery process using the variance of innovations to the common factor. The Gonzalo and Granger approach focuses on the components of the common factor and error correction process. Both approaches use cointegration to restrict multiple market prices to share a common efficient price and both approaches use a VECM for estimation purposes.

5.3.1 Credit risk price discovery contribution - Common factor component

Gonzalo and Granger (1995) assumes that the prices in the informationally-linked markets have a common factor innovation that links the stochastic processes in these cointegrated markets and it is the proportion of this common factor innovation attributable to each market that is being measured. The common factor weights (price discovery shares) attributes to each market can be estimated from a VECM model as follows:

$$\Delta S_t = \lambda_1 (S_{t-1} - \alpha_0 - B_{t-1}) + \sum_{j=1}^{p} \beta_{1j} \Delta S_{t-j} + \sum_{j=1}^{p} \delta_{1j} \Delta B_{t-j} + \varepsilon_{1t}$$

$$\Delta B_t = \lambda_2 (S_{t-1} - \alpha_0 - B_{t-1}) + \sum_{j=1}^{p} \beta_{2j} \Delta S_{t-j} + \sum_{j=1}^{p} \delta_{2j} \Delta B_{t-j} + \varepsilon_{2t}$$

If λ_1 is negative and statistically significant then the bond market is considered to be contributing significantly to price discovery. If λ_2 is positive and statistically significant then stock market is contributing significantly to price discovery. If both λ_1 and λ_2 are appropriately signed and significant, then both stock market and bond market contribute to credit risk price discovery. Further, the Gonzalo-Granger proportional contribution of stock market and bond market to price discovery can be computed as:

$$GG_{stock} = \frac{\lambda_2}{\lambda_2 - \lambda_1}$$

$$GG_{bond} = 1 - GG_{stock} = -\frac{\lambda_1}{\lambda_2 - \lambda_1}$$

5.3.2 Credit risk price discovery contribution – Information Share

In this study, Hasbrouck information share is used to check robustness of Gonzalo and Granger price discovery contribution procedure. Hasbrouck information share model considers the contributions of innovations in each market to the total variance.

A VECM system

$$\Delta \mathrm{X}_t = \Pi \mathrm{X}_{t-1} + \sum_{i=1}^{k} \Gamma_i \Delta \mathrm{X}_{t-i} + e_t,$$

can be transformed into an integrated form of a vector moving average (VMA):

$$\mathrm{X}_t = J\varphi\left(\sum_{\tau=1}^{t} \varepsilon_\tau\right) + \Phi^*(L)\varepsilon_t,$$

Where J is a column vector of ones, φ = (φ1, φ2…φn) is a row vector, and Φ* is a matrix of polynomials in the lag operator.

If the variance-covariance matrix Ω is diagonal, the information share of market j is given by

$$I_j = \frac{\varphi_j^2 \sigma_j^2}{\varphi \Omega \varphi'},$$ where φj is the jth element of φ

If Ω is not diagonal (i.e. the residuals are contemporaneously correlated), the information share is not exactly identified. The results depend on the ordering of variables in the Cholesky factorization of Ω. Hence, different orderings of the variables will create lower and upper bounds of a market's information share.

Similarly, in a bivariate VECM system,

$$\Delta S_t = \lambda_1 (S_{t-1} - \alpha_0 - B_{t-1}) + \sum_{j=1}^{p} \beta_{1j} \Delta S_{t-j} + \sum_{j=1}^{p} \delta_{1j} \Delta B_{t-j} + \varepsilon_{1t}$$

$$\Delta B_t = \lambda_2 (S_{t-1} - \alpha_0 - B_{t-1}) + \sum_{j=1}^{p} \beta_{2j} \Delta S_{t-j} + \sum_{j=1}^{p} \delta_{2j} \Delta B_{t-j} + \varepsilon_{2t}$$

The lower bounds and upper bounds of Hasbrouck's information share measures can be calculated as:

$$HAS_L = \frac{\lambda_2^{\,2}\left(\sigma_1^{\,2} - \dfrac{\sigma_{12}^{\,2}}{\sigma_2^{\,2}}\right)}{\lambda_2^{\,2}\sigma_1^{\,2} - 2\lambda_1\lambda_2\sigma_{12} + \lambda_1^{\,2}\sigma_2^{\,2}}$$

$$HAS_U = \frac{\left(\lambda_2\sigma_1 - \lambda_1 \dfrac{\sigma_{12}}{\sigma_1}\right)^2}{\lambda_2^{\,2}\sigma_1^{\,2} - 2\lambda_1\lambda_2\sigma_{12} + \lambda_1^{\,2}\sigma_2^{\,2}}$$

Where the covariance matrix ε_{1t} and ε_{2t} is represented by σ_1, σ_2 and σ_{12}.

CHAPTER 6

CREDIT RISK PRICE DISCOVERY AMONG RELEVANT MARKETS

In this study both the credit risk price discovery across the relevant markets and the influences of the ratings and maturities on the financial market's price discovery are studied. Chapter 6 focuses on the credit risk price discovery across the overall markets. The credit risk price discovery hypothesis one to three (refer to Chapter 3 Research Hypotheses) will be tested for the overall equity, bond and credit derivatives market. In chapter 7 the rating hypothesis of credit risk price discovery (refer to Chapter 3 Research Hypotheses) will be analyzed. The rating's influence on the financial markets' credit risk price discovery process is tested for the credit market segments with different ratings. And finally in chapter 8 the influences of the maturity factor on financial markets' price discovery for credit risk is investigated for credit market segments with different maturities.

First in this chapter, I will test credit risk price discovery across overall stock, bond and credit derivative markets from January 2000 to October 2007 without considering the influences of the ratings and maturities. The credit risk price discovery of the following financial markets is studied: equity market, bond markets which include investment grade, high yield and crossover bond markets, and the credit derivative markets which include the investment grade and high yield credit default swap markets. To go further test the influences of the liquidity on credit risk price discovery, the liquid investment grade bond market is also included in the tests.

I use S&P500 index as the proxy for the overall equity market. The overall stock market implied credit risk is measured by default distance (DD1) which is calculated from S&P500 index by applying Merton model (1976). In bond market, the investment grade, high yield and crossover bond markets are tested. The liquidity factor of credit risk price discovery is also tested in the liquid investment grade bond market. The bond market implied credit risk is measured by bond market yield spread over US treasury.

I use JPMorgan bond market indices as the proxies for the bond market for the reason that JPMorgan provides bond market indices considering all maturities that enable them to represent the overall bond market. The overall bond market implied credit risk is measured by JULIPBST which is the JP Morgan overall bond market index JULIPLUS spread over US treasury rate. The credit risk implied by the investment grade bond market is measured by JULIBST which is the yield spread of JP Morgan investment grade bond market index JULI over US treasury rate. The high yield bond market credit risk is measured by JPMHYSTW which is yield spread of JPMorgan high yield bond market index JPMHY over US treasury rate. The credit risk in crossover bond market is measured by JULIXBST which is the yield spread of JPMorgan crossover bond market index JULIX over US treasure rate.

For studying influence of the liquidity factor, I test the liquid investment grade bond market by using JULILBST which is the yield spread of JPMorgan liquid investment grade bond market index JULILIQUID over the US treasury. Finally the influences of the fast-growing credit default swap (CDS) markets on financial markets' credit risk price discovery are tested. The credit risk of investment grade CDS market is measured by the CDXIGSM which is spread of the investment grade index CDXIG over LIBOR. Also the credit risk of high yield CDS market is measured by the CDXHYSM which is the yield spread of high yield index CDXHY over LIBOR.

Figure-B.1 to Figure-B.7 plots the time series of market implied credit risk of these markets from January 2000 to October 2007. In between January and March 2002 the stock market implied credit risk reached peak (lowest DD) while bond market yield spread over US treasury and CDS spread approached the highest point. Similarly during July 2007 a jump occurred in bond market yield spread and CDS spread while stock market experienced a temporary falling down. Table-B.1 shows the summary statistics for the market implied credit risk of these markets from January 2000 to October 2007.

6.1 Time series characteristics and unit root analysis

Before testing the credit risk price discovery relationships, the time series characteristics and stationarity are tested for each market implied credit risk time series. Table-B.2 reports the univariate ARIMA analysis of each time series. The ARIMA analysis is tested with and without intercept and trend in which 1, 2 lags and 5 lags are tested respectively for each time series. From the table we can see that the stock market implied credit risk-default distance (DD1) is AR(1) process with intercept but no trend. Overall bond market credit risk JULIPBST is AR (2) with intercept and no trend.

Investment grade bond market credit spread JULIBST is AR (2) with intercept and no trend. Credit spread JPMHYSTW of high yield bond market is AR (2) with intercept and trend. Crossover bond market credit spread JULIXBST is AR (2) with intercept and no trend. Liquid bond market implied credit risk spread JULILBST is AR (2) with intercept and no trend. Investment grade credit default swap market implied credit risk spread CDXIGSM is AR(1) process with intercept and trend; High yield credit default swap market implied credit risk spread CDXHYSM is also a AR(1) process with intercept and trend. In summary, the stock market implied credit risk is a AR(1) process with intercept only, all bond market credit risk spreads are AR(2) process with intercept only, while the credit default swap market implied credit risk shows a AR(1) process with both intercept and trend.

The stationarity (or unit root) of the time series must be first analyzed before applying the time series methodologies to test credit risk price discovery of each market. The stationarity of the time series will decide the choice of the appropriate time series econometric method. For example, Das and Tufano (1996) and Jarrow, Lando, and Turnbull (1997) assume a stationarity process of credit spreads in their valuation methods. However, in this study, the long term cointegration, short term causality and the Hasbrouck (1995) price discovery contribution methodologies are all based on the non-stationarity of the time series. The stationarity of market risk implied credit risk spread is a function of the span of the data and not the number of observations (Shiller and Peron, 1985). According to Joutz, Mansi and Maxwell (2000)'s study, it seems implausible that the Treasury rate or credit spreads are non-stationary over long periods since a non-stationary process implies an explosive volatility structure over time. However, since most pricing models have a relatively short time horizon, it seems plausible over investment horizon that credit spreads could be non-stationary. That is, the investment horizon drives the data frequency chosen and the form of the model considered. Hence, the conclusion on unit root tests of market implied credit risk could be appropriate since the sample collected for this study is the weekly data spanning from January 2000 to October 2007. I examine the stationarity of the market implied credit risk and credit spreads by applying the Augment Dickey-Fuller (ADF) and the Phillips-Perron unit root test statistics.

Table-B.3 reports unit root test results for the stationarity of market implied credit risk. Both the Augmented Dickey-Fuller (ADF) unit root test method and Phillips-Perron unit root test method with structural break are used to test the stationarity of each implied credit risk time series. The ADF tests are conducted with 1, 2, and 5 lags with or without intercept and trend respectively. The Phillips-Perron unit root tests are conducted with structural break shift at February 2002 when the market was most volatile. Both ADF tests and PP tests report the failure to reject the null hypothesis of unit root for any of the market implied credit risk time series and credit spreads. Panel 2 provides the results of the stationarity test on the first differences of the market implied credit risk time series and credit spreads. The market implied credit risk of overall stock market-distance default (DD) is I(1); Investment grade CDS market index spread CDXIGSM is I(1); High yield CDS market index spread CDXHYSM is I(1); Investment grade bond market index yield spread JULIBST is I(1); Liquid investment grade bond market index yield spread JULILBST is I(1); Overall bond market index yield spread JULIPST is I(1); Crossover bond market index yield spread JULIXBST is I(1) and High yield bond market index spread JPMHYSTW is I(1). The time series of market implied credit risk of all equity market, bond market and credit default swap market are non-stationary. The evidence suggests that the first differences are stationary. The results are consistent with credit spreads as being non-stationary at least when examining the variables over a short investment horizon.

6.2 Long term credit risk price discovery among financial markets - Cointegration test

The unit root test results suggest that the time series of all market implied credit risk are non-stationary. While for individual market the market implied credit risk time series is non-stationary, however, for several markets the market implied credit risk time series may move together and a linear combination of these variables are stationary. The existing of a stationary linear combination of several non-stationary time series indicates a cointegrated long-run relationship of credit risk among these financial markets. In terms of credit risk price discovery the cointegration of market implied credit risk series means that in long run the cointegrated financial markets could reach an equilibrium status on credit risk price discovery. I test for the presence of a cointegration vector among the equity, bond and credit default swap market on credit risk by using Johansen maximum likelihood procedure for a finite-order vector autoregression (Johansen, 1988 and 1991). The Johansen trace test for cointegration is used to test whether long run credit risk equilibrium relationship exists among stock, bond and credit derivative market. If in the long run these markets are cointegrated regarding the market implied credit risk, it implies that stock market, bond market and credit derivatives market could equally provide price discovery of credit risk in long run.

I estimate a system of market implied credit risk series of stock market and bond market, bond market and credit default swap market, and stock market and credit default swap market using 1 lag, 2 and 5 lags respectively. The null hypothesis is that there is no cointegrating vector (rank=0), and the alternative hypothesis is that there is a single cointegrating vector (rank=1). Observing that a jump occurred to all market implied credit risk series in between February and March 2002, I also estimate the Johansen cointegration test with and without the structural break at February 2002.

Table-B.4 panel A reports the pair-wise results of Johansen cointegration test of market implied credit risk between stock market and bond market. Table-B.4 panel B reports the pair-wise results of Johansen cointegration test of market implied credit risk between the stock market and credit default swap market. Table-B.4 Panel C reports the pair-wise results of Johansen cointegration test of market implied credit risk between the bond market and credit default swap market. Most of the pair-wise cointegration tests are not significant except the high yield bond market spread and high yield CDS market spread is cointegrated. While with structural break at February 2002, the stock market implied default distance (DD) and bond market are cointegrated; the bond market yield spread and CDS market spread are also cointegrated. However, the stock market implied DD and CDS market spread are not cointegrated. Table-B.4 suggests that in stock market and bond market there exist long run equilibrium relationship of implied credit risk, and also there exists long run equilibrium relationship of implied credit risk in bond market and credit default swap market. However, the stock market and credit default swap market are not cointegrated regarding implied credit risk in long run.

Table-B.5 reports the cointegration test results among three markets. With structural break at February 2002 there exists only one cointegration among all three markets. It implies that in long run equilibrium relationship exists among stock, bond and credit default swap market regarding implied credit risk. From Table-B.4 and Table-B.5 we can see that in long run stock market and bond market, credit derivatives market and bond market are cointegrated in terms of implied credit risk, which means they are moving together in long run. However, no long run equilibrium credit risk relationship has been found between stock market and credit derivatives market. Stock market and credit derivatives market are not moving together in long run. The possible reason may be market psychology and the credit derivatives market is still in the stage of early developing.

6.3 Short term credit risk price discovery among financial markets – Lead lag relationship

After the long term equilibrium relationship tests, the short term lead-lag relationship is tested using bivariate Engle-Granger causality tests. The bivariate Engle-Granger causality between two markets is tested in the vector autoregression (VAR) system and in the vector error correction model (VECM) if two markets are cointegrated. Table-B.6 reports the lead-lag relationship test results for hypothesis 1 and hypothesis 2. From the table we can see that all Granger causality tests between stock market and bond market show that stock market is leading the bond market in terms of credit risk price discovery. Stock market implied default distance-DD1 grange-causes yield spread changes in all investment grade, liquid bond market, crossover bond market and high yield bond market. These test results supports the lead-lag relationship test results for hypothesis 1 and hypothesis 2.

From the table we can see that all Granger causality tests between stock market and bond market show that stock market is leading the bond market in terms of credit risk price discovery. Stock market implied default distance-DD1 grange-causes yield spread changes in all investment grade, liquid bond market, crossover bond market and high yield bond market. These test results supports hypothesis 1 that stock market in leading the bond market in credit risk price discovery. Similar to no clear long run equilibrium credit risk relationship between stock market and credit derivatives market, the short term lead-lag relationship is also not significant between the two markets. Both the test for stock market ganger-causing credit default swap market and the credit market granger-causing stock market are significant, thus the lead-lag relationship between stock market and credit derivative market is unclear at this point. Finally I tested the lead-lag relationship between credit default swap market and bond market. From Table-B.5 we can see that the investment grade credit default swap market grange-causes the investment grade bond and liquid bond market, while high yield credit default swap market grange-causes the high yield bond market. It implies that in short term credit derivatives market is leading the bond market in credit risk price discovery which supports hypothesis 2. The above test results supports hypothesis 1 that stock market is leading the bond market and hypothesis 2 that credit derivative market is leading the bond market in credit risk price discovery. However, the short term lead-lag relationship between the stock market and credit derivatives market is still unclear. But both the stock market and credit derivative market drive the short term bond market implied credit risk dynamics.

6.4 Financial markets' contribution to credit risk price discovery

Finally hypothesis 3 - the financial markets' credit risk price discovery contribution hypothesis is tested by applying Gonzalo and Granger (1996) common factor component methodology and Hasbrouck (1995) information share price distribution methodology. Table-B.7 reports results of Gonzalo and Granger common factor component price discovery contribution tests. In stock and bond markets, we can see stock market provides above 90% of price discovery contribution for credit risk while bond market only contributes less than 10% price discovery contribution. In investment grade credit derivative market and investment grade bond market we can see that investment grade CDS market provides more than 50% but less than 80% credit risk price discovery contribution. Also in high yield CDS market and high yield bond market the high yield CDS market provides more than 50% but less than 70% credit risk price discovery contribution. Because no clear long run equilibrium credit risk relationship and short term lead-lag relation exist between stock market and bond market, the Gonzalo and Granger credit risk price discovery contribution test statistics is not available at this point. These rest results implies that stock market provides most of the credit risk price discovery contribution and credit derivatives market has a second important contribution while the bond market contributes least to credit risk price discovery. The test results are consistent with hypothesis 3.

6.5 Conclusions about credit risk price discovery across overall market

It is found that in long run, stock and bond market, credit derivative and bond market are cointegrated for credit risk price discovery; however, no long run credit risk equilibrium relationship exists between stock market42and credit derivatives market. In short term both the stock market and credit derivative market drive (Granger cause) the bond market for short term credit risk price discovery. From this study we conclude that among three markets stock market provides above 80% of price discovery contribution for credit risk and drives bond market. Credit derivatives market is also leading the bond market in short term credit risk price discovery, however, comparing to the stock market, credit derivatives market's credit risk price discovery contribution is much less than the stock market. The empirical findings in this study on credit risk price discovery are consistent with the liquidity and trading cost explanations of previous studies on price discovery.

CHAPTER 7

RATINGS AND CREDIT RISK PRICE DISCOVERY

Last chapter's test results of credit risk price discovery among the overall equity market, bond market and credit default swap market suggest that, by controlling the credit ratings factor and maturities factor, the overall equity market and the overall credit derivatives market are leading the bond market in price discovery of market implied credit risk, but the credit risk price discovery relationship between the equity market and the credit derivatives market is not clear. This chapter I will extend the credit risk price discovery study from overall market to the rating segments of different financial markets to test the influence of ratings on financial market's credit risk discovery process. Based on Merton model, the correlations of equity market implied credit risk and bond market implied credit risk are different for the high rating firms and low rating firms. Since for low rating firms both the equity holders and bondholders face the same high default risk, the equity market and bond market thus are highly correlated for low rating firms than for high rating firms, because low rating firms operate at a high bankruptcy risk level and a short distance to default. Therefore we could expect a high credit risk price discovery correlation between the stock market and bond market for low rating firms, while a low credit risk price discovery correlation between the stock and the bond market for the high rating firms. Another possible influence of ratings is on the credit risk price discovery process between the credit derivatives market and bond market. Since the low rating firms face more credit risk than high rating firms, the bondholders of low rating firms are more inclined to hedge their credit risks in credit derivatives markets while the bondholders of high rating firms who have less credit risk will not be very active in credit derivatives trading. Therefore for the low rating firms we expect a high credit risk price discovery correlation between the credit derivatives market and bond market and for the high rating firm a low credit risk price discovery relationship between the credit derivative markets and bond markets.

This chapter I will examine the influences of ratings on credit risk price discovery among the equity market, bond market and credit derivatives market by testing rating segments of bond market and rating segments of the credit derivatives market from January 2000 to October 2007. For convenience, rating segments of stock market are not developed for testing in this study. In bond markets both the invest grade rating segments which include AAA, AA, A and BBB segments and the high yield grade rating segments which include BB,B,CCC,CC and D segments are tested. For credit derivatives market, the rating segments of investment grade credit derivative swap market and the rating segments of high yield credit derivative swap market including BB, B and high beta market are tested. I expect a high correlated credit risk price discovery relationship occurring in high yield markets rather than in investment grade markets.

For stock market I still use S&P500 index as the proxy for the overall equity market. The overall stock market implied credit risk is measured by default distance (DD1) which is calculated from S&P500 index by applying Merton model (1976). For bond market, the investment grade rating segments and high yield rating segments are tested. For credit derivative markets also both the investment grade rating segments of credit default swap (CDS) market and high yield rating segment of credit swap market (CDS) segments are included. The bond market implied credit risk is measured by bond market yield spread over US treasury. In this study I use JPMorgan bond market indices as the proxies for the bond market for the reason that JPMorgan provides bond market indices considering all maturities which enable them to represent the different bond market segments to control the maturity factor. In bond markets, the implied credit risk of investment grade rating segments AAA, AA, A and BBB are measured by JULIAAABST, JULIAABST, JULIABST and JULIBBBBST which are the JP

Morgan investment grade segment bond market index spread over US treasury rate respectively. The market implied credit risk of high yield rating segments are measured by the JULIXBBBST, HYBBST, HYBST, HYCCCST, HYCCST, and HYDSTW which are the JP Morgan high yield segment bond market index spread over US treasury rate respectively. For credit default swap markets the market implied credit risk of investment grade rating segment is measured by the CDXIGSM which is the spread of the investment grade index CDXIG over LIBOR. Also the credit risk of high yield rating CDS market segments are measured by the CDXHY1005YSM, CDXHYBB5YSM, CDXHYB5YSM, and CDXHYHB5YSM which are the yield spread of high yield rating segment CDX index over LIBOR respectively.

Figure-C.1 to Figure-C.4 plots the time series of market implied credit risk of different rating segments in equity, bond and credit derivatives markets from January 2000 to October 2007. Similarly to Figure-B.1 to Figure-B.7 in chapter 6, in between January and March 2002 the stock market implied credit risk reached peak (lowest DD) while the yield spreads (over US treasury) of all rating segments in bond market and the CDS spreads of all rating segments in CDS market approached the highest point. During July 2007 a jump occurred in bond market yield spread and CDS spread when stock market experienced a temporary falling down. Table-C.1 shows the summary statistics for the market implied credit risk of these ratings segments in equity, bond and credit derivatives market from January 2000 to October 2007.

7.1 Time series characteristics and unit root test

Table-C.2 reports the univariate ARIMA analysis of each time series. The ARIMA analysis is tested with and without intercept and trend in which 1, 2 lags and 5 lags are tested respectively for each time series. From the table we can see that the stock market implied credit risk-default distance (DD1) is AR (1) process with intercept but no trend. In investment grade bond market rating segments, the AAA rating bond market yield spread JULIAAABST is AR (4) with intercept and no trend. The yield spreads of all other rating segments of investment grade bond market, JULIAABST, JULIABST, and JULIBBBST are all AR (2) with intercept and no trend. Among high yield bond market rating segments, the yield spreads of JPMHYBSTW is AR(2) with intercept and no trend, while JULIXBBBST and JPMHYBBSTW are AR(1) with intercept and no trend. All below B high yield rating segments, JPMHYCCCSTW, JPMHYCCSTW, and JPMHYDSTW are AR (1) with intercept and trend. Investment grade credit default swap market implied credit risk spread CDXIG5YSM is AR(1) process with intercept and trend; In rating segments of high yield credit default swap market, the CDS spread of CDXHY1005YSM and CDXHYBB5YSM are AR(1) process with intercept and trend, while the CDS spread of CDXHYB5YSM and CDXHYHB5YSM are AR(2) process with intercept and trend.

The stationarity (or unit root) of the time series is also first analyzed before applying the time series methodologies to test credit risk price discovery of each rating segments. The stationarity of market risk implied credit risk spread is a function of the span of the data and not the number of observations (Shiller and Peron, 1985). According to Joutz, Mansi and Maxwell (2000)'s study, the investment horizon drives the data frequency chosen and the form of the model considered. Hence in this study the conclusion on unit root tests of market implied credit risk could be appropriate since the sample collected for this study is the weekly data spanning from January 2000 to October 2007. I examine the stationarity of the market implied credit risk and credit spreads by applying the Augment Dickey-Fuller (ADF) and the Phillips-Perron unit root test statistics.

Table-C.3 reports unit root test results for the stationarity of market implied credit risk. Both the Augmented Dickey-Fuller (ADF) unit root test method and Phillips-Perron unit root test method with structural break are used to test the stationarity of each implied credit risk time series. The ADF tests are conducted with 1, 2, and 5 lags with or without intercept and trend respectively. The Phillips-Perron unit root tests are conducted with structural break shift at February 2002 when the market was most volatile. Panel A reports the ADF and PP unit root tests for equity and CDS market rating segments implied credit risk spread, both ADF and PP tests failed to reject the null hypothesis of unit root for equity market and CDS market rating segments implied credit risk spreads. However, the first differences of these credit spreads are stationary, and thus the stock market implied credit risk-default distance (DD) being I(1), Investment grade CDS market index spread CDXIGSM being I(1); High yield CDS market rating segments CDXHY1005YSM, CDXHYBB5YSM, CDXHYB5YSM and CDXHYHBSM being I(1); Panel B provides stationarity test results of bond market rating segments. Both the ADF and PP test results suggest that the market implied credit risk spread of all rating segments are non-stationary. In investment grade bond market rating segments, all JULIAAABST, JULIAABST, JULIABST, JULIBBBBST are I(1). In high yield bond market rating segments, all JULIXBBBST, JPMHYBBSTW, JPMHYBST, JPMHYCCCSTW, JPMHYCCSTW, and JPMHYDSTW are I(1). Similar to unit root test results in chapter 6, The unit root tests of rating segments implied credit risk spread also suggest the non-stationarity characteristics of the rating segments credit spread , which is consistent with credit spreads as being non-stationary at least when examining the variables over a short investment horizon.

7.2 Long term credit risk price discovery in rating segments - Cointegration test

The unit root test results suggest that the time series of all rating segments implied credit risk are non-stationary. While for individual market the market implied credit risk time series is non-stationary, however, for several markets the market implied credit risk time series may move together and a linear combination of these variables are stationary. The existing of a stationary linear combination of several non-stationary time series indicates a cointegrated long-run relationship of credit risk among these financial markets. In terms of credit risk price discovery the cointegration of market implied credit risk series means that in long run the cointegrated financial markets could reach an equilibrium status on credit risk price discovery.

Like chapter 6, I test for the presence of a cointegration vector among the equity, bond market rating segments and credit default swap market rating segments by using Johansen maximum likelihood procedure for a finite-order vector autoregression (Johansen, 1988 and 1991). The Johansen trace test for cointegration is used to test whether long run credit risk equilibrium relationship exists among stock, bond and credit derivative market rating segments. If in the long run these markets are cointegrated regarding the market implied credit risk, it implies that stock market, bond market and credit derivatives market rating segments could equally provide price discovery of credit risk in long run.

I estimate a system of market implied credit risk series of stock market and bond market, bond market and credit default swap market, and stock market and credit default swap market using 1 lag, 2 and 5 lags respectively. The null hypothesis is that there is no cointegrating vector (rank=0), and the alternative hypothesis is that there is a single cointegrating vector (rank=1). Observing that a jump occurred to all market implied credit risk series in between February and March 2002, I also estimate the Johansen cointegration test with and without the structural break at February 2002.

Table-C.4 panel A reports the pair-wise results of Johansen cointegration test of market implied credit risk among invest grade market rating segments. Without the structural break, we can see not any pair-wise cointegration existing between the investment grade equity market and bond market, bond market and CDS market, and also the equity market and CDS market; While with structural break at February 2002, most of the pair-wise cointegration tests for investment grade rating segments are not significant except that equity market and AA rating bond market, equity and A rating market, and investment grade CDX market and BBB rating bond market are cointegrated. Panel A suggests that in long run the credit risk price discovery among investment grade rating segments are not significant. This evidence is consistent with our rating hypothesis that investment grade markets provide less credit risk price discovery.

Table-C.4 Panel B reports the pair-wise results of Johansen cointegration test of market implied credit risk among high yield market rating segments. Without the structural break, we found that equity market and D rating bond market are cointegrated, equity market and all CDS rating segments are not cointegrated, while all B, C rating bond market and CDS market are cointegrated.; While with structural break at February 2002, most of the pair-wise cointegration tests for high yield ratings are significant except that equity market and high beta rating CDS market. Panel B suggests that in long run the credit risk price discovery among high yield rating segments are significant which means that for high yield markets, the equity market, bond market and CDS market provides long run price discovery for credit risk. By comparing the long run credit risk cointegration tests in Table-C.5 we found that in long run the high yield markets provides more credit risk price discovery than the investment grade markets since most of the high yield rating segments are cointegrated while most of the investment grade rating segments are not cointegrated in long run. This finding is consistent with the rating hypothesis that in long run high yield markets provides more credit risk price discovery than the investment grade markets.

Table-C.5 reports the cointegration test results among three markets. Panel A reports the investment grade rating segments cointegration tests among three markets and Panel B reports the high yield rating segments cointegration tests among three markets. In Panel A, both with structural break and without the structural break, we found only two cointegration existing, equity market, investment grade CDS market and AA rating bond market, and the other one, equity market, investment grade CDS market and A rating bond market. In Panel B for high yield rating segments, both with break and without structural break, all high yield rating segments of the equity market, bond market and CDS market are cointegrated. Again, the three market cointegration test results are consistent with the pair-wise cointegration test results among two markets. In long run, most of the high yield rating segments is cointegrated while most of the investment grade rating segments are not. From Table-C.4 pair-wise cointegration tests and Table-C.5 three markets cointegration tests we could conclude that in long run the high yield markets provide more credit risk price discovery than the investment grade markets. This evidence also supports the rating hypothesis 4.

7.3 Short term credit risk price discovery in rating segments – Lead lag relationship

After the long term equilibrium relationship tests, the short term lead-lag relationship is tested using bivariate Engle-Granger causality tests. The bivariate Engle-Granger causality between two markets is tested in the vector autoregression (VAR) system and in the vector error correction model (VECM) if two markets are cointegrated. Table-C.6 Panel A reports the lead-lag relationship test results for investment grade rating segments. From the table the Granger causality tests suggest that equity market DD1 is leading the investment grade bond markets (JULIAAABST, JULIAABST, JULIABST, JULIBBBBST) on credit risk price discovery. Stock market implied default distance-DD1 grange-causes yield spread changes in all investment grade bond market rating segments. No lead-lag relationship exists between the stock market and investment grade CDS market. And for investment grade bond market rating segments and investment grade CDS market, only the investment grade CDS market CDXIG5YSM is leading the BBB rating bond market while no lead-lag relationship existing between the investment grade CDS market and other above BBB rating investment grade bond markets.

Table-C.6 Panel B reports the lead-lag relationship test results for high yield rating segments. For equity market and high yield bond market, the equity market implied default distance-DD1 is leading the BB and B rating bond market segments, however, the equity market does not grange-cause the CCC, CC, and D rating bond market segments. For the stock market and high yield CDS market, the DD1 is leading the CDXHY1005YSM and BB, B high yield rating CDS market segments, but no lead-lag relationship exists between the stock market and high beta CDS market. And for high yield bond rating segments and high yield CDS market rating segments, only B rating high yield CDS market is leading the B rating high yield bond market, while no lead-lag relationship exists between the high yield bond market rating segments and high yield CDS market rating segments. In stock market and bond market, the Granger causality test results only suggests that the stock market is leading both the investment grade and high yield grade bond market rating segments. For stock market and credit derivative markets, the stock market is leading the high yield CDS market while no lead-lag relationship between the stock market and investment grade CDS market. For high yield bond market and high yield CDS market, no lead-lag relationship exists between most of the investment grade and high yield rating segments. From rating hypothesis of credit risk price discovery, we expect a significant lead-lag relationship among the high yield market rating segments. But from Table-C.6 we did not found evidence suggesting that in high yield rating segments more leading-lag relationship existing than in the investment grade rating segments. However, the rating segment causality test still suggests a significant lead-lag relationship between the stock market and both the investment grade and high yield bond market. This evidence confirms our findings in chapter 6 that stock market is leading the bond markets in credit risk price discovery in short run. However, in short run the lead-lag relationship between the bond market and CDS market is not clear both in investment grade and high yield rating segments.

Finally, for stock market and CDS market rating segments, no short term leading-lag relationship are reported between the stock market and investment grade CDS market rating segments, and stock market and high yield CDS market rating segments. This finding is similar to the chapter 6's result that the lead-lag relationship between stock market and credit derivative market is unclear.

From the Engle-Granger causality test results, we did not find evidence supporting the rating hypothesis in short run which suggests that high yield rating segments is leading the investment grading rating segments. In short term, the high yield market does not provide more credit risk price discovery than the investment grade markets. However, the results confirm the credit risk price discovery relationship between the stock market and bond markets that in short term stock market is leading both the investment grade bond market and high yield bond market. One of the possible reasons is that the CDS market is still in its early developing phase.

7.4 Financial markets' contribution to credit risk price discovery in rating segments

According to our modified Merton model (Figure 3.1) in hypothesis 4, we expect a higher correlation among equity, bond and credit default swap market in low rating segments than in high rating segment. Table-C.7 reports Gonzalo and Granger common factor component price discovery contribution tests for rating's influence on the credit risk price discovery process among the equity, bond and credit default swap market. In investment grade segments of stock market and bond market, we found that stock markets contribute 100% price discovery for credit risk, while bond market does not provide a contribution. For investment grade segments of stock market and credit derivatives market, neither of these two markets provides credit risk price discovery contributions statistically. For investment grade credit derivative market and bond market, A ratings bond market contributes to credit risk price discovery but none of the A ratings credit derivative market provides price discovery for credit risk.

In high yield rating segments market, we found that stock market provides 100% price discovery contribution for credit risk in BB, B, and CCC rating segments, but no high yield bond markets contribute to the credit risk price discovery process between the stock market and high yield bond market. For stock market and high yield credit default swap market, neither market contributes to the price discovery of credit risk. For high yield credit derivative market and bond market, high yield bond market contributes 100% price discovery contribution while high yield credit derivatives market did not provides any contribution. From Table 7-7 we conclude that ratings influence on the credit risk price discovery process is mainly occurring in the equity market and credit default swap market, but little influences happened to the stock market and bond market, and credit derivatives market and bond market. In high yield credit default swap market and stock market, we found the stock market contributes 100% credit risk price discovery to BB rating CDS market. However, in high grade credit default swap market and stock market, the stock market did not provide any price discovery contributions.

7.5 Conclusions about ratings influences on credit risk price discovery

In this chapter we test the ratings influences on the credit risk price discovery among the equity, bond and credit derivative markets. The test results only partially supports that the high yield markets will provide more credit risk price discovery than the investment grade markets.

For the long run equilibrium credit risk price discovery relationship, we find that with structural break in 2002 almost all high yield rating segments are cointegrated among equity, bond and CDS market, while for the investment grade rating segments, most of rating segments are not cointegrated except equity market and AA rating bond market, equity and A rating market, and investment grade CDX market and BBB rating bond market.

I conclude that in long run the high yield rating segments provide more credit risk price discovery than the investment grade rating segments. For the short term lead-lag relationship, stock market is leading both the investment grade and high yield bond market rating segments. The causality tests between the stock market and both investment grade and high yield bond rating segments are not significant. Also no leading-lag relationship is found between the investment grade and high yield bond rating segments and CDS market rating segments. The short term leading-lag relationship between the stock market and bond market rating segments confirms the findings in Chapter 6 that stock market is leading the bond market. However, no short term leading-lag relationship existing among the equity market and CDS market, bond market and CDS market.

I only found that rating has influences on the long run equilibrium credit risk price discovery among equity, bond and CDS market, but in the short term, rating’s influence is not significant on leading-lag relationship of credit risk price discovery among equity market and CDS market, and bond market and CDS market. One of possible reasons is that the CDS market is still in its early developing stage. Liquidity has a more important role than the rating factor in short term credit risk price discovery.

CHAPTER 8

MATURITY AND CREDIT RISK PRICE DISCOVERY

Finally, the influences of maturities on the financial market's credit risk price discovery process are investigated in this chapter. In addition to the rating's influences on the price discovery process of credit risk, another possible important factor which may affect the credit risk price discovery is the credit markets' time to maturity. Based on Merton model, the default risk of a firm is negatively correlated with the time to maturity. A firm with long maturity debts is facing more credit risk than a firm with short maturity debts. The correlations of equity market implied credit risk and bond market implied credit risk are different for firms with long maturity debts and those with short maturity securities. For firms with long maturity debts, both the equity holders and bondholders face the same high default risk, therefore it is reasonable that the equity market and bond market thus are highly correlated for firms with long maturity debts than for firms with short maturity debts since firms with long maturity debts operate at a high bankruptcy risk level and a short distance to default. We then could expect a high credit risk price discovery correlation between the stock market and bond market for firms with long maturity debts, while a low credit risk price discovery correlation between the stock and the bond market for the those firms with short maturity debts.

Another possible influence of maturity is on the credit risk price discovery process between the credit derivatives market and bond market. Since firms with long maturity debts face more credit risk than firms with short maturity debts , the bondholders of firms with long maturity debts are more inclined to hedge their credit risks in credit derivatives markets while the bondholders of firms with short maturity securities who have less credit risk will not be very active in credit derivatives trading. Therefore for firms with long maturity debts we expect a high credit risk price discovery correlation between the credit derivatives market and bond market, and for firms with short maturity debts a low credit risk price discovery relationship between the credit derivative markets and bond markets.

In this chapter I will examine the influences of maturity on credit risk price discovery among the equity market, bond market and credit derivatives market by testing different maturity segments of equity, bond market and credit default swap market from January 2000 to October 2007. The maturity segments for stock market implied credit risk-default distance (DD) are developed by using Merton model. In bond markets both different maturity segments of investment grade bond market and maturity segments of the high yield bond markets are tested. Similar to equity market, the bond market maturity segments are divided into one to three years, three to five years, five to seven years, seven to ten years and more than ten years segments. For credit derivatives market, also both the maturity segments of investment grade credit derivative swap market and the maturity segments of high yield credit derivative swap market are tested. Again the maturity segments of one to three years, three to five years, five to seven years, seven to ten years and more than ten years are divided for credit default swap markets. I expect a highly correlated credit risk price discovery relationship occurring in long maturity markets rather than in short maturity markets.

For stock market I still use S&P500 index as the proxy for the overall equity market. The default distance at different horizon DD13, DD35, DD57, DD710 and DD10PLUS are calculated from S&P500 index by using Merton model (1976): DD13 the default distance on horizon one to three years, DD35 the default distance on horizon three to five years, DD57 the default distance on horizon five to seven years, DD710 the default distance with horizon seven to ten years, and DD10PLUS the default distance with horizon more than 10 years. For bond market, the investment grade rating segments and high yield rating segments are tested. For credit derivative markets also both the investment grade rating segments of credit default swap (CDS) market and high yield rating segment of credit swap market (CDS) segments are included. The bond market implied credit risk is measured by bond market yield spread over US treasury. I still use JPMorgan bond market maturity segment indices as the proxies of implied credit risk in different bond market maturity segment. For investment bond market maturity segments 1-3 year, 3-5 year, 5-7 year, 7-10 year, and over 10 years, the implied credit risk is measured by JULI13BST, JULI35BST, JULI57BST, JULI710BST, and JULI10PLUSBST. The implied credit risk of crossover bond market maturity segments are measured by JULIX13BST, JULIX35BST, JULIX57BST, JULIX710BST and JULIX10PLUSBST. The implied credit risk of high yield bond market maturity segments are measured by JPMHY13STW, JPMHY35STW, JPMHY57STW, JPMHY710STW and JPMHY10PLUSSTW. Similarly, the market implied credit risk of investment grade credit default swap market maturity segments of 3-year, 5-year, 7-year, and 10-year are measured by CDXIG3YSM, CDXIG5YSM, CDXIG7YSM, and CDXIG10YSM, which are respectively the 3year, 5 year, 7 year and 10 year CDXIG spread over LIBOR. And finally the market implied credit risk of high yield credit default swap market maturity segments of 3-year, 5-year, 7-year, and 10-year rating segment are measured by CDXHY3YSM, CDXHY5YSM, CDXHY7YSM, and CDXHY10YSM which are the 3 year, 5 year, 7 year, and 10 year CDXHY spread over LIBOR.

Figure-D.1 to Figure-D.5 plots the time series of market implied credit risk of different maturity segments in equity, bond and credit derivatives markets from January 2000 to October 2007. Similarly to Figure-C.1 to Figure-C.1 in chapter 7, in between January and March 2002 the stock market implied credit risk reached peak (lowest DD) while the yield spreads (over US treasury) of all maturity segments in bond market and the CDS spreads of all maturity segments in CDS market approached the highest point. During July 2007 a jump occurred in bond market yield spread and CDS spread when stock market experienced a temporary falling down. Table-

D.1 shows the summary statistics for the market implied credit risk of these ratings segments in equity, bond and credit derivatives market from January 2000 to October 2007.

8.1 Time series characteristics and unit root test

Table-D.2 reports the univariate ARIMA analysis of each time series. The ARIMA analysis is tested with and without intercept and trend in which 1, 2 lags and 5 lags are tested respectively for each time series. From the table we can see that the stock market implied credit risk-default distance of different maturity segments DD13, DD35, DD57, DD710 and DD10PLUS are all AR (1) process with intercept but no trend. In investment grade bond market maturity segments, all maturity segments implied credit risk time series JULI13BST, JULI35BST, JULI57BST, JULI710BST and JULI10PLUSBST are AR (2) with intercept and no trend. The market implied credit risk of maturity segments of crossover bond markets JULIX13BST, JULIX35BST, JULIX57BST, JULIX710BST, and JULIX10PLUSBST are AR(1) with intercept and no trend. Among high yield bond market maturity segments, the yield spread of JPMHY13STW is AR(1) with intercept and trend. JPMHY35STW and JPMHY57STW are AR(2) with intercept and no trend. JPMHY710STW is AR(2) with intercept and trend, while JPMHY10PLUSSTW is AR(1) with intercept and no trend. All investment grade credit default swap market implied credit risk spread of different maturity segments, CDXIG3YSM, CDXIG5YSM, CDXIG7YSM and CDXIG10YSM are AR(1) process with intercept and no trend; In maturity segments of high yield credit default swap market, All CDS spread of different maturity segments CDXHY3YSM, CDXHY5YSM, CDX7YSM and CDX10YSM are also AR(1) process with intercept and no trend.

Table-D.3 reports unit root test results for the stationarity of market implied credit risk of different maturity segments in equity, bond and credit default swap markets. Both the Augmented Dickey-Fuller (ADF) unit root test method and Phillips-Perron unit root test method with structural break are used to test the stationarity of each implied credit risk time series. The ADF tests are conducted with 1, 2, and 5 lags with or without intercept and trend respectively.

The Phillips-Perron unit root tests are conducted with structural break shift at February 2002 when the market was most volatile. Panel A reports the ADF and PP unit root tests for equity and CDS market maturity segments implied credit risk spread, both ADF and PP tests failed to reject the null hypothesis of unit root for equity market and CDS market maturity segments implied credit risk spreads. However, the first differences of these credit spreads are stationary, and thus all maturity segments of stock market implied credit risk-default distance, DD13, DD35, DD57, DD710 and DD10PLUS being I(1). For all investment grade CDS market maturity rating segments, the implied credit risk CDXIG3YSM, CDXIG5YSM, CDXIG7YSM and CDX10YSM are also I(1); Table 8-3 also reports that high yield CDS market maturity segments CDXHY3YSM, CDXHY5YSM, CDXHY7YSM and CDXHY10YSM are I(1), non stationary. Table-D.3 Panel B provides stationarity test results of market implied credit risk of bond market maturity segments. Both the ADF and PP test results show that the all market implied credit risk spread of investment grade bond market maturity segments and high yield bond market maturity segments are non-stationary. In investment grade bond market maturity segments, JULIX13BST, JULIX35BST, JULIX57BST, JULIX710BST, and JULIX10PLUSBST are I(1). In high yield bond market maturity segments, JPMHY13STW, JPMHY35STW, JPMHY57STW, JPMHY710STW and JPMHY10PLUSSTW are all I(1). The unit root tests of rating segments implied credit risk spread also suggest the non-stationarity characteristics of the rating segments credit spread , which is consistent with credit spreads as being non-stationary at least when examining the variables over a short investment horizon. However, the ADF and PP test of crossover bond market maturity segments show the stationarity of the market implied credit spread of these maturity segments. Thus a different methodology is applied to the crossover bond market in the later testing of the credit risk price discovery in crossover bond market based on the stationarity of the crossover bond market implied credit risk.

8.2 Long term credit risk price discovery among maturity segments - Cointegration test

The unit root test results suggest that the implied credit risk of stock market maturity segments, investment grade bond market maturity segments, high yield bond market maturity segments, investment grade credit default swap market maturity segments, high yield credit default swap market maturity segments are non-stationary. But the implied credit risk of crossover bond market maturity segments is stationary. While for individual market the market implied credit risk time series is non-stationary, however, for several markets the market implied credit risk time series may move together and a linear combination of these variables are stationary. The existing of a stationary linear combination of several non-stationary time series indicates a cointegrated long-run relationship of credit risk among these financial markets. In terms of credit risk price discovery the cointegration of market implied credit risk series means that in the long run the cointegrated financial markets could reach an equilibrium status on credit risk price discovery.

Similar to previous chapters, I test for the presence of a cointegration vector among the equity, bond market maturity segments and credit default swap market maturity segments by using Johansen maximum likelihood procedure for a finite-order vector autoregression (Johansen, 1988 and 1991). The Johansen trace test for cointegration is used to test whether long run credit risk equilibrium relationship exists among stock, bond and credit derivative market maturity segments. If in the long run these markets are cointegrated regarding the market implied credit risk, it implies that stock market, bond market and credit derivatives market maturity segments could equally provide price discovery of credit risk in long run.

I estimate a system of market implied credit risk series of stock market and bond market, bond market and credit default swap market, and stock market and credit default swap market using 1 lag, 2 and 5 lags respectively. The null hypothesis is that there is no cointegrating vector (rank=0), and the alternative hypothesis is that there is a single cointegrating vector (rank=1). Observing that a jump occurred to all market implied credit risk series in between February and March 2002, I also estimate the Johansen cointegration test with and without the structural break at February 2002.

Table-D.4 Panel A reports the pair-wise results of Johansen cointegration test of market implied credit risk among different maturity segments of equity market and bond market, credit default swap maturity segments and equity maturity segments. Without the structural break at February 2002, most of the pair-wise cointegration tests for equity market maturity segments and bond market maturity segments are not significant except that the 5-7 year default distance and 5-7 year crossover bond market credit spread is cointegrated. While with structural break at February 2002, we can see several long maturity market implied credit risk are cointegrated: 1) long maturity stock market implied credit risk, the 10 year plus default distance, and the long maturity investment grade bond market credit spread, JULIX10PLUSBST, is cointegrated; 2) stock market implied 5-7 year default distance is cointegrated with 5-7 year crossover bond market; 3) stock market implied 7-10 year default distance is cointegrated with 5-7 year crossover bond market 4) stock market implied 10 year plus default distance is cointegrated with 10 year plus crossover bond market. Also in Table-D.4 Panel A no cointegration between short maturity (less than 5 years) stock market implied default distance and short maturity (less than 5 years) is reported. This evidence suggests that the long term credit risk price discovery (cointegration) occurs between the equity market and long maturity bond market, however, in short maturity bond market and stock market no such long term cointegration exists for long term credit risk price discovery. For the stock market and credit default swap maturity segments, when testing without structural break, no cointegration reported in Table-D.4 Panel A for any stock market maturity segments and investment grade credit default swap market maturity segments, stock market and high yield credit default swap maturity segments. With a structural break, we found that 3-5 year and 5-7 year default distance and 3-5 year, 5-7 year investment grade credit default swap market are cointegrated, also stock market and all high yield grade credit default swap market maturity segments are cointegrated. From these results, we can see that again stock market and high yield credit default swap market are high correlated in long term which confirms hypothesis 3. However, no conclusive finding about the long term credit risk price discovery process between the maturity segments of stock market and credit default swap markets could be made.

Table-D.4 Panel B reports the pair-wise results of Johansen cointegration test of market implied credit risk between bond market maturity segments and credit default swap market maturity rating segments. With and without the structural break, we found that all investment grade credit defaults swap market maturity segments and all investment grade bond market maturity segments are cointegrated. This result repeats our findings about the investment grade credit default market and investment grade bond market, but does not imply and maturity influence on the investment grade bond market and investment grade CDS market. At the same time, when testing with and without the structural break, we found that all high yield credit defaults swap market maturity segments and all high yield bond market maturity segments are cointegrated. Again, this results repeats our cointegration findings about the high yield credit default market and high yield bond market, but does not imply and maturity influence on the high yield bond market and high yield CDS market.

The results of Panel B suggests that in long run the credit risk price discovery among bond market and credit derivative markets are significant, which confirms our finding in hypothesis 3 that, in the long run, the bond market and credit derivative market are cointegrated for credit risk price discovery. However, since all maturity segments of investment grade bond market and CDS market, and all maturity segments of high yield bond market and CDS market are cointegrated, we could not reach any conclusions about the maturity influences on the long term credit risk price discovery between the bond market and CDS market. The influence of maturity factor in inconclusive.

Table-D.5 reports the cointegration test results among maturity segments of equity, bond and credit derivative market. Again, mixed cointegration results are reported. The influence of maturity on long-term credit risk price discovery is inconclusive from this test and further study is warranted.

8.3 Short term credit risk price discovery in maturity segments – Lead lag relationship

After the long term equilibrium relationship tests, the short term lead-lag relationship is tested using bivariate Engle-Granger causality tests. The bivariate Engle-Granger causality between two markets is tested in the vector autoregression (VAR) system and in the vector error correction model (VECM) if two markets are cointegrated. Table-D.6 Panel A reports the lead-lag relationship test results for maturity segments of equity market and bond market. From the table the Granger causality tests suggest that all maturity segments of equity market is leading the corresponding maturity segment of investment grade bond market and high yield bond market on short term credit risk price discovery. This finding confirms that stock market is leading the bond market in short term price discovery, but does not support our hypothesis that long maturity segment has more credit price discovery function than the short maturity segments.

Table-D.6 Panel B reports the lead-lag relationship test results for maturity segments of stock market and credit derivative market. We found no lead-lag relationship reported for most rating segments of stock market and credit derivative market except that 3-5year, 5-7 year, and 10 year maturity stock market implied default distance is leading the 3-5 year, 5-7 year, and 10 year plus CDS market. This finding is also suggesting that the leading-lag relationship between the stock market and credit derivative market is not obvious which is consistent with our findings in hypothesis 2.

Finally, Table-D.6 Panel C reports the Engle-Granger causality test of maturity segments between the bond market and credit defaults swaps market. We found that both the short maturity segments, 1-3 year, 3-5 year and 5-7 year of investment grade credit default swap market and the short maturity segments of high yield credit default swap market are leading the short maturity segments of investment grade bond market and short maturity segments of high yield bond market respectively. However, no lead-lag relationship are reported between long maturity segment of credit default swap market (investment grade and high yield grade) and long maturity of bond market (investment grade and high yield market). From lead-lag testing in previous chapters, we know that in short term credit derivative market is leading the bond market in credit risk price discovery, the finding in Table-D.4 Panel C again partially confirms the previous findings. But, the maturity factor influences is contrary to our hypothesis, while the short maturity segments provides more lead-lag relationship than the long maturity segments for credit risk price discovery.

From the Table-D.6 Engle-Granger causality test of maturity segments among equity, bond and credit derivative markets, and the results confirms the lead-lag relationship discovery in previous chapter, but results about influences of the maturity on short term credit risk price discovery is mixed and inconclusive. I did not find evidence supporting the maturity hypothesis which suggests that in short run long maturity segments is providing more credit risk price discovery than short maturity segments. The influence of maturity on credit risk price discovery needs further study.

8.4 Financial markets' contribution to credit risk price discovery in maturity segments

According to our modified Merton model (Figure 3.1) in hypothesis 5, we expect a higher correlation among equity, bond and credit default swap market in long maturity segments than in short segment. Table-D.7 reports Gonzalo and Granger common factor component price discovery contribution tests for maturity's influence on the credit risk price discovery process among the equity, bond and credit default swap market. In short maturity segments of stock market and bond market, we found that stock markets contribute 100% price discovery for credit risk to high grade long maturity bond markets, while bond market don't provide any contributions. For short maturity segments of stock market and credit derivatives market, neither of these two markets provides credit risk price discovery contributions statistically. For short maturity credit derivative market and bond market, short maturity investment grade bond market contributes to credit risk price discovery but none of the short maturity investment grade credit derivative market provides price discovery for credit risk.

In long maturity segments market, we found that stock market provides 100% price discovery contribution to both investment grade bond markets and high yield bond market, but no long maturity bond markets contribute to the credit risk price discovery process between the stock market and bond market. For stock market and long maturity credit default swap market, stock markets provide 100% price discovery contribution to long maturity high yield credit default swap market, but no contributions to credit risk price discovery in long maturity investment grade credit default swap market. For long maturity credit derivative market and bond market, long maturity bond market contributes 100% price discovery contribution to the credit risk price discovery in both long maturity investment grade credit derivatives market and long maturity high yield credit derivatives market.

From Table-D.7 we can see that maturity influence on the credit risk price discovery process is mainly occurring in the equity market and credit default swap market, but little influences happened to the stock market and bond market, and credit derivatives market and bond market. In long maturity credit default swap market and stock market, we found the stock market contributes 100% credit risk price discovery to long maturity high yield credit default swap market, but no contributions to long maturity investment grade credit derivatives market. However, in short maturity credit default swap market and stock market, both stock market and credit derivative market did not provide any price discovery contributions.

In summary, from price discovery contribution perspective, the maturity has no influence on the credit risk price discovery between stock market and bond market, credit derivatives market and bond market. The only influence of the maturity occurred between the stock market and high yield credit derivatives market in which stock market contributes 100% price discovery to long maturity high yield credit default market but no contribution to the long maturity investment grade credit default swap market.

8.5 Conclusions about maturity influences on credit risk price discovery

In this chapter we test the maturity influences on the credit risk price discovery among the equity, bond and credit derivative markets. The evidence of maturity influence on the financial market's credit risk price discovery process is mixed and inconclusive. In both long maturity and short maturity segments tests, we get the similar results in Chapter 6 overall market tests and Chapter 7 ratings influence tests that 1) the stock market is leading the bond market; and 2) the credit derivatives market is leading the bond market. The only evidence of maturities influence on financial market credit risk price discovery occurred in the stock market and credit derivatives market. The long maturity high yield credit derivatives market will price discovery contribution to the stock market than the short maturity high yield credit derivatives market. The test results only partially supports hypothesis 5 that long maturity markets will provide more credit risk price discovery than short maturity markets. Further studies are needed.

CHAPTER 9

CONCLUSIONS AND FUTURE RESEARCH

This study investigates financial markets' price discovery for credit risk across the stock, bond, and credit derivatives markets from January 2000 to October 2007. This study also aims to investigate what factor affects financial market's price discovery for credit risk. Four factors are studied: liquidity, transaction cost, credit ratings and maturities.

From the study we found that in long run, stock and bond market, credit derivative and bond market are cointegrated for credit risk price discovery; however, no long run credit risk equilibrium relationship exists between stock market and credit derivatives market. In short term both the stock market and credit derivative market drive (Granger cause) the bond market for short term credit risk price discovery. However, the credit risk price discovery relationship between the stock market and credit derivatives market is unclear both in the short term and the long run. From this study we conclude that among three markets stock market provides above 80% of price discovery contribution for credit risk and drives bond market. Credit derivatives market is also leading the bond market in short term credit risk price discovery, however, comparing to the stock market, credit derivatives market's credit risk price discovery contribution is much less than the stock market. The empirical findings in this study on credit risk price discovery are consistent with the liquidity and trading cost explanations of previous studies on price discovery.

The test of the ratings influences on the credit risk price discovery among the equity, bond and credit derivative markets only partially supports that the high yield markets will provide more credit risk price discovery than the investment grade markets. For the long run equilibrium credit risk price discovery relationship, we find that with structural break in 2002 almost all high yield rating segments are cointegrated among equity, bond and CDS market, while for the investment grade rating segments, most of rating segments are not cointegrated except equity market and AA rating bond market, equity and A rating market, and investment grade CDX market and BBB rating bond market. We conclude that in long run the high yield rating segments provide more credit risk price discovery than the investment grade rating segments. For the short term lead-lag relationship, stock market is leading both the investment grade and high yield bond market rating segments. The causality tests between the stock market and both investment grade and high yield bond rating segments are not significant. Also no leading-lag relationship is found between the investment grade and high yield bond rating segments and CDS market rating segments. The short term leading-lag relationship between the stock market and bond market rating segments confirms that stock market is leading the bond market. However, no short term leading-lag relationship existing among the equity market and CDS market, bond market and CDS market. We only found that rating has influences on the long run equilibrium credit risk price discovery among equity, bond and CDS market, but in the short term, rating's influence is not significant on leading-lag relationship of credit risk price discovery among equity market and CDS market, and bond market and CDS market. One of possible reasons is that the CDS market is still in its early developing stage. Liquidity has a more important role than the rating factor in short term credit risk price discovery.

The evidence of influences of maturity on the financial market's credit risk price discovery process is mixed and inconclusive. In both long maturity and short maturity segments tests, we get the similar results that 1) stock market is leading the bond market; and 2) credit derivatives market is leading the bond market in credit risk price discovery. The only evidence of maturities influence on financial market credit risk price discovery occurred in the stock market and credit derivatives market. The long maturity high yield credit derivatives market will price discovery contribution to the stock market than the short maturity high yield credit derivatives market. The test results only partially supports hypothesis 5 that long maturity markets will provide more credit risk price discovery than short maturity markets.

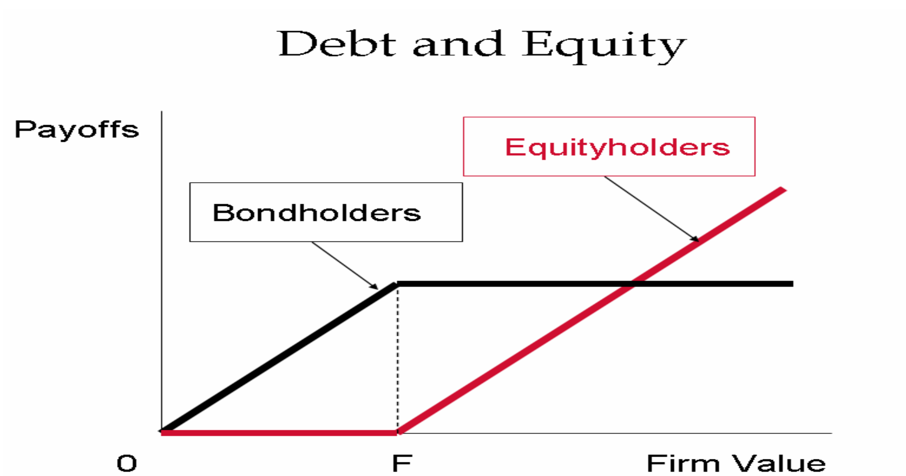
Finally, it is found from this study that the liquidity factor plays a significant role in the financial market's credit risk price discovery, which is consistent with the liquidity and trading cost explanations of other previous price discovery research.

Future research can be extended in several ways. First, this study tests the influences of the liquidity, transaction cost, maturity and credit ratings influence on credit risk price discovery. According to the Merton model, the asset volatility is also a factor that affects the default risk. We can extend this present study to test the financial market's credit risk price discovery under different market conditions, such as normal, volatile and stress periods. Second, current research empirically examines credit derivative market influences on the credit risk price discovery within the Merton structural framework. However, a theoretical linkage between the credit derivatives market and stock market is better established by extending the Merton structural framework. Third, the credit risk price discovery research can be extended from the stock market, bond market, and credit derivatives market to credit securitized market, such as collateral debt obligation (CDOs) market, collateral loan obligation (CLOs) market, and asset backed securities (ABS) market. Fourth, this research studies financial markets' price discovery for corporate borrowers. The future studies could also include the consumer's credit risk price discovery in financial markets. My dissertation will be the foundation or platform for this overall research agenda.

APPENDIX A

MERTON MODEL

The trigger of the default event of a company is that the asset value (A) of a company falls below the face value (D) of all debt obligations. The face value of the debt is the exercise price of the put option of the equity. If the firm's liabilities are approximated as a single issue of pure discount debt with face value D maturing at date T, then the boundary condition for the equity (E) of the firm at date T is $E_T = \max\{0, A_T - D\}$, which is identical to the boundary condition for a call option. This shows that equity is a call option on the assets of the firm with exercise price equal to the face vale of its debt obligations (D).



Let E_0 and A_0 be the values of equity and asset today and ET and AT are their values at time T, assuming the asset value a lognormal diffusion process, then the current equity price is therefore

$$E_0 = A_0 N(d_1) - De^{-rT} N(d_2)$$

where

$$d_1 = \frac{\ln(A_0 e^{r/T} / D)}{\sigma_A \sqrt{T}}) + 0.5\sigma_A \sqrt{T}$$

$$d_2 = d_1 - \sigma_A \sqrt{T}$$

This is exactly the BS call option pricing equation. σ_A is the volatility of the asset value, and r is the risk-free rate, both of which are assumed to be constant.

Define $D^*=D_e r^{-T}$ as the present value of the face value of the debt obligations and let L=D*/A be the measure of leverage, then using these definitions the equity value is

$$E_0 = A_0[N(d_1) - LN(d_2)] \tag{1}$$

where

$$d_1 = \frac{\ln(L)}{\sigma_A \sqrt{T}} + 0.5\sigma_A \sqrt{T}$$
$$d_2 = d_1 - \sigma_A \sqrt{T}$$

Because the equity value is a function of the asset value (Jones et al 1984), by using Ito lemma we can determine the instantaneous volatility of the equity from the asset volatility

$$E_0 \sigma_E = \frac{\partial E}{\partial A} A_0 \sigma_A$$

where σE is the instantaneous volatility of the company's equity at time zero. From equation 1, we have

$$\sigma_E = \frac{\sigma_A N(d_1)}{N(d_1) - LN(d_2)} \tag{2}$$

The distance to default (DD) can be calculated by DD=(A-D)/σ_A , which is d_1.

Then the risk-neutral probability P that the company will default by time T is the probability that shareholders will not exercise their call option to buy the assets of the company for D at time T. The probability of default (PD) is given by

$$PD = 1 - P(DD) = 1 - N(d_1) = N(-d_2) \tag{3}$$

The probability of default (PD) depends on the leverage L, the asset volatility σ_A, and the time to maturity T.

Implied credit spread of the risky debt from Merton model

We can use Merton model to derive the yields on the risky debt securities. Define B_0 as the market price of the debt at time zero. The value of the assets at any time equals to the total value of the debt financing and equity.

$$B_0 = A_0 - E_0$$

Substituting it into equation 1, we get

$$B_0 = A_0[N(-d_1) + LN(d_2)] \tag{4}$$

The yield to maturity on the debt is defined implicitly by

$$B_0 = De^{-yT} = D^* e^{(r-y)T}$$

Substituting it into equation 4 and using A_0=D*/L gives the yield to maturity y as

$$y = r - \ln[N(d_2) + N(-d_1)/L]/T$$

The credit spread s implied by the Merton model is therefore

$$s = y - r = -\ln[N(d_2) + N(-d_1)/L]/T \tag{5}$$

Same as the risk-neutral probability of default (PD) in equation 3, the implied credit spread depends only on leverage L, the asset volatility σ_A, and the time to maturity T.

APPENDIX B

FIGURES AND TABLES IN CHAPTER 6

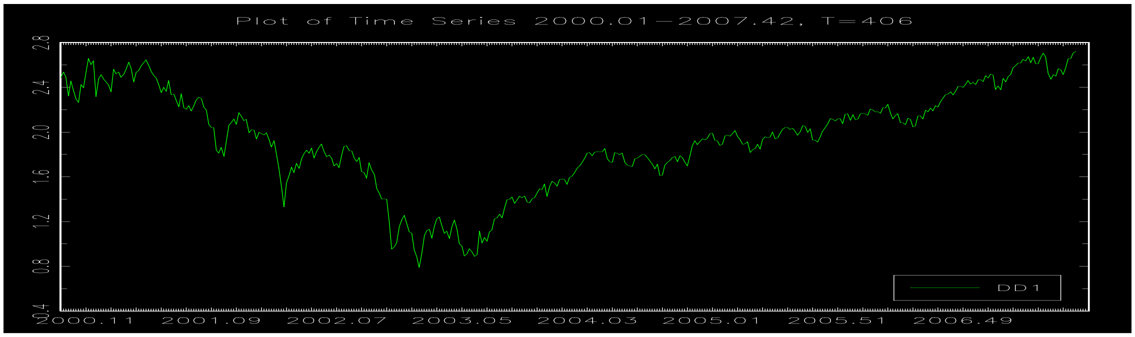


Figure B-1 Plot of stock market implied credit risk – Default Distance (DD) (01/2000-10/2007)

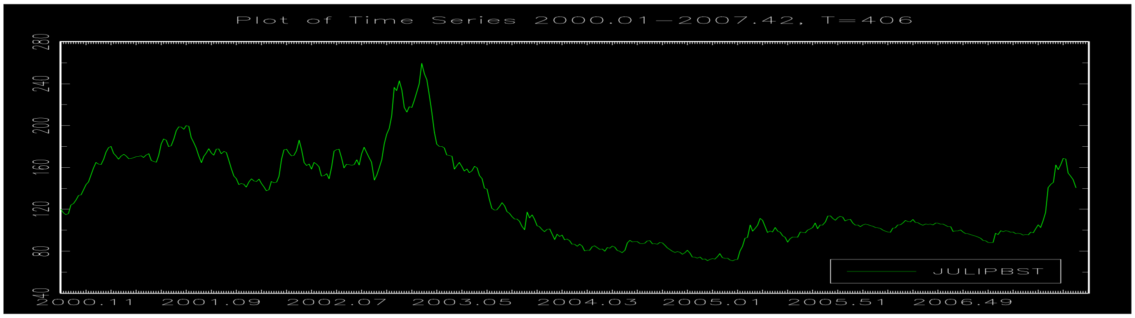


Figure B-2 Plot of Bond market yield spread over US treasury (JULI plus index over US treasury) (01/2000-10/2007)

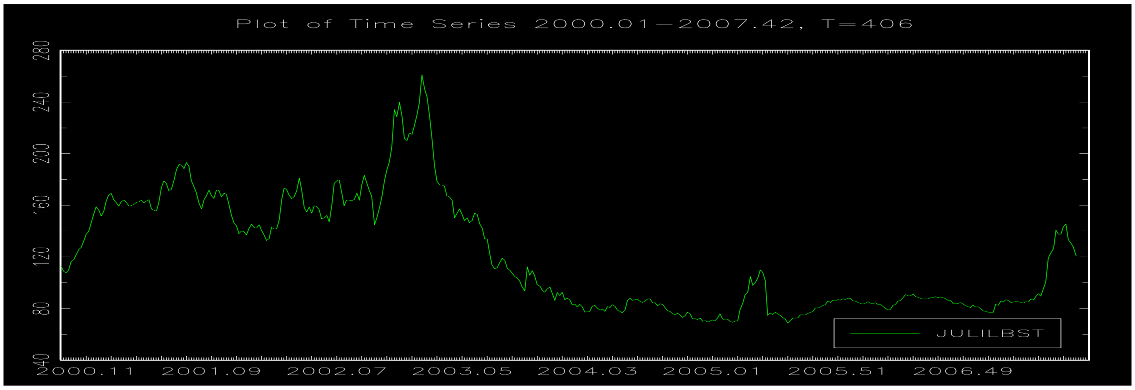


Figure B-3 Plot of liquid bond market yield spread over US treasury (JULI Liquid index over US treasury) (01/2000-10/2007)

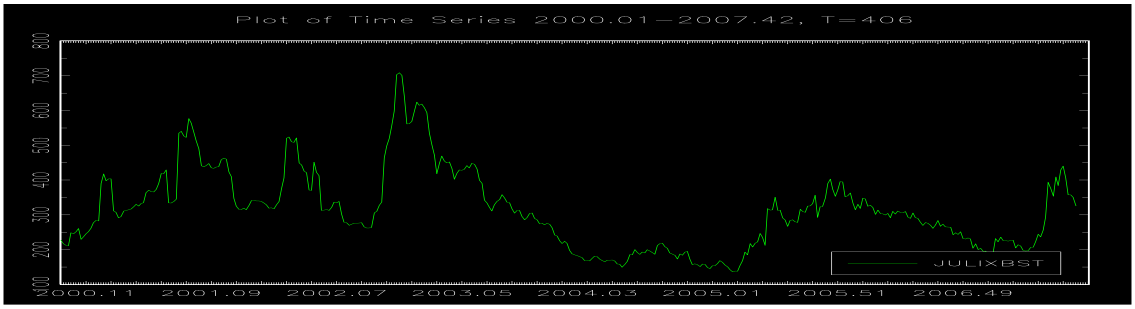


Figure B-4 Plot of crossover bond market yield spread over US treasury (JULI Crossover Index over US treasury) (01/2000-10/2007)

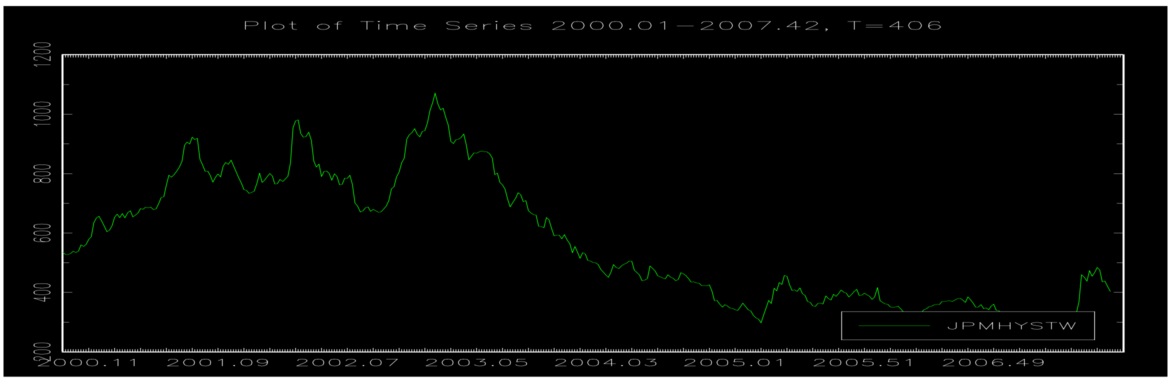


Figure B-5 Plot of high yield bond market yield spread over US treasury (JPMorgan High Yield index over us Treasury) (01/2000-10/2007)

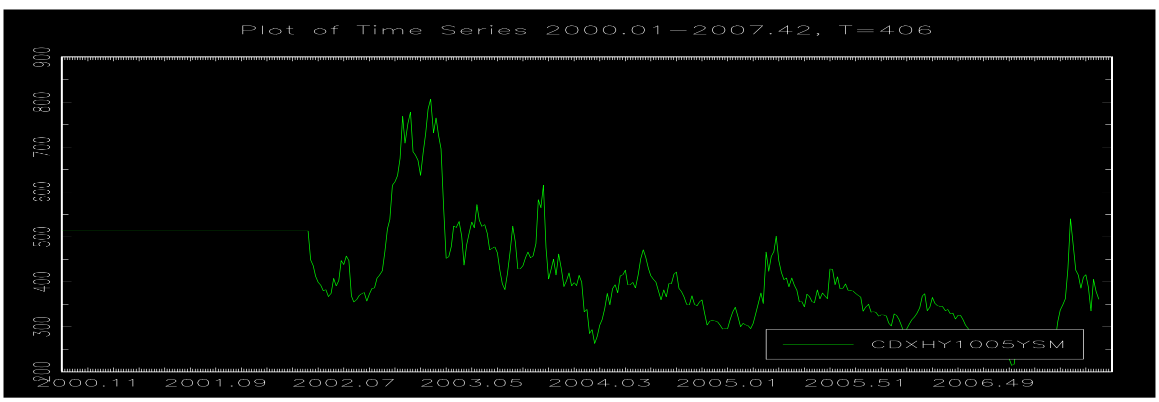


Figure B-6 Plot of high yield credit default swap market index spread. (01/2000-10/2007)

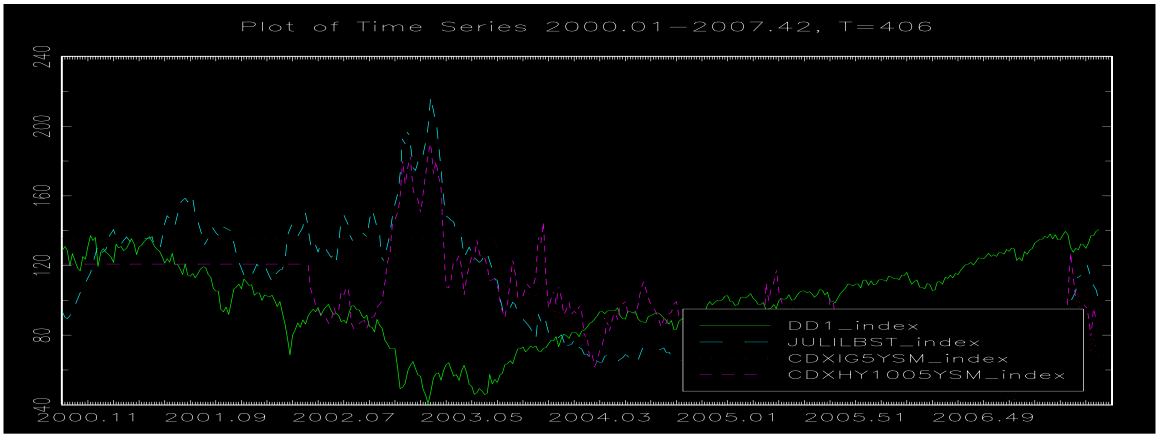


Figure B-7 Stock market implied DD, Bond market yield spread over US treasury and High yield credit default swap market index spread. (01/2000-10/2007)

Table B-1 Summary statistics of market implied credit risk from January 2000 to October 2007

This table reports the summary statistics of implied credit risk of stock market, bond market and credit derivative market respectively. DD1 is the stock market implied credit risk-default distance. JULIBST is the investment grade bond market yield spread over US treasury; JULILBST is the liquid bond market yield spread over US treasury; JULIPBST is the overall bond market (Including investment grade and high yield bond market) yield spread over US treasury; JULIXBST is the crossover bond market yield spread over US treasury; and JPMHYSTW is the high yield bond market yield spread over US treasury. In credit derivative market, the 5-year investment grade CDS market index spread CDXIG5YSM and 5-year high yield CDS index spread CDXHY1005YSM are provided.

Market	Variable	Mean	Minimum	Maximum	Std.Dev	Skewness	Kurtosis	Normality (JARQUE-BERA Test)	P-value(Chi^2)
Equity Market									
	DD1	1.9377	0.7883	2.7231	0.4531	-0.4134	2.5393	15.1525	0.0005
Bond Market									
	JULIBST	120.7440	68.6785	250.2560	42.9439	0.6102	2.2153	35.6109	0.0000
	JULILBST	120.4080	68.6564	261.0920	43.7001	0.7075	2.5474	37.3319	0.0000
	JULIPBST	129.2090	70.7323	259.3870	41.4517	0.6241	2.5425	29.8930	0.0000
	JULIXBST	312.6970	136.1050	708.6120	112.5630	0.8390	3.6409	54.5785	0.0000
	JPMHYSTW	572.7370	266.3890	1071.2200	211.7730	0.3769	1.8128	33.4571	0.0000
Credit Derivative Market									
	CDXIG5YSM	70.0428	29.6250	95.0000	23.4694	-0.1424	1.4007	15.1525	0.0005
	CDXHY1005YSM	424.7940	213.7670	807.0500	108.3440	0.6747	3.7201	39.5785	0.0000

Table B-2 Univariate ARIMA analysis of market implied credit risk

Panel A shows the univariate ARIMA analysis for stock market implied default distance (DD1) and credit default swap market spread from January 2000 to October 2007. Intercept and trend are tested respectively with 2 lags and 5 lags. DD1 is AR (1) with intercept and no trend. CDXIG5YSM is AR (1) with intercept and trend. CDXHY1005YSM is AR (1) with intercept and trend.

Panel A			**Equity Market**	**Credit derivative market**			
			DD1	**CDXIG5YSM**		**CDXHY1005YSM**	
			T-statistics	**T-statistics**	**P-value**	**T-statistics**	**P-value**
No Intercept, No Trend	2-lags without intercept	AR1	19.63402**	20.48706**	0.0000	21.18897**	0.0000**
		AR2	0.6279	-0.2580	0.7966	-0.9843	0.3256
	5-lags without intercept	AR1	19.5585**	20.28142**	0.0000	21.06662**	0.0000**
		AR2	0.8724	-1.4847	0.1384	-0.26134	0.7940
		AR3	-1.5734	0.4998	0.6175	-0.83402	0.4048
		AR4	0.1880	0.6128	0.5404	-0.33073	0.7410
		AR5	1.3838	0.3003	0.7641	1.13647	0.2564
With Intercept, No Trend	2-lags with intercept	AR1	19.45996**	20.33829**	0.0000	20.76827**	0.0000**
		AR2	0.5509	-0.3271	0.7438	-1.29372	0.1965
		Constant	6.89564**	4.72043**	0.0000	11.70027**	0.0000**
	5-lags with intercept	AR1	19.39341**	20.1507**	0.0000	20.60838**	0.0000**
		AR2	0.8628	-1.4872	0.1377	-0.26326	0.7925
		AR3	-1.5657	0.4956	0.6204	-0.81708	0.4144
		AR4	0.1791	0.5990	0.5495	-0.33282	0.7395
		AR5	1.3261	0.2663	0.7901	0.81467	0.4158
		Constant	6.50701**	4.254**	0.0000	11.47352**	0.0000**
With Intercept, With Trend	2-lags with intercept with trend	AR1	19.43013**	19.89724**	0.0000	20.4242**	0.0000**
		AR2	0.5443	-0.6671	0.5051	-1.62891	0.1041
		Constant	4.51509**	17.88774**	0.0000	15.06871**	0.0000**
		Trend	0.3310	-6.85268**	0.0000	-3.95332**	0.0001**
	5-lags with intercept with trend	AR1	19.36484**	19.79055**	0.0000	20.18563**	0.0000**
		AR2	0.8611	-1.4709	0.1421	-0.25402	0.7996
		AR3	-1.5664	0.4110	0.6813	-0.83641	0.4034
		AR4	0.1819	0.6839	0.4945	-0.30806	0.7582
		AR5	1.3200	-0.0728	0.9420	0.42684	0.6697
		Constant	4.35506**	15.94607**	0.0000	15.54373**	0.0000**
		Trend	0.3279	-6.01487**	0.0000	-4.0941**	0.0001**

** significant at 95% confidence level

Table B-2 -Continued

Panel B shows the univariate ARIMA analysis for bond market implied credit risk – yield spread over US treasury. Intercept and trend are tested respectively with 2 lags and 5 lags. Investment grade bond market index spread JULIBST is AR (2) with intercept and no trend. Liquid bond market index spread JULILBST is AR (2) with intercept and no trend. Overall bond market index JULIPBST is AR (2) with intercept and no trend. Crossover bond market index spread is AR (1) with intercept and no trend. High yield bond market index JPMHYSTW is AR (2) with intercept and trend.

Panel B			**Bond Market**									
			JULIBST		**JULILBST**		**JULIPBST**		**JULIXBST**		**JPMHYSTW**	
			T-statistics	**P-value**	**T-statistics**	**P-value**	**T-statistics**	**P-value**	**T-statistics**	**P-value**	**T-statistics**	**P-value**
No Intercept, No Trend	2-lags without intercept	AR1	27.42023**	0.0000	27.26024**	0.0000	27.93292**	0.0000	22.88628**	0.0000	25.57256**	0.0000**
		AR2	-6.27315**	0.0000	-6.15408**	0.0000	-6.67731**	0.0000	-2.59689**	0.0098	-4.79134**	0.0000**
	5-lags without intercept	AR1	25.83926**	0.0000	25.80031**	0.0000	26.07059**	0.0000	22.52605**	0.0000	24.4713**	0.0000**
		AR2	-2.6599	0.0081	-2.73492**	0.0065	-2.62322**	0.0090	-0.8962	0.3707	-2.01615**	0.0445**
		AR3	-0.4662	0.6413	-0.5033	0.6150	-0.4777	0.6331	-0.2747	0.7837	-0.4900	0.6244
		AR4	-1.4381	0.1512	-1.3797	0.1684	-1.6191	0.1062	-1.2936	0.1966	0.1166	0.9073
		AR5	1.7781	0.0762	1.9033	0.0577	1.8351	0.0672	1.2568	0.2096	-0.5475	0.5844
With Intercept, No Trend	2-lags with intercept	AR1	27.22915**	0.0000	27.06487**	0.0000	27.73687**	0.0000	22.55665**	0.0000	25.42037**	0.0000**
		AR2	-6.32883**	0.0000	-6.22534**	0.0000	-6.75397**	0.0000	-2.86129**	0.0044	-4.81045**	0.0000**
		Constant	6.06225**	0.0000	6.12626**	0.0000	7.06984**	0.0000	8.14567**	0.0000	4.41557**	0.0000**
	5-lags with intercept	AR1	25.57512**	0.0000	25.5272**	0.0000	25.76585**	0.0000	22.05178**	0.0000	24.29276**	0.0000**
		AR2	-2.63111**	0.0088	-2.70644**	0.0071	-2.58764**	0.0100	-0.8648	0.3877	-2.00097**	0.0461
		AR3	-0.4558	0.6488	-0.4940	0.6216	-0.4627	0.6438	-0.2513	0.8017	-0.4823	0.6299
		AR4	-1.4192	0.1566	-1.3611	0.1742	-1.5900	0.1126	-1.2711	0.2044	0.1217	0.9032
		AR5	1.6576	0.0982	1.7730	0.0770	1.6726	0.0952	0.9061	0.3655	-0.6030	0.5468
		Constant	6.02917**	0.0000	5.99765**	0.0000	7.142**	0.0000	8.61831**	0.0000	4.66694**	0.0000**
With Intercept, With Trend	2-lags with intercept with trend	AR1	27.23**	0.0000	27.06752**	0.0000	27.74093**	0.0000	22.52845**	0.0000	25.37797**	0.0000**
		AR2	-6.42093**	0.0000	-6.32901**	0.0000	-6.82189**	0.0000	-2.9151**	0.0038	-4.87971**	0.0000**
		Constant	6.12775**	0.0000	6.16891**	0.0000	5.96952**	0.0000	5.51366**	0.0000	5.70755**	0.0000**
		Trend	-1.44608	0.1489	-1.5056	0.1330	-1.0666	0.2868	-0.7915	0.4291	-1.6429	0.1012
	5-lags with intercept with trend	AR1	25.48611**	0.0000	25.43754**	0.0000	25.69427**	0.0000	21.99053**	0.0000	24.19715**	0.0000**
		AR2	-2.61881**	0.0092	-2.69564**	0.0073	-2.57708**	0.0103	-0.8593	0.3907	-1.98709**	0.0476**
		AR3	-0.4498	0.6531	-0.4896	0.6247	-0.4568	0.6481	-0.2476	0.8046	-0.4793	0.6320
		AR4	-1.3914	0.1649	-1.3328	0.1834	-1.5626	0.1190	-1.2617	0.2078	0.1462	0.8839
		AR5	1.5151	0.1305	1.6317	0.1035	1.5474	0.1226	0.8205	0.4125	-0.7306	0.4655
		Constant	6.18129**	0.0000	6.01149**	0.0000	6.18543**	0.0000	5.98303**	0.0000	6.58762**	0.0000**
		Trend	-1.4650	0.1437	-1.4276	0.1542	-1.1515	0.2502	-0.9456	0.3450	-2.04651**	0.0414**

Table B-3 Unit root test

The Augmented Dickey-Fuller and Phillips-Perron test for unit root results are reported in this table. Intercept and trend are tested with 2,5,10 and 16 lags respectively. The Phillips-Perron unit root tests are conducted with structural break shift at February 2002 when the market was most volatile. Both ADF tests and PP tests report that 1) stock market implied DD1 is I(1); 2) investment grade CDS index spread CDXIG5YSM is I(1); 3) high yield CDS index spread CDXHY1005YSM is stationary I(0) with intercept and trend.

	Equity Market		**Credit Derivative Market**			
Levels	**DD1**		**CDXIG5YSM**		**CDXHY1005YSM**	
No Intercept, No Trend	**ADF**	**PP**	**ADF**	**PP**	**ADF**	**PP**
2 lags	-0.0941		-1.2078		-0.9307	
5 lags	0.0812		-1.2517		-0.8748	
10 lags	0.0009		-1.2636		-0.8636	
16 lags	-0.0731		-1.3191		-0.8582	
Intercept, No Trend						
2 lags	-1.1821	-0.9156	-1.2057	-0.0869	-2.7969	-4.0723**
5 lags	-0.8742	-0.7102	-1.1153	0.2588	-2.4856	-3.9929**
10 lags	-0.8516	-1.2879	-1.0959	0.0338	-2.4361	-4.0548**
16 lags	-1.0394	-1.04	-1.0412	0.0677	-2.4044	-4.2985**
Intercept and Trend						
2 lags	-1.5911	-1.2818	-2.7473	-2.8971	-3.9529**	-4.1253**
5 lags	-1.3048	-1.0786	-2.5051	-2.4061	-3.5814**	-4.0255**
10 lags	-1.3879	-1.4268	-2.4485	-2.7425	-3.7213**	-4.162**
16 lags	-1.6087	-1.4341	-2.1112	-2.456	-4.0106**	-4.5132**
1st Difference	**DDI_d1**		**CDXIG5YSM_d1**			
No Intercept, No Trend	**ADF**		**ADF**			
2 lags	-12.4833**		-12.9991**			

** significant at 95% confidence level: Rejection of unit root

Table B-3 -Continued

The Augmented Dickey-Fuller and Phillips-Perron test for unit root results are reported in this table. Intercept and trend are tested with 2,5,10 and 16 lags respectively. The Phillips-Perron unit root tests are conducted with structural break shift at February 2002 when the market was most volatile. Both ADF tests and PP tests report that 1) investment grade bond market yield spread JULIBST is I(1); 2) liquid bond market yield spread JULILBST (1); 3) overall bond market yield spread is I(1); 4) crossover bond market yield spread JULIXBST is I(1) and 5) high yield bond market spread JPMHYSTW is I(1).

	Bond Market									
Levels	**JULIBST**		**JULILBST**		**JULIPBST**		**JULIXBST**		**JPMHYSTW**	
No Intercept, No Trend	**ADF**	**PP**	**ADF**	**PP**	**ADF**	**PP**	**ADF**	**PP**	**ADF**	**PP**
2 lags	-0.513		-0.5523		-0.4453		-0.7915		-0.6192	
5 lags	-0.4913		-0.4931		-0.397		-0.7411		-0.6476	
10 lags	-0.5903		-0.5806		-0.4967		-0.6839		-0.7144	
16 lags	-0.7359		-0.6999		-0.637		-0.8575		-0.7748	
Intercept, No Trend										
2 lags	-1.6991	-1.3337	-1.8075	-1.9718	-1.9071	-1.509	-2.88	-2.3643	-1.1136	-0.9033
5 lags	-1.4778	-1.2008	-1.5342	-1.6675	-1.6392	-1.3361	-2.6982	-2.326	-1.1832	-1
10 lags	-1.4417	-1.206	-1.4667	-1.6171	-1.6406	-1.3709	-2.6592	-2.398	-1.1238	-1.0225
16 lags	-1.5413	-1.4814	-1.553	-1.7727	-1.6704	-1.5763	-2.5042	-2.6473	-1.2532	-1.1608
Intercept and Trend										
2 lags	-2.6244	-1.4814	-2.771	-1.7369	-2.6121	-1.5737	-3.2903	-2.6535	-2.8112	-1.4232
5 lags	-2.1594	-1.2919	-2.2829	-1.4758	-2.1308	-1.3643	-3.091	-2.5672	-2.8021	-1.5498
10 lags	-1.8726	-1.2589	-1.9677	-1.4708	-1.9809	-1.3812	-3.1391	-2.6524	-2.8109	-1.5068
16 lags	-1.894	-1.5161	-2.0328	-1.6566	-1.916	-1.5893	-2.7989	-2.8742	-2.9408	-1.6735
1st Difference	**JULIBST_d1**		**JULILBST_d1**		**JULIPBST_d1**		**JULIXBST_d1**		**JPMHYSTW_d1**	
No Intercept, No Trend	**ADF**		**ADF**		**ADF**		**ADF**		**ADF**	
2 lags	-9.677**		-9.9153**		-9.3573**		-10.3428**		-9.7859**	

** significant at 95% confidence level: Rejection of unit root

Table B-4 Long-term credit risk price discovery between two markets (Pair-wise) – Cointegration tests

The long term credit risk equilibrium relationship among stock market, bond market and credit derivatives market are investigated by using cointegration test. This table reports results of the Johansen trace test for cointegration between two markets (pair-wise). The Johansen cointegration tests are conducted without structural break and with structural break at February 2002. Intercept and trend with 1,2,5 lags are tested respectively.

	Without Break						**With Break**					
	Intercept			**Intercept and Trend**			**Intercept**			**Intercept and Trend**		
Likelihood Ration (LR) r=0	**1 lag**	**2 lags**	**5 lags**	**1 lag**	**2 lags**	**5 lags**	**1 lag**	**2 lags**	**5 lags**	**1 lag**	**2 lags**	**5 lags**
Stock Market-Bond Market												
DD1-JULIBST	7.76	11.97	20.11	11.26	16.4	23.14	23.06	29.22**	36.52**	24.42	30.37**	38.41**
DD1-JULIPBST	7.73	11.76	20.47**	11.28	16.14	23.42	21.3	27.37**	35.15**	23.88	29.62**	38.38**
DD1-JULILBST	7.76	11.97	20.11	11.26	16.4	23.14	22.43	28.57**	35.15**	24.18	30.09**	37.38**
DD1-JULIXBST	7.45	9.69	15.82	12.53	15.3	20.58	21.15	24.28	29.42**	24.27	27.29	32.36**
DD1-JPMHYSTW	6.51	9.27	14.08	10.53	13.2	18.64	28.5**	26.6**	32.01**	28.41	26.55	32.64**
Stock Market- Credit Derivative Market												
DD1-CDXIG5YSM	10.42	11.36	12.71	16.07	17.34	16.03	22.92	24.29	25.96**	25.85	27.64	27.9
DD1-CDXHY1005YSM	12.12	14.19	17.62	19.16	22.1	24.48	23.27	27.07**	28.19**	23.68	27.74	29.96**
Bond Market - Credit Derivative Market												
CDXIG5YSM-JULIBST	9.35	13.86	11.77	19.14	24.27	18.54	30.12**	37.5**	30.13**	36.49**	44.96**	34.29**
CDXIG5YSM-JULIPBST	7.41	11.74	9.79	17.85	22.8	16.52	27.48**	34.51**	28.22**	33.34**	41.64**	31.89**
CDXIG5YSM-JULILBST	10.24	15.25	12.63	20.92	26.74**	20.12	29.11**	36.45**	29.73**	34.48**	42.53**	32.92**
CDXIG5YSM-JULIXBST	11.37	14.46	14.22	20.4	24.46	20.71	29.75**	34.36**	30.33**	34.39**	40.42**	34.7**
CDXIG5YSM-JPMHYSTW	18.73	19.1	18.02	27.85	28.56**	23.98	36.9**	37.62**	31.64**	42.91**	43.29**	34.77**
CDXHY1005YSM-JULIBST	18.3	19.37	14.93	21.73	24.1	19.45	30.18**	36.56**	28.26**	38.67**	43.47**	33.15**
CDXHY1005YSM-JULIPBST	18.18	19	14.35	23.3	24.53	19.94	27.41**	32.57**	25.34**	42.11**	44.87**	34.24**
CDXHY1005YSM-JULILBST	19.01	20.67**	15.68	22.73	25.86**	20.64	31.66**	38.44**	29.61**	41.22**	46.71**	35.69**
CDXHY1005YSM-JULIXBST	24.43**	25.21**	22.73**	34.09**	35.36**	33.28**	31.64**	34.06**	31.61**	44.11**	45.7**	42.66**
CDXHY1005YSM-JPMHYSTW	43.99**	32.67**	30.69**	49.02**	38.86**	37.83**	60.63**	50.32**	46.88**	62.5**	51.63**	48.63**

Table B-5 Long term credit risk price discovery among three markets– Cointegration tests

The long-term credit risk equilibrium relationship among stock market, bond market and credit derivatives market are investigated by using cointegration test. This table reports results of the Johansen trace test for cointegration among three markets. The Johansen cointegration tests are conducted without structural break and with structural break at February 2002. Intercept and trend with 1, 2, 5 lags are tested respectively.

Stock Market-Bond Market-Credit Derivative Market			**DD1-JULIBST-CDXIG5YSM**	**DD1-JULIPBST-CDXIG5YSM**	**DD1-JULILBST-CDXIG5YSM**	**DD1-JULIXBST-CDXIG5YSM**	**DD1-JPMHYSTW-CDXIG5YSM**
Without Break							
Intercept							
	1 lag	r=0	22.11	19.47	22.11	19.59	27.62
		r=1	8.24	7.45	8.24	8.04	6.98
	2 lags	r=0	28.68	25.68	28.68	22.83	28.65
		r=1	12	10.91	12	9.54	9.38
	5 lags	r=0	33.22	30.5	33.22	27.22	30.81
		r=1	15.27	13.15	15.27	11.66	14.11
Intercept and Trend							
	1 lag	r=0	32.87	31.48	32.87	28.37	34.98
		r=1	11.23	10.81	11.23	11.5	9.6
	2 lags	r=0	40.02	38.51	40.02	32.65	36.48
		r=1	16	15.43	16	13.85	12.48
	5 lags	r=0	39.93	38.06	39.93	33.76	35.62
		r=1	21.6	19.93	21.6	16.83	17.4
With Break							
Intercept							
	1 lag	r=0	40.18	38.16	39.48	38.45	45.95**
		r=1	18.14	15.89	17.6	15.97	21.68
	2 lags	r=0	48.74**	46.76**	47.7**	43.5**	45.88**
		r=1	23.59	21.36	23.09	18.16	23.42
	5 lags	r=0	46.88**	46.64**	45.37**	44.6**	43.66**
		r=1	27.23	25.98	26.43	23.15	23.72
Intercept and Trend							
	1 lag	r=0	49.14**	47.93**	48.7**	44.64	52.31**
		r=1	25.84	25.7	25.41	22.01	24.13
	2 lags	r=0	58.24**	57.31**	57.64**	50.64**	52.06**
		r=1	31.57	31.05	31.33	25.5	26.78
	5 lags	r=0	52.73**	53.03**	51.3**	49.39**	47.56
		r=1	31.9	31.86	31.38	28.37	27.22

Table B-5 -Continued

The long-term credit risk equilibrium relationship among stock market, bond market and credit derivatives market are investigated by using cointegration test. This table reports results of the Johansen trace test for cointegration among three markets. The Johansen cointegration tests are conducted without structural break and with structural break at February 2002. Intercept and trend with 1, 2, 5 lags are tested respectively.

Stock Market-Bond Market-Credit Derivative Market			DD1-JULIBST-CDXHY1005YSM	DD1-JULIPBST-CDXHY1005YSM	DD1-JULILBST-CDXHY1005YSM	DD1-JULIXBST-CDXHY1005YSM	DD1-JPMHYSTW-CDXHY1005YSM
Without Break							
Intercept							
	1 lag	r=0	34.49	35	34.49	30.69	52.53
		r=1	7.49	6.8	7.49	7.86	7.54
	2 lags	r=0	37.25**	36.64**	37.25**	32.93	44.89**
		r=1	12.12	11.41	12.12	10.64	10.32
	5 lags	r=0	40.74**	40.56**	40.74**	38.33**	46.42**
		r=1	19.87	19.06	19.87	18.86	15.37
Intercept and Trend							
	1 lag	r=0	39.51	43.02**	39.51	42.29**	56.96**
		r=1	11.35	11.08	11.35	12.73	11.8
	2 lags	r=0	42.44**	43.82**	42.44**	44.85**	49.28**
		r=1	16.85	16.43	16.85	16.26	14.43
	5 lags	r=0	44.74**	46.68**	44.74**	53.02**	51.65**
		r=1	23.61	23.05	23.61	24.1	20.19
With Break							
Intercept							
	1 lag	r=0	49.52**	48.05**	46.39**	42.02**	71.21**
		r=1	20.5	19.87	20.1	19.34	22.35
	2 lags	r=0	56.07**	52.69**	53.52**	46.34**	61.83**
		r=1	25.85	25.78	25.52	24.19	24.74
	5 lags	r=0	52.81**	51.08**	50.24**	51.83**	59.72**
		r=1	28.81	29.79	28.42	30.58	26.75
Intercept and Trend							
	1 lag	r=0	57.67**	63.17**	55.05**	54.61**	73.08**
		r=1	20.58	20.56	20.19	19.88	22.55
	2 lags	r=0	63.46**	66.48**	61.66**	58.67**	63.29**
		r=1	25.93	25.75	25.58	24.47	25.07
	5 lags	r=0	59.81**	63.56**	57.34**	62.98**	62.35**
		r=1	29.48	30.1	28.91	32.17	28.25

Table B-6 Short term credit risk price discovery – Lead-lag relationship tests

The short term credit risk price discovery-Lead-lag relationship is tested using bivariate Engle-Granger causality test within a vector autoregression (VAR) model or a vector error correction (VECM) model if the two markets are cointegrated. This table reports the lead-lag relationship (Engle-Granger causality) test results for stock market and bond market, stock market and credit derivatives market.

	Intercept			**Intercept and Trend**		
	1 lag	2 lags	5 lags	1 lag	2 lags	5 lags
Stock Market & Bond Market						
DD1-->JULIBST	**10.5131 (0.0000)	**6.8696 (0.0001)	**4.4206 (0.0002)	**9.9824 (0.0001)	**6.6946 (0.0002)	**4.4049 (0.0002)
JULIBST-->DD1	1.193 (0.3038)	1.1796 (0.3165)	0.8044 (0.5666)	1.2600(0.2842)	1.2607 (0.2868)	0.8615 (0.5228)
DD1-->JULIPBST	** 8.9287(0.0001)	** 6.2226(0.0004)	**3.8722 (0.0008)	**8.3539(0.0003)	**5.9264 (0.0005)	**3.7565 (0.0011)
JULIPBST-->DD1	0.8815 (0.4145)	0.7476 (0.5239)	0.7964 (0.5729)	0.9160 (0.4006)	0.7862 (0.5018)	0.8366 (0.5417)
DD1-->JULILBST	**9.6826(0.0001)	**6.4264 (0.0003)	** 4.2995(0.0003)	**9.2048 (0.0001)	**6.2544 (0.0003)	**4.2868 (0.0003)
JULILBST-->DD1	1.1089(0.3304)	1.0297 (0.3787)	0.7283(0.6269)	1.1920 (0.3042)	1.1249 (0.3381)	0.7851(0.5817)
DD1-->JULIXBST	**10.1707 (0.0000)	**13.3513 (0.0000)	**7.5821(0.0000)	**9.4028 (0.0001)	**12.6534 (0.0000)	** 7.2616(0.0000)
JULILXBST-->DD1	0.3352(0.7153)	0.2898(0.8328)	1.1421 (0.3359)	0.3198 (0.7264)	0.2495 (0.8617)	1.2151 (0.2961)
DD1-->JPMHYSTW	**9.6516 (0.0001)	**7.5393 (0.0001)	** 5.1182(0.0000)	**9.5342(0.0001)	**7.6267 (0.0000)	**5.3342 (0.0000)
JPMHYSTW-->DD1	0.9981 (0.3690)	0.7076 (0.5476)	0.8271 (0.5490)	1.1138 (0.3288)	0.8400 (0.4721)	0.8735 (0.5138)
Stock Market & Credit Derivatives Market						
DD1-->CDXIG5YSM	**7.3570 (0.0012)	**5.3145 (0.0023)	**3.5189(0.0050)	** 7.4610(0.0011)	**5.5934 (0.0017)	**4.2975 (0.0013)
CDXIG5YSM-->DD1	*2.6702 (0.0754)	**2.7854 (0.0466)	**2.6538(0.0245)	**3.4752 (0.0358)	*2.7039 (0.0517)	**2.3608(0.0426)
DD1-->CDXHY1005YSM	0.5648(0.5708)	0.6514 (0.5846)	1.1869 (0.3266)	0.6150(0.5432)	1.0163 (0.3906)	1.3909(0.2352)
CDXHY1005YSM-->DD1	1.8100 (0.1703)	*2.4729 (0.0683)	** 3.8914(0.0026)	1.5187(0.2254)	*2.2913 (0.0854)	**3.7869 (0.0032)

** significant at 95% confidence level; * significant at 90% confidence level

Table B-6 -Continued

The short term credit risk price discovery-Lead-lag relationship is tested using bivariate Engle-Granger causality test within a vector autoregression (VAR) model or a vector error correction (VECM) model if the two markets are cointegrated. This table reports the lead-lag relationship (Engle-Granger causality) test results for credit derivative market and bond market.

	Intercept			**Intercept and Trend**		
	1 lag	2 lags	5 lags	1 lag	2 lags	5 lags
Bond Market & Credit Derivatives Market						
CDXIG5YSM-->JULIBST	1.9479 (0.1438)	1.6521 (0.1767)	1.4967 (0.1778)	**3.6441 (0.0269)	*2.5243(0.0572)	*1.8180(0.0942)
JULIBST-->CDXIG5YSM	0.9699(0.3799)	0.8342 (0.4756)	1.6527 (0.1313)	1.3644 (0.2566)	0.9717 (0.4059)	1.1912 (0.3099)
CDXIG5YSM-->JULIPBST	1.3130 (0.2701)	0.8375 (0.4738)	1.1904 (0.3103)	0.8797 (0.4157)	0.8531 (0.4655)	1.4383 (0.1985)
JULIPBST-->CDXIG5YSM	1.4453(0.2368)	1.1760(0.3185)	1.6750 (0.1256)	1.9023 (0.1505)	1.3121 (0.2699)	1.5426(0.1628)
CDXIG5YSM-->JULILBST	2.1153 (0.1218)	1.7466 (0.1568)	1.4957 (0.1781)	**3.5288(0.0302)	*2.4351 (0.0643)	1.7603 (0.1059)
JULILBST-->CDXIG5YSM	1.0419(0.3536)	0.8526 (0.4657)	1.6718(0.1264)	1.4052(0.2464)	0.9836 (0.4003)	1.1983 (0.3061)
CDXIG5YSM-->JULIXBST	*2.8479 (0.0590)	** 3.1886(0.0236)	** 2.8288(0.0104)	1.8445(0.1593)	**2.7239 (0.0439)	**2.7772 (0.0117)
JULILXBST-->CDXIG5YSM	2.2710(0.1044)	1.8012 (0.1462)	0.6333 (0.7036)	* 2.8044 (0.0616)	* 2.2343(0.0836)	0.9093 (0.4880)
CDXIG5YSM-->JPMHYSTW	1.7396 (0.1768)	1.1584 (0.3253)	*2.0053 (0.0639)	1.6476 (0.1937)	1.0600 (0.3659)	1.7733(0.1031)
JPMHYSTW-->CDXIG5YSM	*2.7697 (0.0638)	2.0035(0.1128)	*1.9149 (0.0771)	**3.2663 (0.0391)	* 2.5134(0.0580)	** 2.1353(0.0485)
CDXHY1005YSM-->JULIBST	** 3.0450(0.0486)	1.9898 (0.1148)	*1.8221 (0.0934)	** 4.5479(0.0111)	**3.0932(0.0269)	** 2.1939(0.0427)
JULIBST-->CDXHY1005YSM	** 8.5158(0.0002)	**6.5904(0.0002)	**3.9469 (0.0008)	**8.1179 (0.0003)	**6.0940 (0.0005)	**3.8205 (0.0010)
CDXHY1005YSM-->JULIPBST	**5.2255 (0.0057)	*2.6005 (0.0517)	**2.4261(0.0257)	**6.2893 (0.0020)	**4.1157 (0.0068)	**3.2237 (0.0042)
JULIPBST-->CDXHY1005YSM	**8.6295 (0.0002)	**6.4157 (0.0003)	**4.4559 (0.0002)	** 8.1741(0.0003)	**5.9744 (0.0005)	4.4423(4.4423)
CDXHY1005YSM-->JULILBST	**2.8607 (0.0583)	1.9341 (0.1233)	1.6799(0.1244)	** 4.1582(0.0163)	**2.8229(0.0385)	*1.9750 (0.0681)
JULILBST-->CDXHY1005YSM	**8.5050 (0.0002)	** 6.3491(0.0003)	**3.6808 (0.0014)	**8.0676 (0.0004)	**5.8721 (0.0006)	**3.5710 (0.0018)
CDXHY1005YSM-->JULIXBST	*2.4214 (0.0900)	1.6865 (0.1692)	1.2861 (0.2623)	**3.0902 (0.0465)	**2.6974 (0.0455)	** 2.0447(0.0588)
JULILXBST-->CDXHY1005YSM	0.4937 (0.6107)	0.4303 (0.7314)	0.6442 (0.6949)	0.1883 (0.8284)	0.1877 (0.9047)	0.8458 (0.5351)
CDXHY1005YSM-->JPMHYSTW	**7.9917 (0.0004)	**5.3571 (0.0012)	**3.0471 (0.0063)	**7.8416 (0.0005)	**5.2472 (0.0015)	**2.9487 (0.0079)
JPMHYSTW-->CDXHY1005YSM	0.7048(0.4948)	0.4826 (0.6945)	0.6337 (0.7033)	0.6975 (0.4984)	0.4606 (0.7100)	0.6960 (0.6530)

** significant at 95% confidence level; * significant at 90% confidence level

Table B-7 Credit risk price discovery contribution tests

The financial markets' credit risk price discovery contributions are reported in this table. Gonzalo and Granger (1996) common factor component price discovery contribution methodology are used to test the credit risk price discovery contribution of stock market, bond market and credit derivatives market.

		Intercept and Trend			
		λ1(t-value)	**λ2(t-value)**	**GG1(Market1)**	**GG2(Market2)**
Market 1	**Market 2**				
Stock Market	**Bond Market**				
DD1	JULIBST	-0.092(-4.333)	1.407(1.007)	*93.86%	6.14%
DD1	JULIPBST	-0.088(-4.193)	0.842(0.568)	*90.54%	9.46%
DD1	JULILBST	-0.097 (-4.327)	2.391 (1.485)	*96.10%	3.90%
DD1	JULIXBST	-0.124(-4.096)	-1.434(-0.135)	*100%	0.00%
DD1	JPMHYSTW	-0.096 (-4.252)	15.533(2.312)	*99.38%	0.61%
Stock Market	**Credit Derivatives Market**				
DD1	CDXIG5YSM	-0.100 (-4.063)	5.611(3.211)		
DD1	CDXHY1005YSM	-0.102(-3.969)	36.517(2.769)		
Credit Derivatives Market	**Bond Market**				
CDXIG5YSM	JULIBST	-0.070 (-1.588)	0.083(2.113)	*54.24%	45.75%
CDXIG5YSM	JULIPBST	-0.086(-1.939)	0.076(1.770)	46.91%	*53.08%
CDXIG5YSM	JULILBST	-0.063(-1.426)	0.090(2.065)	*58.82%	41.18%
CDXIG5YSM	JULIXBST	-0.082(-2.559)	0.217 (1.402)	*72.%	27.42%
CDXIG5YSM	JPMHYSTW	-0.066 (-1.779)	0.400(2.642)	*85.84%	14.16%
CDXHY1005YSM	JULIBST	-0.101 (-2.251)	0.011(1.956)	9.82%	*90.17%
CDXHY1005YSM	JULIPBST	-0.090(-1.689)	0.0223(0.139)	19.86%	*80.142%
CDXHY1005YSM	JULILBST	-0.101 (-2.251)	0.011(1.956)	9.82%	*90.17%
CDXHY1005YSM	JULIXBST	-0.092(-2.100)	0.105(3.718)	*53.29%	46.70%
CDXHY1005YSM	JPMHYSTW	-0.042 (-0.966)	0.084(3.548)	*66.66%	33.33%

* The market which has a bigger credit risk price discovery in the pair

APPENDIX C

FIGURES AND TABLES IN CHAPTER 7

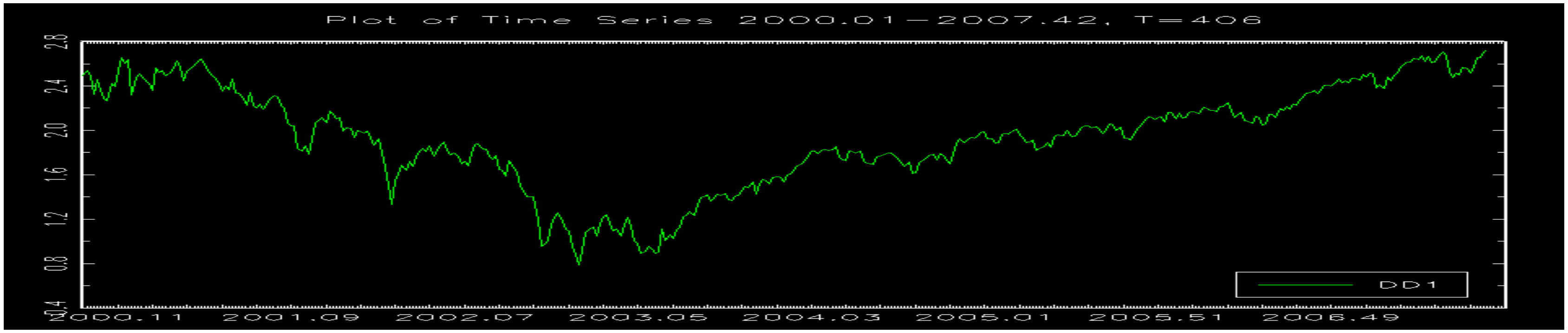


Figure C-1 Plot of stock market implied credit risk – Default Distance (DD) (01/2000-10/2007)

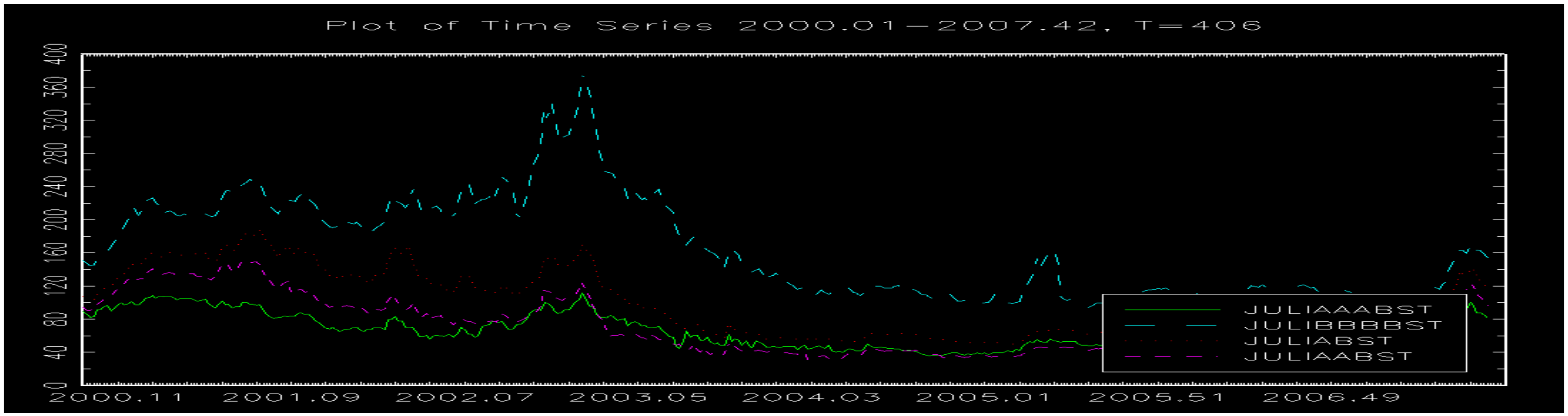


Figure C-2 Plot of investment grade bond market yield spread over US treasury (01/2000-10/2007): JULIAAA, JULIAA, JULIA, JULIBBB index spreads respectively

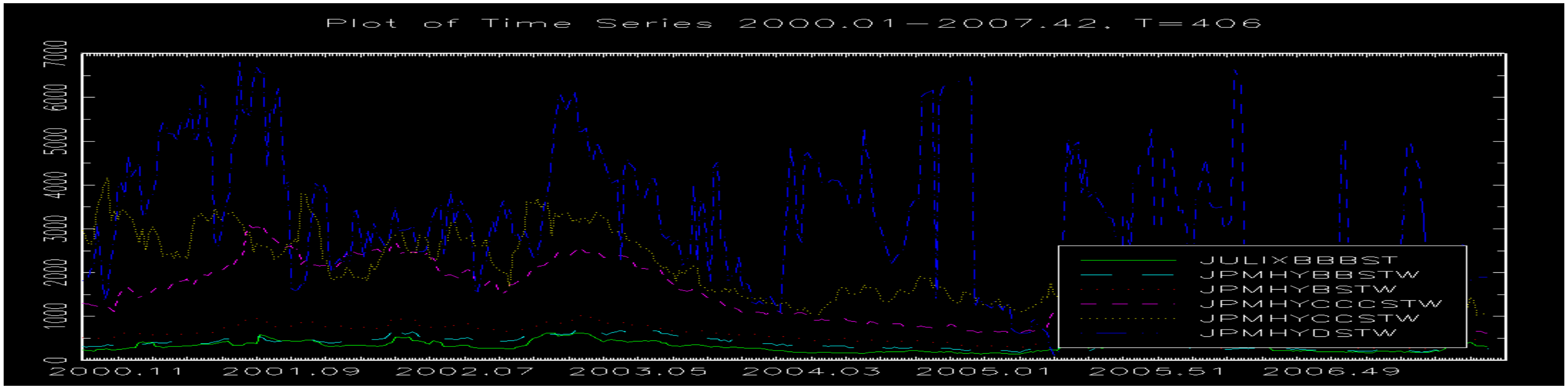


Figure C-3 Plot of high yield bond market index spread over US treasury (01/2000-10/2007): JPMHYBB, JPMHYB, JPMHYCCC, JPMHYCC, JPMHYD index spread respectively

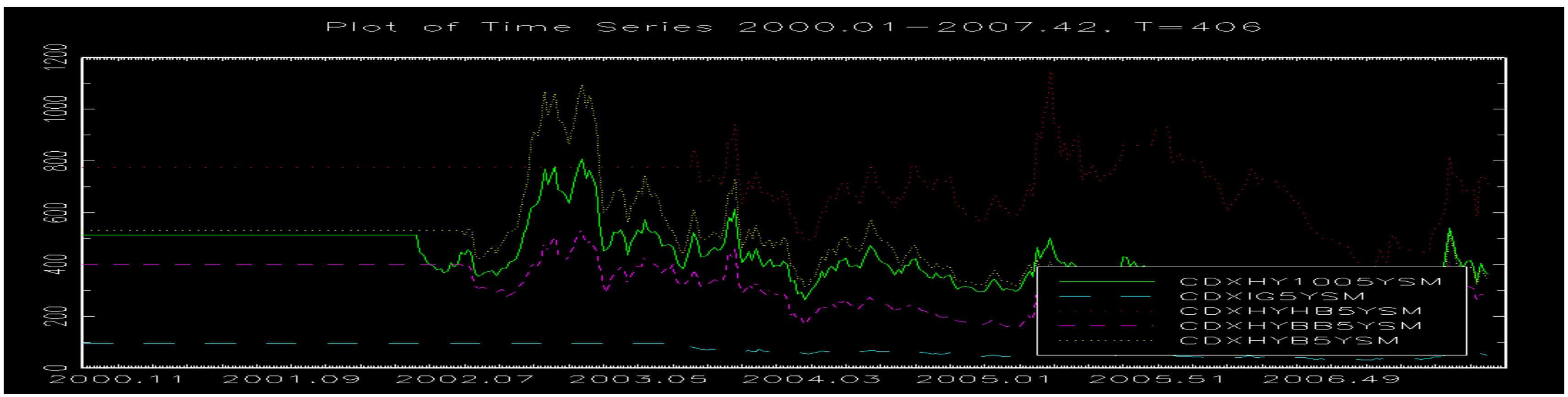


Figure C-4 Plot of investment grade and high yield credit default swap market spreads (01/2000-10/2007): CDXIG5Y, CHXHY5Y, CDXHYHB5Y, CDXHYBB5Y, CDXHYB5Y index spread respectively

Table C-1 Summary statistics of market implied credit risk in ratings segments from January 2000 to October 2007.

DD1 is the stock market implied credit risk-default distance. Investment grade bond market rating segments include: JULI indices for AAA, AA, A and BBB; High yield bond market rating segments include: BBB, BB, B, CCC, CC and D. Investment grade credit derivative market rating segments include: CDXIG5Y; High yield credit default derivatives market rating segments include: BB (CDXHYBB), B (CDXHYB), High Beta (CDXHYHB) and overall high yield CDS market (CDXHY 100).

Market	Variable	Mean	Minimum	Maximum	Std.Dev	Skewness	Kurtosis	Normality (JARQUE-BERA Test)	P-value(Chi^2)
Equity Market									
	DD1	1.9377	0.7883	2.7231	0.4531	-0.4134	2.5393	15.1525*	0.0005
Bond Market									
Investment Grade									
	JULIAAABST	64.9269	35.7170	111.5630	19.8000	0.6263	2.2043	37.2541*	0.0000
	JULIAABST	72.1217	30.5256	151.4930	32.6221	0.7429	2.3583	44.3096*	0.0000
	JULIABST	98.6378	49.8485	187.9260	38.6896	0.5337	1.8883	40.1843*	0.0000
	JULIBBBBST	165.2170	93.7526	379.4940	60.6485	0.8500	3.1068	49.0791*	0.0000
High Yield									
	JULIXBBBST	304.7200	136.1050	624.5020	110.8830	0.7202	3.1339	35.4031*	0.0000
	JPMHYBBST	373.8000	182.8180	730.7770	133.7490	0.7021	2.5482	36.8134*	0.0000
	JPMHYBST	543.6420	239.4570	1038.5300	211.7390	0.3579	1.8194	32.2461*	0.0000
	JPMHYCCCST	1361.6900	407.3910	3082.2500	724.9120	0.5081	1.8799	38.6893*	0.0000
	JPMHYCCST	1945.0800	698.7340	4159.8300	823.7110	0.5686	2.0401	37.4631*	0.0000
	JPMHYDSTW	3204.4900	96.4576	6878.2800	1571.5400	0.3109	2.2722	15.5027*	0.0004
Credit Derivative Market									
Investment Grade									
	CDXIG5YSM	70.0428	29.6250	95.0000	23.4694	-0.1424	1.4007	44.6406*	0.0000
High Yield									
	CDXHY1005YSM	424.7940	213.7670	807.0500	108.3440	0.6747	3.7201	39.5785*	0.0000
	CDXHYBB5YSM	303.4990	139.3080	538.0210	93.8045	0.0294	1.7354	27.1098*	0.0000
	CDXHYB5YSM	463.2500	213.5970	1095.3900	165.3070	1.3004	5.5791	226.9397*	0.0000
	CDXHYHB5YSM	720.2300	348.5770	1148.4900	114.9330	-0.9083	4.4014	89.0478*	0.0000

** significant at 95% confidence level; * significant at 90% confidence level

Table C-2 Univariate ARIMA analysis for market implied credit risk in different rating segments

Panel A reports the univariate ARIMA analysis for stock market implied default distance (DD1) and credit default swap spread of investment grade rating segments and high yield rating segments. High grade credit default swap market rating segments include CDXIG5Y, while high yield credit default swap market rating segments include BB (CDXHYBB), B (CDXHYB), High Beta (CDXHYHB) and overall high yield CDS market (CDXHY 100).

Panel A			Equity Market		Investment Grade CDS Market		High Yield CDS Market							
			DD1		CDXIG5YSM		CDXHY1005YSM		CDXHYBB5YSM		CDXHYB5YSM		CDXHYHB5YSM	
			T-statistics	P-value	T-statistics	P-value	T-statistics	P-value	T-statistics	P-value	T-statistics	P-value		
No Intercept, No Trend	2-lags without intercept	AR1	19.63402**	0.0000	20.48706*	0.0000	21.18897*	0.0000	20.12539*	0.0000	23.56981*	0.0000	23.56981*	0.0000
		AR2	0.6279	0.0563	-0.25798	0.7966	-0.9843	0.3256	0.05044	0.9598	-3.16131*	0.0017	-3.16131*	0.0017
	5-lags without intercept	AR1	19.5585**	0.0000	20.28142*	0.0000	21.06662*	0.0000	20.01936*	0.0000	23.35586*	0.0000	23.35586*	0.0000
		AR2	0.8724	0.4877	-1.4847	0.1384	-0.26134	0.7940	0.24056	0.8100	-2.19686*	0.0286	-2.19686*	0.0286
		AR3	-1.5734	0.9852	0.49978	0.6175	-0.83402	0.4048	-1.18616	0.2363	0.42026	0.6745	0.42026	0.6745
		AR4	0.1880	0.6531	0.61281	0.5404	-0.33073	0.7410	0.42909	0.6681	-1.64906	0.0999	-1.64906	0.0999
		AR5	1.3838	0.0485	0.30032	0.7641	1.13647	0.2564	0.81025	0.4183	2.08274*	0.0379	2.08274*	0.0379
With Intercept, No Trend	2-lags with intercept	AR1	19.45996**	0.0000	20.33829*	0.0000	20.76827*	0.0000	19.79091*	0.0000	23.28837*	0.0000	23.28837*	0.0000
		AR2	0.5509	0.4975	-0.32709	0.7438	-1.29372	0.1965	-0.17441	0.8616	-3.34376*	0.0009	-3.34376*	0.0009
		Constant	6.89564**	0.0000	4.72043*	0.0000	11.70027*	0.0000	8.40188*	0.0000	7.33878*	0.0000	7.33878*	0.0000
	5-lags with intercept	AR1	19.39341**	0.0000	20.1507*	0.0000	20.60838*	0.0000	19.70749*	0.0000	23.00232*	0.0000	23.00232*	0.0000
		AR2	0.8628	0.5693	-1.48722	0.1377	-0.26326	0.7925	0.22905	0.8189	-2.17757*	0.0300	-2.17757*	0.0300
		AR3	-1.5657	0.9011	0.49564	0.6204	-0.81708	0.4144	-1.18135	0.2382	0.42455	0.6714	0.42455	0.6714
		AR4	0.1791	0.5487	0.59902	0.5495	-0.33282	0.7395	0.41518	0.6782	-1.63455	0.1029	-1.63455	0.1029
		AR5	1.3261	0.3026	0.26634	0.7901	0.81467	0.4158	0.61352	0.5399	1.86418	0.0630	1.86418	0.0630
		Constant	6.50701**	0.0000	4.254*	0.0000	11.47352*	0.0000	7.9612*	0.0000	6.92908*	0.0000	6.92908*	0.0000
With Intercept, With Trend	2-lags with intercept with trend	AR1	19.43013**	0.0000	19.89724*	0.0000	20.4242*	0.0000	19.35947*	0.0000	23.1238*	0.0000	23.1238*	0.0000
		AR2	0.5443	0.6363	-0.66712	0.5051	-1.62891	0.1041	-0.62222	0.5342	-3.51056*	0.0005	-3.51056*	0.0005
		Constant	4.51509**	0.0000	17.88774*	0.0000	15.06871*	0.0000	15.30116*	0.0000	8.80953*	0.0000	8.80953*	0.0000
		Trend	0.3310	0.0425	-6.85268*	0.0000	-3.95332*	0.0001	-5.00761*	0.0000	-2.74638*	0.0063	-2.74638*	0.0063
	5-lags with intercept with trend	AR1	19.36484**	0.0000	19.79055*	0.0000	20.18563*	0.0000	19.27735*	0.0000	22.76095*	0.0000	22.76095*	0.0000
		AR2	0.8611	0.5877	-1.47089	0.1421	-0.25402	0.7996	0.20962	0.8341	-2.16036*	0.0313	-2.16036*	0.0313
		AR3	-1.5664	0.8839	0.41097	0.6813	-0.83641	0.4034	-1.2042	0.2292	0.41175	0.6807	0.41175	0.6807
		AR4	0.1819	0.5249	0.68386	0.4945	-0.30806	0.7582	0.42795	0.6689	-1.60661	0.1089	-1.60661	0.1089
		AR5	1.3200	0.3962	-0.07276	0.9420	0.42684	0.6697	0.15356	0.8780	1.66752	0.0962	1.66752	0.0962
		Constant	4.35506**	0.0000	15.94607*	0.0000	15.54373*	0.0000	15.28307*	0.0000	8.46756*	0.0000	8.46756*	0.0000
		Trend	0.3279	0.0481	-6.01487*	0.0000	-4.0941*	0.0001	-4.99724*	0.0000	-2.6177*	0.0092	-2.6177*	0.0092

** significant at 95% confidence level; * significant at 90% confidence level

Table C-2 - Continued

Panel B reports the univariate ARIMA analysis for bond market credit spread of investment grade rating segments and high yield rating segments. Investment grade bond market rating segments include AAA (JULIAAA), AA (JULIAA), A (JULIA), and BBB (JULIBBB); High Yield bond market rating segments include: BB (JULIXBB), B (JPMHYB), CCC (JPMHYCCC), CC (JPMHYCC), and D (JPMHYD)

Panel B			Investment Grade Bond Market								High Yield Bond Market										
			JULIAAABST		JULIAABST		JULIABST		JULIBBBBST		JULIXBBBST		JPMHYBBSTW		JPMHYBSTW		JPMHYCCCSTW		JPMHYCCSTW		JPMHYDSTW
			T-statistics	P-value	T-statistics	P-value	T-statistics	P-value	T-statistics	P-value	T-statistics	P-value	T-statistics	P-value	T-statistics	P-value	T-statistics	P-value	T-statistics	P-value	T-statistics
No Intercept, No Trend	2-lags without intercept	AR1	20.32107*	0.0000	24.82175*	0.0000	27.45952*	0.0000	26.82428*	0.0000	21.85288*	0.0000	22.13216*	0.0000	23.52426*	0.0000	22.74638*	0.0000	18.68205*	0.0000	17.76218*
		AR2	-0.12503	0.9006	-4.24136*	0.0000	-6.32598*	0.0000	-5.79956*	0.0000	-1.6549	0.0987	-1.86281	0.0632	-3.08716*	0.0022	-2.40509*	0.0166	1.49407	0.1359	1.91394
	5-lags without intercept	AR1	20.569*	0.0000	24.09074*	0.0000	26.06322*	0.0000	25.39467*	0.0000	21.59016*	0.0000	21.97097*	0.0000	22.94404*	0.0000	22.51477*	0.0000	18.67026*	0.0000	17.43305*
		AR2	-1.11169	0.2669	-1.93644	0.0535	-3.70217*	0.0002	-2.07886*	0.0383	-0.42493	0.6711	-1.0758	0.2827	-1.10259	0.2709	-0.90522	0.3659	1.92764	0.0546	0.69465
		AR3	2.71913*	0.0068	-0.92963	0.3531	0.84895	0.3964	-1.01271	0.3118	-0.20165	0.8403	-1.80189	0.0723	-0.35615	0.7219	-1.28499	0.1995	-2.51807*	0.0122	-0.01862
		AR4	-2.54555*	0.0113	0.95247	0.3414	-0.93951	0.3480	-1.44015	0.1506	-0.33891	0.7349	1.69615	0.0906	-0.27099	0.7865	1.42464	0.1550	-0.59237	0.5539	-0.44984
		AR5	0.96181	0.3367	-0.99834	0.3187	0.23033	0.8180	2.13308*	0.0335	-0.11842	0.9058	-0.12989	0.8967	-0.18756	0.8513	-1.21199	0.2262	3.25699*	0.0012	1.97918*
With Intercept, No Trend	2-lags with intercept	AR1	20.10199*	0.0000	24.6602*	0.0000	27.28515*	0.0000	26.62853*	0.0000	21.52772*	0.0000	21.92586*	0.0000	23.35821*	0.0000	22.63554*	0.0000	18.34973*	0.0000	16.43331*
		AR2	-0.23925	0.8110	-4.28144*	0.0000	-6.36397*	0.0000	-5.8739*	0.0000	-1.89731	0.0585	-1.97789*	0.0486	-3.13558*	0.0018	-2.43532*	0.0153	1.22856	0.2200	0.67901
		Constant	6.87419*	0.0000	4.53173*	0.0000	5.35039*	0.0000	5.98035*	0.0000	7.65189*	0.0000	5.72342*	0.0000	4.65303*	0.0000	2.70976*	0.0070	6.06474*	0.0000	11.51329*
	5-lags with intercept	AR1	20.3249*	0.0000	23.89988*	0.0000	25.82912*	0.0000	25.11815*	0.0000	21.16656*	0.0000	21.76697*	0.0000	22.74491*	0.0000	22.39454*	0.0000	18.40071*	0.0000	16.38374*
		AR2	-1.09602	0.2737	-1.92054	0.0555	-3.67029*	0.0003	-2.05296*	0.0407	-0.4019	0.6880	-1.0764	0.2824	-1.0907	0.2761	-0.90107	0.3681	1.9031	0.0578	0.56953
		AR3	2.70538*	0.0071	-0.92208	0.3570	0.8482	0.3968	-0.99691	0.3194	-0.18163	0.8560	-1.79956	0.0727	-0.34766	0.7283	-1.27871	0.2017	-2.50407*	0.0127	-0.12435
		AR4	-2.5165*	0.0122	0.96695	0.3342	-0.91334	0.3616	-1.42404	0.1552	-0.32349	0.7465	1.68779	0.0922	-0.26355	0.7923	1.4231	0.1555	-0.61245	0.5406	-0.60025
		AR5	0.81064	0.4181	-1.08657	0.2779	0.12453	0.9010	1.99729*	0.0465	-0.43602	0.6631	-0.22889	0.8191	-0.26944	0.7877	-1.25442	0.2104	3.04665*	0.0025	1.03223
		Constant	7.02442*	0.0000	4.72269*	0.0000	5.53149*	0.0000	5.8773*	0.0000	8.49186*	0.0000	5.33997*	0.0000	4.92719*	0.0000	2.82259*	0.0050	5.11341*	0.0000	10.90273*
With Intercept, With Trend	2-lags with intercept with trend	AR1	20.05142*	0.0000	24.62951*	0.0000	27.27081*	0.0000	26.61435*	0.0000	21.48866*	0.0000	21.85105*	0.0000	23.30146*	0.0000	22.54902*	0.0000	17.5149*	0.0000	16.22393*
		AR2	-0.31338	0.7542	-4.29826*	0.0000	-6.40276*	0.0000	-5.97595*	0.0000	-1.96649*	0.0499	-2.0814*	0.0380	-3.24048*	0.0013	-2.50929*	0.0125	0.51034	0.6101	0.47323
		Constant	6.0453*	0.0000	3.81003*	0.0002	4.75728*	0.0000	6.13296*	0.0000	5.57003*	0.0000	6.138*	0.0000	6.14039*	0.0000	4.76593*	0.0000	16.57838*	0.0000	8.3818*
		Trend	-1.09728	0.2732	-0.69282	0.4888	-0.94324	0.3461	-1.55161	0.1215	-0.95638	0.3395	-1.65462	0.0988	-1.87847	0.0610	-2.01413*	0.0447	-7.21453*	0.0000	-2.03515*
	5-lags with intercept with trend	AR1	20.25519*	0.0000	23.86673*	0.0000	25.77769*	0.0000	25.01152*	0.0000	21.09599*	0.0000	21.68934*	0.0000	22.62563*	0.0000	22.28807*	0.0000	17.62807*	0.0000	16.18344*
		AR2	-1.0779	0.2817	-1.91657	0.0560	-3.65738*	0.0003	-2.0417*	0.0418	-0.39588	0.6924	-1.08056	0.2805	-1.07635	0.2824	-0.89732	0.3701	1.8478	0.0654	0.54259
		AR3	2.69764*	0.0073	-0.91848	0.3589	0.84932	0.3962	-0.98899	0.3233	-0.17703	0.8596	-1.79885	0.0728	-0.34227	0.7323	-1.27145	0.2043	-2.5001*	0.0128	-0.14608
		AR4	-2.50072*	0.0128	0.98545	0.3250	-0.88498	0.3767	-1.40319	0.1613	-0.31501	0.7529	1.69277	0.0913	-0.23424	0.8149	1.43344	0.1525	-0.70633	0.4804	-0.63643
		AR5	0.6843	0.4942	-1.16197	0.2459	0.00747	0.9940	1.86601	0.0628	-0.54828	0.5838	-0.32183	0.7478	-0.45393	0.6501	-1.36869	0.1719	2.44101*	0.0151	0.84931
		Constant	6.37781*	0.0000	4.23526*	0.0000	5.26204*	0.0000	6.0659*	0.0000	6.46306*	0.0000	5.68032*	0.0000	7.21372*	0.0000	5.26693*	0.0000	15.44765*	0.0000	8.17537*
		Trend	-1.22757	0.2203	-0.93753	0.3491	-1.20045	0.2307	-1.51985	0.1293	-1.27081	0.2045	-1.47747	0.1403	-2.38014*	0.0178	-2.28046*	0.0231	-6.72078*	0.0000	-1.98226*

Table C-3 Unit Root Test in rating segments

The Augmented Dickey-Fuller and Phillips-Perron test for unit root results are reported in this table. Intercept and trend are tested with 2,5,10 and 16 lags respectively. The Phillips-Perron unit root tests are conducted with structural break shift at February 2002 when the market was most volatile. Panel A reports unit root tests in rating segments of equity and credit default swap market.

Panel A	**Equity Market**		**Investment Grade CDS Market**		**High Yield CDS Market**							
Levels	**DD1**		**CDXIG5YSM**		**CDXHY1005YSM**		**CDXHYBB5YSM**		**CDXHYB5YSM**		**CDXHYHB5YSM**	
No Intercept, No Trend	**ADF**	**PP**	**ADF**	**PP**	**ADF**	**PP**	**ADF**	**PP**	**ADF**	**PP**	**ADF**	**PP**
2 lags	-0.0941		-1.2078		-0.9307		-0.9914		-0.5789		-0.9894	
5 lags	0.0812		-1.2517		-0.8748		-0.9283		-0.5328		-0.9231	
10 lags	0.0009		-1.2636		-0.8636		-0.9073		-0.4957		-0.9328	
16 lags	-0.0731		-1.3191		-0.8582		-0.9078		-0.5005		-0.9255	
Intercept, No Trend												
2 lags	-1.1821	-0.9156	-1.2057	-0.087	-2.7969	-4.0723*	-2.384	-1.565	-3.2089*	-1.785	-2.2395	-2.494
5 lags	-0.8742	-0.7102	-1.1153	0.2588	-2.4856	-3.9929*	-2.0019	-1.238	-2.7819	-1.311	-1.9966	-2.261
10 lags	-0.8516	-1.2879	-1.0959	0.0338	-2.4361	-4.0548*	-1.9003	-1.199	-2.5658	-1.306	-2.0387	-2.383
16 lags	-1.0394	-1.04	-1.0412	0.0677	-2.4044	-4.2985*	-1.7529	-1.107	-2.7743	-1.387	-2.0282	-2.475
Intercept and Trend												
2 lags	-1.5911	-1.2818	-2.7473	-2.897	-3.9529*	-4.1253*	-3.7278*	-2.777	-3.6318*	-2.828	-3.1046	-2.53
5 lags	-1.3048	-1.0786	-2.5051	-2.406	-3.5814*	-4.0255*	-3.0578	-2.139	-3.1744	-2.258	-2.8266	-2.262
10 lags	-1.3879	-1.4268	-2.4485	-2.743	-3.7213*	-4.162*	-3.0211	-2.103	-2.9652	-2.252	-2.9921	-2.368
16 lags	-1.6087	-1.4341	-2.1112	-2.456	-4.0106*	-4.5132*	-2.9103	-1.957	-3.2775	-2.355	-3.1292	-2.444
1st Difference	**DDI_d1**		**CDXIG5YSM_d1**				**CDXHYBB5YSM**		**CDXHYB5YSM**		**CDXHYHB5YSM**	
No Intercept, No Trend	**ADF**		**ADF**									
2 lags	-12.4833**		-12.9991**				-12.3142		-12.3958		-10.9149	

1) ** significant at 95% confidence level: Rejection of unit root

Table C-3 - Continued

The Augmented Dickey-Fuller and Phillips-Perron test for unit root results are reported in this table. Intercept and trend are tested with 2,5,10 and 16 lags respectively. The Phillips-Perron unit root tests are conducted with structural break shift at February 2002 when the market was most volatile. Panel B reports unit roots tests in bond market investment grade rating segments and high yield rating segments.

Panel B	Investment Grade Bond Market								High Yield Bond Market											
Levels	JULIAAABST		JULIAABST		JULIABST		JULIBBBBST		JULIXBBBST		JPMHYBBSTW		JPMHYBSTW		JPMHYCCCSTW		JPMHYCCSTW		JPMHYDSTW	
No Intercept, No Trend	ADF	PP	ADF	PP	ADF	PP	ADF	PP	ADF	PP	ADF	PP	ADF	PP	ADF	PP	ADF	PP	ADF	PP
2 lags	-0.4683		-0.582		-0.4576		-0.616		-0.761		-0.69		-0.6544		-0.788		-1.3498		-2.1017*	
5 lags	-0.6358		-0.822		-0.6377		-0.53		-0.737		-0.687		-0.6705		-0.7921		-1.7319		-1.7078	
10 lags	-0.7025		-0.948		-0.6561		-0.619		-0.675		-0.685		-0.6825		-0.9971		-1.5607		-1.3587	
16 lags	-0.7475		-1.084		-0.8316		-0.813		-0.945		-0.69		-0.7028		-0.8379		-1.5319		-1.1954	
Intercept, No Trend																				
2 lags	-1.5742	-1.6505	-1.43	-1.2747	-1.4446	-1.2897	-1.859	-2.099	-2.681	-2.2434	-1.697	-2.0064	-1.3559	-1.0981	-0.9465	-0.7875	-2.5162	-2.7649	-5.1877*	-4.9316*
5 lags	-1.718	-1.841	-1.665	-1.5111	-1.5863	-1.4266	-1.502	-1.7127	-2.525	-2.1816	-1.572	-1.8838	-1.4372	-1.1856	-0.9665	-0.7566	-2.4815	-2.7377	-4.609*	-4.4569*
10 lags	-1.7485	-1.9531	-1.737	-1.6061	-1.4462	-1.4085	-1.434	-1.6579	-2.447	-2.2746	-1.337	-1.598	-1.0935	-0.9773	-1.1705	-1.2011	-2.1045	-2.2043	-3.5686*	-3.5505*
16 lags	-2.1661	-2.4556	-1.794	-1.8247	-1.4825	-1.5254	-1.523	-1.8172	-2.44	-2.607	-1.473	-1.8944	-1.0923	-1.0235	-1.02	-1.1296	-1.5472	-1.4781	-3.2557*	-3.189*
Intercept and Trend																				
2 lags	-1.2321	-1.7993	-1.213	-1.257	-1.7206	-1.3229	-2.924	-1.7994	-3.224	-2.5719	-2.903	-1.6843	-2.9532	-1.5637	-2.9054	-1.6117	-4.7882*	-4.4511*	-5.7189*	-5.3675*
5 lags	-1.0882	-1.847	-1.394	-1.4953	-1.7804	-1.4678	-2.393	-1.4644	-3.028	-2.4778	-2.783	-1.5824	-3.21	-1.6901	-3.027	-1.5762	-3.9476*	-4.1319*	-5.2553*	-4.9074*
10 lags	-0.8559	-1.8763	-1.158	-1.542	-1.2722	-1.4164	-2.108	-1.4851	-3.039	-2.5834	-2.5	-1.3139	-2.5985	-1.3345	-3.0257	-1.9704	-3.6331*	-3.6811*	-4.179*	-4.0104*
16 lags	-1.5534	-2.5389	-0.928	-1.7255	-0.9681	-1.5097	-1.975	-1.6893	-2.788	-2.9225	-2.664	-1.5382	-2.6204	-1.4029	-3.4392*	-2.0103	-2.7405	-2.7756	-3.9924*	-3.8343*

1st Difference	JULIAAABST_d1	JULIAABST	JULIABST	JULIBBBBST	JULIXBBBST	JPMHYBBSTW	JPMHYBSTW	JPMHYCCCSTW	JPMHYCCSTW	JPMHYDSTW
No Intercept, No Trend	ADF	ADF	ADF	ADF	ADF	ADF				
2 lags	-10.4537**	-10.3450**	-9.3993**	-9.9112**	-10.5328**	-12.56**	-10.0986**	-11.1151**	-12.7966**	

1) ** significant at 95% confidence level: Rejection of unit root

Table C-4 Long-term credit risk price discovery between two markets (Pair-wise) in same rating segment – Cointegration tests

	Without Break						With Break					
Likelihood Ration (LR) r=0	Intercept			Intercept and Trend			Intercept			Intercept and Trend		
Investment Grade Markets	1 lag	2 lags	5 lags	1 lag	2 lags	5 lags	1 lag	2 lags	5 lags	1 lag	2 lags	5 lags
Stock Market-Bond Market												
DD1-JULIAAABST	9.33	12.29	18.36	13.79	17.69	22.88	17.79	21.46	26.07*	18.4	22.19	27.08
DD1-JULIAABST	11.56	16.44	22.04*	17.54	24	28.35*	29.24*	36.34*	41.39*	53.69*	50.58*	49.46*
DD1-JULIABST	10.74	15.5	27.03*	15.54	22.18	32.75*	28.04*	37.09	46.11*	28.74	38.13*	48.35*
DD1-JULIBBBBST	6.93	10.63	17.13	10.33	14.67	20.22	22.65	26.77*	33.8*	24.96	28.4	36.13*
Stock Market- Credit Derivative Market												
DD1-CDXIG5YSM	10.42	11.36	12.71	16.07	17.34	16.03	22.92	24.29	25.96*	25.85	27.64	27.9
Bond Market - Credit Derivative Market												
CDXIG5YSM-JULIAAABST	7.3	6.44	6.96	14.51	14.11	11.92	20.17	20.81	22.71	23.7	24.4	24.71
CDXIG5YSM-JULIAABST	5.08	5.72	6.86	11.2	11.93	10.67	18.06	19.11	21.75	19.87	21.13	22.74
CDXIG5YSM-JULIABST	5.79	8.04	8.18	12.35	15.16	13.12	18.09	22.98	25.87*	19.29	24.55	25.77
CDXIG5YSM-JULIBBBBST	11.62	15.96	14.11	22.77	28.03*	22.22	27.34*	32.85*	34.81*	35.55*	41.63*	40.81*
High Yield Markets	Without Break						With Break					
Stock Market-Bond Market												
DD1-JULIXBBBST	7.87	9.21	15.58	12.93	14.94	20.38	21.44	23.87	29.61*	23.74	25.97	31.88*
DD1-JPMHYBBSTW	6.35	7.97	9.6	14.09	14.75	14.57	33.2*	31.15*	32.75*	34.07*	31.69*	33.56*
DD1-JPMHYBSTW	5.97	8.73	12.96	10.83	13.44	18.76	24.88	25	30.68*	24.81	25.12	31.8*
DD1-JPMHYCCCSTW	11.25	12.95	12.49	16.62	18.96	20.16	23.99	27.51*	29.68*	24.61	28.29	31.45*
DD1-JPMHYCCSTW	12.64	12.87	13.62	27.56*	26.69*	22.68	43.62*	41.05*	40.52*	45.62*	43.32*	41.83*
DD1-JPMHYDSTW	34.49*	30.08*	22.62*	44.25*	40.42*	32.55*	46.58*	42.86*	38.02*	47.73*	44.06*	39.09*
Stock Market- Credit Derivative Market												
DD1-CDXHY1005YSM	12.12	14.19	17.62	19.16	22.1	24.48	24.65	28.67*	30.37*	24.88	28.9	31.38*
DD1-CDXHYBB5YSM	9.71	10.92	12.57	18.53	19.88	19.81	27.16*	29.89*	30.83*	27.58	30.33*	31.31*
DD1-CDXHYB5YSM	11.38	14.65	16.5	15.43	20.06	20.64	22.22	28.83*	27.07*	22.3	28.84	27.42
DD1-CDXHYHB5YSM	13.32	12.31	13.62	18.98	18.02	19.99	21.85	21.09	24.81	22.4	21.61	25.95
Bond Market - Credit Derivative Market												
CDXHY1005YSM-JULIXBBBST	25.32*	26.94*	26.22*	33.55*	36.26*	36.56*	32.99*	37.68*	37.63*	41.77*	46.15*	48.08*
CDXHYBB5YSM-JPMHYBBSTW	22.44*	20.33*	19.27	29.51*	28.09*	26.47*	36.59*	37.35*	37.17*	38.35*	38.47*	38.75*
CDXHYB5YSM-JPMHYBSTW	16.32	16.34	16.86	22.42	23.11	25.51	33.17*	34*	35.46*	33.11*	34*	35.85*
CDXHYHB5YSM-JPMHYCCCSTW	15.83	13.13	14.35	22.56	20.52	23.93	32.48*	31.36*	34.96*	32.94*	31.8*	36.24*
CDXHYHB5YSM-JPMHYCCSTW	20.78*	18.13	18.11	34.81*	31.36*	27.38*	44.87*	41.69*	37.31*	47.6*	44.34*	39.43*
CDXHYHB5YSM-JPMHYDSTW	46.79*	41.72*	37.77*	52.84*	47.36*	42.67*	51.34*	46.04*	41.89*	52.92*	47.45*	42.95*

**significant at 95% confidence level; * significant at 90% confidence level

Table C-5 Long term credit risk price discovery among three markets in same rating segment– Cointegration tests

This table reports results of the Johansen trace test for cointegration among equity, bond and credit derivative markets in investment grade rating segments. The Johansen cointegration tests are conducted without structural break and with structural break at February 2002. Intercept and trend with 1, 2, 5 lags are tested respectively.

Panel A Investment Grade Market

Stock Market-Bond Market-Credit Derivative Market			DD1-CDXIG5YSM-JULIAAABST	DD1-CDXIG5YSM-JULIAABST	DD1-CDXIG5YSM-JULIABST	DD1-CDXIG5YSM-JULIBBBBST
Without Break						
Intercept						
	1 lag	r=0	22.45	28.71	26.74	20.85
		r=1	10.18	10.51	9.81	7.69
	2 lags	r=0	25.81	37.72*	36.17*	26.25
		r=1	12.6	13.14	13.05	11.26
	5 lags	r=0	30.41	39.92*	43.45*	30.31
		r=1	13.72	14.61	15.1	15.73
Intercept and Trend						
	1 lag	r=0	32.11	37.55	35.97	31.35
		r=1	13.59	15.38	14.03	10.18
	2 lags	r=0	36.16	46.45*	45.88*	37.49
		r=1	17.27	18.81	18.7	14.4
	5 lags	r=0	37.64	44.46*	48.86*	37.34
		r=1	20.07	18.62	20.48	20.3
With Break						
Intercept						
	1 lag	r=0	35.45	46.91*	43.42*	35.86
		r=1	17.73	24.47	20.83	15.46
	2 lags	r=0	39.96	56.77*	54.25*	41.03
		r=1	20.66	30.89	26.55	19.95
	5 lags	r=0	47.45*	59.47*	62.9*	46.63*
		r=1	24.09	32.06	33.4	22.13
Intercept and Trend						
	1 lag	r=0	42.54	52.26*	50.53*	45.86
		r=1	23.92	29.35	25.28	21.46
	2 lags	r=0	47.3	62.31*	62.62*	51.23*
		r=1	28.15	34.2	30.59	25.42
	5 lags	r=0	52.94*	62.6*	67.77*	53.64*
		r=1	30.16	34.74	37.02	27.65

**significant at 95% confidence level; * significant at 90% confidence level

Table C-5 - Continued

This table reports results of the Johansen trace test for cointegration among equity, bond and credit derivative markets in high yield rating segments. The Johansen cointegration tests are conducted without structural break and with structural break at February 2002. Intercept and trend with 1, 2, 5 lags are tested respectively.

Panel B High Yield Market

Stock Market-Bond Market-Credit Derivative Market			DD1-JULIXBBBST-CDXHY1005YSM	DD1-CDXHYBB5YSM-JPMHYBBSTW	DD1-CDXHYB5YSM-JPMHYBSTW	DD1-CDXHYHB5YSM-JPMHYCCCSTW	DD1-CDXHYHB5YSM-JPMHYCCSTW	DD1-CDXHYHB5YSM-JPMHYDSTW
Without Break								
Intercept								
	1 lag	r=0	30.92	37.9*	28.04	27.87	26.69	49.87*
		r=1	8.34	6.62	5.74	11.37	11.8	13.5
	2 lags	r=0	33.7	35	31.01	26.08	25.69	45.09*
		r=1	10.14	8.56	8.41	13.54	11.99	12.59
	5 lags	r=0	40.9*	35.92*	36.78*	26.43	27.22	42.18*
		r=1	19.42	11.01	14.44	13.1	13.94	13.26
Intercept and Trend								
	1 lag	r=0	40.78	45.82*	32.36	32.68	41.07	59.02*
		r=1	13.13	12.91	9.92	16	19.01	19.29
	2 lags	r=0	44.77*	43.13*	35.27	31.5	38.79	54.1*
		r=1	15.81	14.94	12.67	18.46	18.03	18.39
	5 lags	r=0	54.25*	42.83*	41.45	34.12	36.66	50.16*
		r=1	24.72	15.6	18.5	20.51	19.3	20.12
With Break								
Intercept								
	1 lag	r=0	43.7*	59.94*	47.04*	40.53	57.07*	61.16*
		r=1	20.76	25	21.71	18.4	21.22	22.03
	2 lags	r=0	48.68*	56.4*	49.69*	40.64	53.26*	56.42*
		r=1	24.64	28.2	26.41	18.67	20.53	21.3
	5 lags	r=0	56.84*	57.45*	52.29*	44.1*	53.89*	55.32*
		r=1	33.99	28.19	26.94	20.43	24.69	24.8
Intercept and Trend								
	1 lag	r=0	52.09*	65.23*	46.94	41.15	59.18*	62.54*
		r=1	21.07	25.38	21.65	19.24	21.85	22.65
	2 lags	r=0	56.55*	60.14*	49.7*	41.35	55.52*	57.78*
		r=1	25.21	28.77	26.51	19.5	21.16	21.91
	5 lags	r=0	66.04*	62.11*	53.37*	46.04	55.85*	56.82*
		r=1	34.7	28.86	27.78	22.11	25.9	26.24

** significant at 95% confidence level; * significant at 90% confidence level

Table C-6 Short term credit risk price discovery in same rating segments– Lead-lag relationship tests

The short term credit risk price discovery-Lead-lag relationship is tested using bivariate Engle-Granger causality test within a vector autoregression (VAR) model or a vector error correction (VECM) model if the two markets are cointegrated. This table reports the lead-lag relationship (Engle-Granger causality) test results for stock market and bond market, stock market and credit derivatives market of investment grade rating segments.

Panel A Investment Grade Market	**Intercept**			**Intercept and Trend**		
	1 lag	2 lags	5 lags	1 lag	2 lags	5 lags
Stock Market & Bond Market						
DD1-->JULIAAABST	6.4865* 0.0016	3.7166* 0.0113	2.6508* 0.0150	6.0821* 0.0024	3.4779* 0.0157	2.5737 * 0.0179
JULIAAABST-->DD1	0.606 0.5458	1.3136 0.2688	1.8901 0.0799	0.6046 0.5465	1.3457 0.2583	1.8511 0.0867
DD1-->JULIAABST	8.4741* 0.0002	5.2519* 0.0014	3.6677* 0.0013	7.3852* 0.0007	4.8438* 0.0024	3.406* 0.0025
JULIAABST-->DD1	1.7188 0.1800	1.4763 0.2196	0.7125 0.6396	1.7530 0.1739	1.5492 0.2004	0.7952 0.5738
DD1-->JULIABST	10.0492* 0.0000	7.0698* 0.0001	5.7053* 0.0000	9.2624* 0.0001	6.6456* 0.0002	5.7129* 0.0000
JULIABST-->DD1	1.3362 0.2634	1.1429 0.3308	1.1617 0.3249	1.3735 0.2538	1.2121 0.3043	1.2504 0.2783
DD1-->JULIBBBBST	10.684* 0.0000	7.1946* 0.0001	4.2986* 0.0003	10.2558* 0.0000	7.0525* 0.0001	4.2953* 0.0003
JULIBBBBST-->DD1	0.5448 0.5802	0.6957 0.5548	0.5515 0.7690	0.6243 0.5359	0.7865 0.5016	0.6038 0.7275
Stock Market & Credit Derivatives Market						
DD1-->CDXIG5YSM	0.2744 0.7601	0.2781 0.8412	0.4003 0.8790	0.2846 0.7524	0.2883 0.8339	0.4892 0.8167
CDXIG5YSM-->DD1	0.0127 0.9874	0.0108 0.9985	0.4447 0.8489	0.0149 0.9852	0.0108 0.9985	0.4400 0.8522
Bond Market & Credit Derivatives Market						
CDXIG5YSM-->JULIAAABST	0.038 0.9627	0.0484 0.9859	0.9018 0.4929	0.0242 0.9761	0.0505 0.9850	0.8130 0.5599
JULIAAABST-->CDXIG5YSM	1.2274 0.2936	1.3964 0.2426	1.2192 0.2941	1.3747 0.2535	1.5933 0.1896	1.2177 0.2948
CDXIG5YSM-->JULIAABST	0.0564 0.9451	1.0385 0.3748	1.4759 0.1835	0.0168 0.9833	0.8506 0.4665	1.2339 0.2866
JULIAABST-->CDXIG5YSM	0.4227 0.6554	0.7171 0.5419	0.7532 0.6070	0.4964 0.6089	0.6901 0.5582	0.6895 0.6582
CDXIG5YSM-->JULIABST	0.5981 0.5501	0.9841 0.3996	0.8493 0.5321	0.4484 0.6388	0.7004 0.5520	0.6903 0.6576
JULIABST-->CDXIG5YSM	0.6148 0.5410	0.5023 0.6808	0.7648 0.5977	0.6326 0.5315	0.4963 0.6850	0.7333 0.6229
CDXIG5YSM-->JULIBBBBST	10.684* 0.0000	7.1946* 0.0001	4.2986* 0.0003	10.2558* 0.0000	7.0525* 0.0001	4.2953* 0.0003
JULILBBBBST-->CDXIG5YSM	0.5448 0.5802	0.6957 0.5548	0.5515 0.7690	0.6243 0.5359	0.7865 0.5016	0.6038 0.7275

** significant at 95% confidence level; * significant at 90% confidence level

Table C-7 Credit risk price discovery contribution tests in rating segments

Table C-7 reports each rating segment of equity, bond and credit default swap market's price discovery contribution to credit risk. Gonzalo and Granger (1996) common factor component price discovery contribution methodology are used to test the credit risk price discovery contribution of stock market, bond market and credit derivatives market.

Investment Grade Market		**Intercept and Trend**			
		λ1(t-value)	**λ2(t-value)**	**GG1(Market1)**	**GG2(Market2)**
Market 1	**Market 2**				
Stock Market	**Bond Market**				
DD1	JULIAAABST	-0.001 (-0.216)	0.917* (3.389)	**100%	0.00%
DD1	JULIAABST	-0.009 (-1.085)	1.961*(4.594)	**100%	0.00%
DD1	JULIABST	-0.006 (-0.902)	1.743* (4.362)	**100%	0.00%
DD1	JULIBBBBST	-0.000 (-0.272)	0.677* (3.303)	**100%	0.00%
Stock Market	**Credit Derivatives Market**				
DD1	CDXIG5YSM	-0.000 (-0.616)	-0.072 (-2.739)	0.00%	0.00%
Credit Derivatives Market	**Bond Market**				
CDXIG5YSM	JULIAAABST	-0.049*(-3.122)	-0.005(-0.297)	0.00%	**100%
CDXIG5YSM	JULIAABST	-0.045*(-3.020)	-0.016 (-0.908)	0.00%	**100%
CDXIG5YSM	JULIABST	-0.052 *(-3.246)	-0.019(-0.858)	0.00%	**100%
CDXIG5YSM	JULIBBBBST	-0.024 (-1.554)	0.442*(3.428)	**100%	0.00%

High Yield Market		**Intercept and Trend**			
		λ1(t-value)	**λ2(t-value)**	**GG1(Market1)**	**GG2(Market2)**
Market 1	**Market 2**				
Stock Market	**Bond Market**				
DD1	JULIXBBBST	-0.001(-0.622)	1.150*(3.374)	**100%	0.00%
DD1	JPMHYBBSTW	0.003(0.784)	-3.418(-3.029)	0.00%	0.00%
DD1	JPMHYBSTW	-0.001(-1.033)	1.504*(3.068)	**100%	0.00%
DD1	JPMHYCCCSTW	0.000(0.009)	7.606*(3.389)	**100%	0.00%
DD1	JPMHYCCSTW	0.000(0.339)	-2.444(-4.927)	0.00%	0.00%
DD1	JPMHYDSTW	0.000 (0.208)	-4.159(-5.979)	0.00%	0.00%
Stock Market	**Credit Derivatives Market**				
DD1	CDXHY1005YSM	0.001(0.637)	-3.343(-4.029)	0.00%	0.00%
DD1	CDXHYBB5YSM	-0.000(-1.391)	0.328*(3.771)	**100%	0.00%
DD1	CDXHYB5YSM	-0.005(-0.857)	-8.321(-3.197)	0.00%	0.00%
DD1	CDXHYHB5YSM	0.000(-0.607)	-1.668(-3.664)	0.00%	0.00%
Credit Derivatives Market	**Bond Market**				
CDXHY1005YSM	JULIXBBBST	-0.089*(-3.532)	0.061*(2.597)	40.67%	59.33%
CDXHYBB5YSM	JPMHYBBSTW	-0.089*(3.621)	0.029(1.143)	0.00%	**100%
CDXHYB5YSM	JPMHYBSTW	-0.028(-1.681)	0.033*(2.645)	**100%	0.00%
CDXHYHB5YSM	JPMHYCCCSTW	-0.062*(-3.390)	0.035(0.96)	0.00%	100.00%
CDXHYHB5YSM	JPMHYCCSTW	0.001(0.242)	0.062*(4.832)	**100%	0.00%
CDXHYHB5YSM	JPMHYDSTW	-0.001(-0.332)	0.598*(5.994)	**100%	0.00%

* Significant at 95% confidence level for credit risk price discovery contribution

**The market which has a bigger price discovery contribution

APPENDIX D

FIGURES AND TABLES IN CHAPTER 8

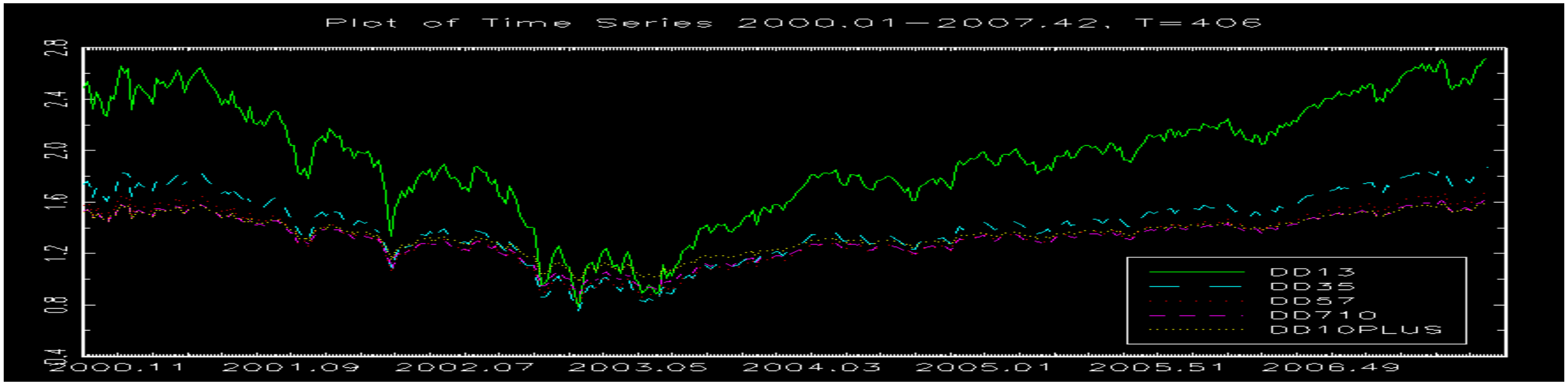


Figure D-1 Plot of stock market implied credit risk at different maturities of 1-3year (DD13), 3-5 year (DD35), 5-7 year (DD57), 7-10 year (DD710) and 10 year plus (DD10PLUS) from 01/2000 to 10/2007

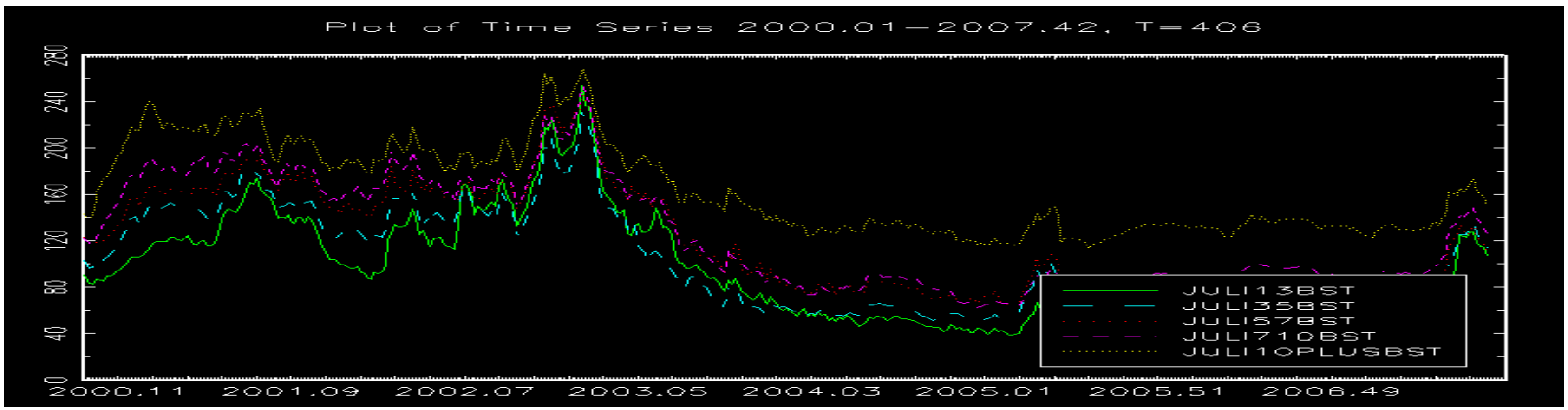


Figure D-2 Plot of investment grade bond market implied credit risk spread at different maturities of 1-3year (JULI13), 3-5 year (JULI35), 5-7 year (JULI57), 7-10 year (JULI710) and 10 year plus (JULI10PLUS) from 01/2000 to 10/2007

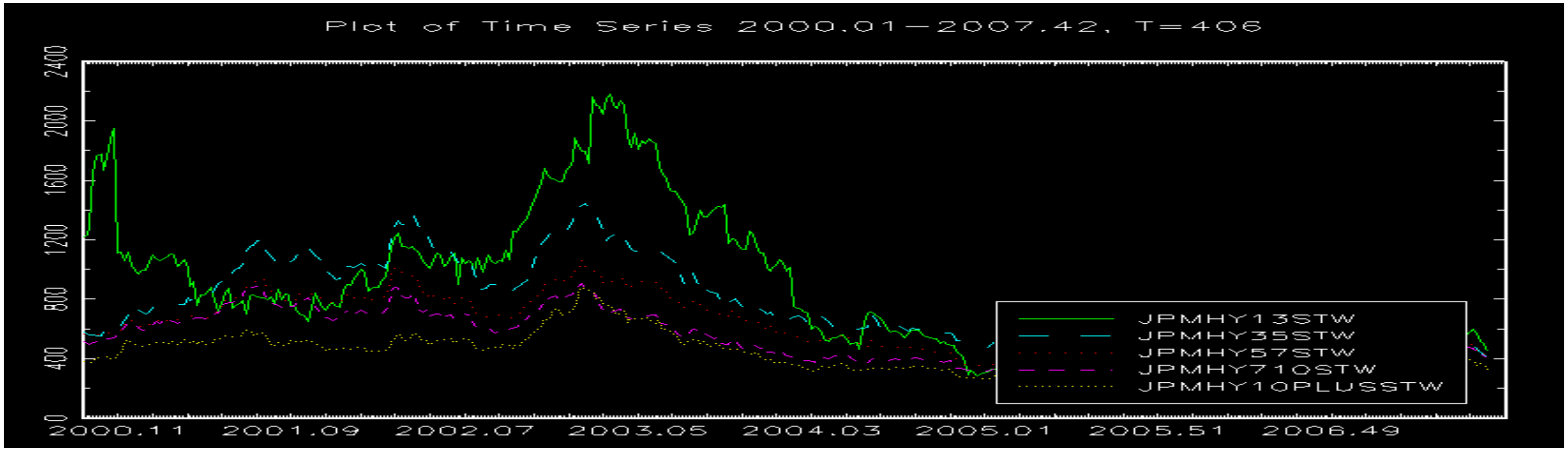


Figure D-3 Plot of high yield bond market implied credit risk spread at different maturities of 1-3year (JPMHY13), 3-5 year (JPMHY35), 5-7 year (JPMHY57), 7-10 year (JPMHY710) and 10 year plus (JPMHY10PLUS) from 01/2000 to 10/2007

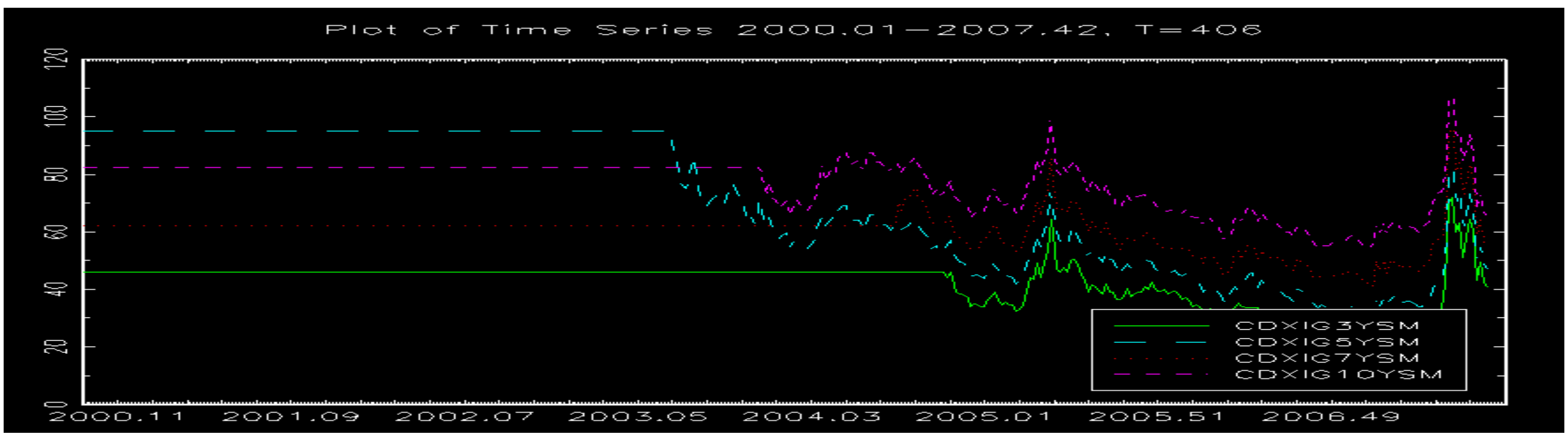


Figure D-4 Plot of investment grade credit default swap market spread at different maturities of 3year (CDXIG3Y), 5 year (CDXIG5Y), 7 year (CDXIG7Y), and 10 year (CDXIG10Y) from 3 01/2000 to 10/2007

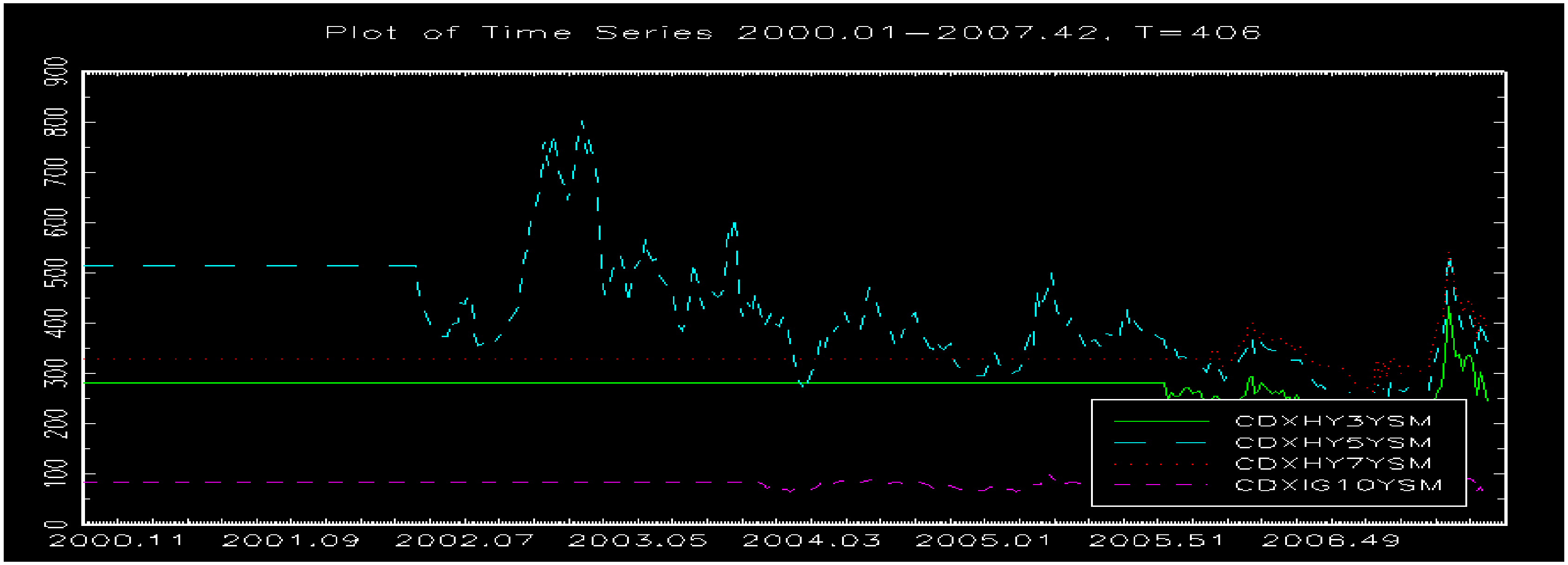


Figure D-5 Plot of high yield credit default swap market spread at different maturities of 3year (CDXHY3Y), 5 year CDXHY5Y), 7 year (CDXHY7Y), and 10 year (CDXHY10Y) from 3 01/2000 to 10/2007

Table D-1 Summary statistics of market implied credit risk in maturity segments from January 2000 to October 2007

Stock market implied credit risk-default distance at maturities of 1-3 year (DD13), 3-5 year (DD35), 5-7 years (DD57), 7-10 year (DD710), and 10 year plus (DD10PLUS); Investment grade bond market credit spread at maturities of 1-3 year (JULI13), 3-5 year (JULI35), 5-7 years (JULI57), 7-10 year (JULI710), and 10 year plus (JULI10PLUS); High yield grade bond market at maturities of 1-3 year (JPMHY13), 3-5 year (JPMHY35), 5-7 years (JPMHY57), 7-10 year (JPMHY710), and 10 year plus (JPMHY10PLUS); Investment grade credit default swap spread at maturities of 3 year (CDXIG3Y), 5 year (CDXIG5Y), 7 year (CDXIG7Y), and 10 year (CDXIG10Y); High yield credit default swap spread at maturities of 3 year (CDXHY3Y), 5 year (CDXHY5Y), 7 year (CDXHY7Y), and 10 year (CDXHY10Y).

Market	Variable	Mean	Minimum	Maximum	Std.Dev	Skewness	Kurtosis	Normality (JARQUE-BERA Test)	P-value(Chi^2)
Equity Market									
	DD13	1.9377	0.7883	2.7231	0.4531	-0.4134	2.5393	15.1525	0.0005
	DD35	1.4170	0.7534	1.8705	0.2616	-0.4134	2.5393	15.1525	0.0005
	DD57	1.3287	0.8147	1.6799	0.2026	-0.4134	2.5393	15.1525	0.0005
	DD710	1.3182	0.8838	1.6151	0.1712	-0.4134	2.5393	15.1525	0.0005
	DD10PLUS	1.3480	0.9845	1.5964	0.1433	-0.4134	2.5393	15.1525	0.0005
Bond Market									
Investment Grade									
	JULI13BST	91.0059	38.5315	254.0920	47.1770	0.8718	3.0058	51.4344	0.0000
	JULI35BST	100.9320	51.0091	233.6050	43.2589	0.6297	2.1771	38.2872	0.0000
	JULI57BST	119.6050	63.8358	245.7930	45.4962	0.5964	2.2075	34.6953	0.0000
	JULI710BST	126.3500	61.9393	252.7250	46.7538	0.4674	1.8453	37.3378	0.0000
	JULI10PLUSBST	169.4260	117.0800	273.2930	37.0642	0.6626	2.4264	35.2720	0.0000
High Yield									
	JULIX13BST	306.1010	66.0968	866.9360	161.8420	0.9768	3.6897	72.6071	0.0000
	JULIX35BST	336.2880	95.1040	775.3240	133.3220	0.8271	3.8960	59.8724	0.0000
	JULIX57BST	302.1650	152.2290	625.8420	97.8245	1.0985	3.8404	93.6011	0.0000
	JULIX710BST	290.1380	137.8750	693.1170	113.7790	1.5135	4.8844	215.0661	0.0000
	JULIX10PLUSBST	306.2150	145.8780	703.6630	99.0388	1.2170	5.0993	174.7705	0.0000
	JPMHY13STW	838.3560	267.0500	2179.7800	468.4300	0.9838	3.1346	65.7975	0.0000
	JPMHY35STW	731.8850	227.7700	1460.5600	303.5950	0.4119	2.1028	25.1012	0.0000
	JPMHY57STW	583.8650	260.3540	1062.2900	218.5810	0.2434	1.7002	32.5915	0.0000
	JPMHY710STW	517.5120	272.6730	903.9650	176.5440	0.4525	1.8020	38.1361	0.0000
	JPMHY10PLUSSTW	423.1990	225.5610	878.9470	133.2410	0.9591	3.5387	67.1532	0.0000
Credit Derivative Market									
Investment Grade									
	CDXIG3YSM	42.2053	19.5024	72.0098	7.7809	-0.6991	4.4343	67.8691	0.0000
	CDXIG5YSM	70.0495	29.6250	95.0000	23.4634	-0.1428	1.4017	44.5941	0.0000
	CDXIG7YSM	59.9249	41.0000	96.0074	7.0746	0.3063	6.7469	243.8429	0.0000
	CDXIG10YSM	76.7262	54.2500	107.0060	9.2305	-0.6822	2.9707	31.5036	0.0000
High Yield									
	CDXHY3YSM	269.8530	118.8180	432.8070	34.0316	-1.8913	9.5964	978.1407	0.0000
	CDXHY5YSM	424.8010	213.7670	807.0500	108.3430	0.6746	3.7202	39.5685	0.0000
	CDXHY7YSM	333.4070	261.1540	540.8530	25.5047	3.7727	24.6875	8919.8569	0.0000
	CDXHY10YSM	76.7262	54.2500	107.0060	9.2305	-0.6822	2.9707	31.5036	0.0000

Table D-2 Univariate ARIMA analysis for market implied credit risk in different maturity segments

Panel A reports the univariate ARIMA analysis for investment grade and high yield bond market spread at maturity segments of 1-3 year, 3-5 year, 5-7 year, 7-10 year and 10 year plus.

			Investment Grade Bond Market									
Panel A			JULI13BST		JULI35BST		JULI57BST		JULI710BST		JULI10PLUSBST	
			T-statistics	P-value	T-statistics	P-value	T-statistics	P-value	T-statistics	P-value	T-statistics	P-value
No Intercept, No Trend	2-lags without intercept	AR1	27.10617*	0.0000	26.92291*	0.0000	23.06555*	0.0000	27.2067*	0.0000	25.0547*	0.0000
		AR2	-6.05844*	0.0000	-5.90648*	0.0000	-2.6935*	0.0074	-6.0938*	0.0000	-4.3748*	0.0000
	5-lags without intercept	AR1	25.68362*	0.0000	25.64361*	0.0000	22.48669*	0.0000	25.7616*	0.0000	24.2959*	0.0000
		AR2	-2.74016*	0.0064	-2.75865*	0.0061	-0.20302	0.8392	-2.8157*	0.0051	-2.0751*	0.0386
		AR3	0.20118	0.8407	-0.01238	0.9901	-1.02701	0.3050	-0.62468	0.5325	-0.6901	0.4905
		AR4	-2.10587*	0.0358	-1.94065	0.0530	-0.63755	0.5241	-0.80146	0.4233	-0.73034	0.4656
		AR5	1.99396*	0.0468	2.17371*	0.0303	0.43855	0.6612	1.31051	0.1908	1.36387	0.1734
With Intercept, No Trend	2-lags with intercept	AR1	26.93043*	0.0000	26.72975*	0.0000	22.87994*	0.0000	27.0256*	0.0000	24.8346*	0.0000
		AR2	-6.12721*	0.0000	-5.98338*	0.0000	-2.74856*	0.0063	-6.1345*	0.0000	-4.4613*	0.0000
		Constant	4.42419*	0.0000	5.39426*	0.0000	5.22272*	0.0000	5.5319*	0.0000	8.9892*	0.0000
	5-lags with intercept	AR1	25.41673*	0.0000	25.36341*	0.0000	22.25974*	0.0000	25.5325*	0.0000	24.0203*	0.0000
		AR2	-2.70909*	0.0070	-2.72846*	0.0066	-0.1908	0.8488	-2.7916*	0.0055	-2.0531*	0.0407
		AR3	0.21089	0.8331	-0.00395	0.9969	-1.0106	0.3128	-0.6178	0.5371	-0.68252	0.4953
		AR4	-2.08152*	0.0380	-1.91721	0.0559	-0.62929	0.5295	-0.78964	0.4302	-0.72289	0.4702
		AR5	1.85445	0.0644	2.02978*	0.0430	0.34065	0.7335	1.22132	0.2227	1.24178	0.2151
		Constant	4.47309*	0.0000	5.31851*	0.0000	5.50706*	0.0000	5.4482*	0.0000	8.8008*	0.0000
With Intercept, With Trend	2-lags with intercept with trend	AR1	26.92397*	0.0000	26.72949*	0.0000	22.83118*	0.0000	27.0178*	0.0000	24.8286*	0.0000
		AR2	-6.19568*	0.0000	-6.08915*	0.0000	-2.82856*	0.0049	-6.2090*	0.0000	-4.6118*	0.0000
		Constant	4.20756*	0.0000	5.63744*	0.0000	5.74572*	0.0000	5.5542*	0.0000	9.4329*	0.0000
		Trend	-1.15956	0.2469	-1.57145	0.1169	-1.50648	0.1327	-1.2896	0.1979	-1.79389	0.0736
	5-lags with intercept with trend	AR1	25.33416*	0.0000	25.26266*	0.0000	22.15667*	0.0000	25.4613*	0.0000	23.9262*	0.0000
		AR2	-2.69649*	0.0073	-2.71632*	0.0069	-0.17926	0.8578	-2.7813*	0.0057	-2.0428*	0.0417
		AR3	0.21631	0.8289	0.00257	0.9980	-0.99355	0.3210	-0.61541	0.5386	-0.67842	0.4979
		AR4	-2.05538*	0.0405	-1.88425	0.0603	-0.60649	0.5445	-0.76773	0.4431	-0.7112	0.4774
		AR5	1.72344	0.0856	1.86016	0.0636	0.1775	0.8592	1.11476	0.2656	1.08736	0.2775
		Constant	4.38429*	0.0000	5.5924*	0.0000	6.60896*	0.0000	5.4341*	0.0000	9.3136*	0.0000
		Trend	-1.2524	0.2112	-1.5403	0.1243	-1.9147	0.0563	-1.2294	0.2196	-1.7520	0.0805

			High Yield Bond Market									
Panel A			JULIX13BST		JULIX35BST		JULIX57BST		JULIX710BST		JULIX10PLUSBST	
			T-statistics	P-value	T-statistics	P-value	T-statistics	P-value	T-statistics	P-value	T-statistics	P-value
No Intercept, No Trend	2-lags without intercept	AR1	21.8014*	0.0000	21.4794*	0.0000	20.0726*	0.0000	21.6921*	0.0000	22.7496*	0.0000
		AR2	-1.70337	0.0893	-1.34763	0.1785	-0.03336	0.9734	-1.54114	0.1241	-2.4779*	0.0136
	5-lags without intercept	AR1	21.5460*	0.0000	21.5415*	0.0000	21.3716*	0.0000	21.5085*	0.0000	22.8234*	0.0000
		AR2	-0.44037	0.6599	-0.62315	0.5335	0.25485	0.7990	-0.90065	0.3683	-1.9682*	0.0497
		AR3	-0.18832	0.8507	0.58524	0.5587	-0.01781	0.9858	0.42474	0.6713	0.88434	0.3770
		AR4	0.70229	0.4829	-2.4081*	0.0165	-5.3664*	0.0000	0.08404	0.9331	-2.4328*	0.0154
		AR5	-1.65074	0.0996	2.1522*	0.0320	7.0769*	0.0000	-0.90302	0.3671	2.6857*	0.0075
With Intercept, No Trend	2-lags with intercept	AR1	21.4475*	0.0000	21.0750*	0.0000	19.3062*	0.0000	21.2949*	0.0000	22.2933*	0.0000
		AR2	-1.9729*	0.0492	-1.66513	0.0967	-0.7308	0.4653	-1.86932	0.0623	-2.8963*	0.0040
		Constant	5.9886*	0.0000	8.0220*	0.0000	12.9780*	0.0000	8.0478*	0.0000	10.8243*	0.0000
	5-lags with intercept	AR1	21.0787*	0.0000	21.0075*	0.0000	20.4698*	0.0000	21.0008*	0.0000	22.1971*	0.0000
		AR2	-0.41324	0.6797	-0.59385	0.5530	0.26574	0.7906	-0.87226	0.3836	-1.93127	0.0542
		AR3	-0.16442	0.8695	0.60017	0.5487	-0.00383	0.9970	0.43161	0.6663	0.87927	0.3798
		AR4	0.74095	0.4592	-2.3867*	0.0175	-5.4122*	0.0000	0.11304	0.9101	-2.4021*	0.0168
		AR5	-2.0515*	0.0409	1.75239	0.0805	6.3936*	0.0000	-1.33058	0.1841	2.2093*	0.0277
		Constant	7.1628*	0.0000	8.2370*	0.0000	11.0436*	0.0000	9.2042*	0.0000	10.3964*	0.0000
With Intercept, With Trend	2-lags with intercept with trend	AR1	21.3910*	0.0000	21.0265*	0.0000	19.2524*	0.0000	21.2488*	0.0000	22.2667*	0.0000
		AR2	-2.0588*	0.0402	-1.7437	0.0820	-0.80025	0.4240	-1.93452	0.0538	-2.8970*	0.0040
		Constant	4.7937*	0.0000	5.7807*	0.0000	7.9588*	0.0000	5.5829*	0.0000	5.8541*	0.0000
		Trend	-1.2628	0.2074	-1.08492	0.2786	-0.93206	0.3519	-0.95318	0.3411	-0.1196	0.9049
	5-lags with intercept with trend	AR1	20.9835*	0.0000	20.9189*	0.0000	20.3957*	0.0000	20.9276*	0.0000	22.1686*	0.0000
		AR2	-0.40346	0.6868	-0.58667	0.5578	0.26715	0.7895	-0.86546	0.3873	-1.92868	0.0545
		AR3	-0.15857	0.8741	0.60309	0.5468	-0.00311	0.9975	0.43188	0.6661	0.87812	0.3804
		AR4	0.7643	0.4451	-2.3717*	0.0182	-5.4131*	0.0000	0.12142	0.9034	-2.3985*	0.0169
		AR5	-2.2181*	0.0271	1.6313	0.1036	6.3234*	0.0000	-1.43714	0.1515	2.2029*	0.0282
		Constant	6.0916*	0.0000	6.0401*	0.0000	6.8026*	0.0000	6.6268*	0.0000	5.6148*	0.0000
		Trend	-1.8096	0.0711	-1.1656	0.2445	-0.6935	0.4884	-1.2889	0.1982	-0.0749	0.9404

			JPMHY13STW		JPMHY35STW		JPMHY57STW		JPMHY710STW		JPMHY10PLUSSTW	
Panel A			T-statistics	P-value	T-statistics	P-value	T-statistics	P-value	T-statistics	P-value	T-statistics	P-value
No Intercept, No Trend	2-lags without intercept	AR1	19.0492*	0.0000	25.7251*	0.0000	24.2979*	0.0000	24.8710*	0.0000	21.0270*	0.0000
		AR2	1.13454	0.2572	-4.9156*	0.0000	-3.7384*	0.0002	-4.2154*	0.0000	-0.84793	0.3970
	5-lags without intercept	AR1	19.2458*	0.0000	24.5909*	0.0000	23.4514*	0.0000	24.1726*	0.0000	20.8747*	0.0000
		AR2	0.45844	0.6469	-1.85028	0.0650	-1.15948	0.2470	-2.2465*	0.0252	-0.11232	0.9106
		AR3	-0.75397	0.4513	-1.19512	0.2328	-0.27533	0.7832	-0.34524	0.7301	0.19181	0.8480
		AR4	2.8192*	0.0051	0.8476	0.3972	-0.97502	0.3301	0.69877	0.4851	0.46557	0.6418
		AR5	-2.4652*	0.0141	-0.95267	0.3413	0.4006	0.6889	-1.0385	0.2997	-1.50935	0.1320
With Intercept, No Trend	2-lags with intercept	AR1	18.8863*	0.0000	25.5992*	0.0000	24.1492*	0.0000	24.6944*	0.0000	20.8391*	0.0000
		AR2	1.04361	0.2973	-4.9419*	0.0000	-3.7569*	0.0002	-4.2587*	0.0000	-0.91809	0.3591
		Constant	3.3530*	0.0009	3.5581*	0.0004	4.2661*	0.0000	5.4490*	0.0000	5.7679*	0.0000
	5-lags with intercept	AR1	19.1055*	0.0000	24.4384*	0.0000	23.2779*	0.0000	23.9648*	0.0000	20.6664*	0.0000
		AR2	0.45049	0.6526	-1.83841	0.0667	-1.14781	0.2517	-2.2299*	0.0263	-0.10746	0.9145
		AR3	-0.74978	0.4538	-1.18572	0.2364	-0.26659	0.7899	-0.34045	0.7337	0.198	0.8432
		AR4	2.8087*	0.0052	0.85235	0.3945	-0.96807	0.3336	0.70477	0.4814	0.46705	0.6407
		AR5	-2.5442*	0.0113	-1.01364	0.3114	0.3459	0.7296	-1.11424	0.2659	-1.59447	0.1116
		Constant	3.4234*	0.0007	3.8427*	0.0001	4.4885*	0.0000	5.7062*	0.0000	6.2940*	0.0000
With Intercept, With Trend	2-lags with intercept with trend	AR1	18.7381*	0.0000	25.5650*	0.0000	24.0913*	0.0000	24.6412*	0.0000	20.7915*	0.0000
		AR2	0.98305	0.3262	-4.9988*	0.0000	-3.8126*	0.0002	-4.3939*	0.0000	-0.98122	0.3271
		Constant	4.8113*	0.0000	4.3676*	0.0000	5.5841*	0.0000	7.8441*	0.0000	5.7250*	0.0000
		Trend	-2.0563*	0.0404	-1.31496	0.1893	-1.61447	0.1072	-2.3341*	0.0201	-1.22834	0.2200
	5-lags with intercept with trend	AR1	18.9677*	0.0000	24.3639*	0.0000	23.1718*	0.0000	23.8377*	0.0000	20.6081*	0.0000
		AR2	0.44188	0.6588	-1.83083	0.0679	-1.13364	0.2576	-2.2124*	0.0275	-0.10114	0.9195
		AR3	-0.76813	0.4429	-1.17904	0.2391	-0.26016	0.7949	-0.3429	0.7319	0.1927	0.8473
		AR4	2.7980*	0.0054	0.87137	0.3841	-0.94588	0.3448	0.74431	0.4571	0.47199	0.6372
		AR5	-2.5514*	0.0111	-1.1195	0.2636	0.22886	0.8191	-1.33268	0.1834	-1.6851	0.0928
		Constant	4.8367*	0.0000	5.1109*	0.0000	6.3315*	0.0000	9.1223*	0.0000	6.6144*	0.0000
		Trend	-2.0509*	0.0409	-1.6622	0.0973	-1.9591	0.0508	-2.8915*	0.0040	-1.5853	0.1137

Table D-2 -Continued

Panel B reports the univariate ARIMA analysis for stock market implied credit risk-Default Distance (DD) at maturity segments of 1-3 year, 3-5 year, 5-7 year, 7-10 year and 10 year plus. It also reports the ARIMA analysis of investment grade and high yield credit default swap spread at maturity segments of 3 year, 5 year, 7 year, and 10 year.

Panel B			Equity Market										Credit Derivative Markets															
			DD13		DD35		DD57		DD710		DD10PLUS		CDXIG3YSM		CDXIG5YSM		CDXIG7YSM		CDXIG10YSM		CDXHY3YSM		CDXHY5YSM		CDXHY7YSM		CDXHY10YSM	
			T-statistics	P-value	T-statistics	P-value	T-statistics	P-value	T-statistics	P-value	T-statistics	P-value	T-statistics	P-value	T-statistics	P-value	T-statistics	P-value	T-statistics	P-value	T-statistics	P-value	T-statistics	P-value	T-statistics	P-value	T-statistics	P-value
No Intercept, No Trend	2-lags without intercept	AR1	19.63402*	0.0000	19.6434*	0.0000	19.6483*	0.0000	19.6536*	0.0000	19.6188*	0.0000	9.5531*	0.0000	9.9494*	0.0000	9.9207*	0.0000	10.0452*	0.0000	7.9014*	0.0000	9.3751*	0.0000	9.3362*	0.0000	9.6027*	0.0000
		AR2	0.6279	0.5305	0.63029	0.5289	0.63143	0.5281	0.63304	0.5271	0.67638	0.4992	0.09138	0.9274	-0.25689	0.7978	-0.20418	0.8387	-0.28143	0.7790	1.89514	0.0613	0.35361	0.7245	0.3954	0.6935	0.15735	0.8753
	5-lags without intercept	AR1	19.5585*	0.0000	19.5748*	0.0000	19.5541*	0.0000	19.5493*	0.0000	19.5802*	0.0000	9.3383*	0.0000	9.8067*	0.0000	9.7297*	0.0000	9.8623*	0.0000	7.5479*	0.0000	9.3186*	0.0000	9.7037*	0.0000	10.4017*	0.0000
		AR2	0.8724	0.3835	0.8647	0.3877	0.8887	0.3747	0.89574	0.3709	0.87663	0.3812	-0.69558	0.4885	-1.08214	0.2822	-0.702	0.4845	-0.61359	0.5411	1.10389	0.2727	-0.39404	0.6945	-0.04182	0.9667	-0.05141	0.9591
		AR3	-1.5734	0.1164	-1.57589	0.1158	-1.57295	0.1165	-1.56988	0.1172	-1.57346	0.1164	0.63884	0.5246	0.86878	0.3873	0.26525	0.7914	-0.04556	0.9638	0.03406	0.9729	-0.04739	0.9623	-0.75657	0.4513	-1.75179	0.0833
		AR4	0.1880	0.8510	0.20428	0.8382	0.18956	0.8498	0.181	0.8565	0.20443	0.8381	-0.41224	0.6812	-0.23069	0.8181	0.37418	0.7092	0.59164	0.5556	0.74323	0.4593	1.51003	0.1346	2.2966*	0.0240	3.0215*	0.0033
		AR5	1.3838	0.1672	1.36829	0.1720	1.38181	0.1678	1.38747	0.1661	1.36898	0.1718	0.79312	0.4298	0.32621	0.7450	-0.1418	0.8876	-0.24862	0.8042	-0.5473	0.5856	-1.28181	0.2033	-2.1230*	0.0366	-2.4013*	0.0184
With Intercept, No Trend	2-lags with intercept	AR1	19.45996*	0.0000	19.4600*	0.0000	19.4600*	0.0000	19.4600*	0.0000	19.4600*	0.0000	8.8946*	0.0000	9.2444*	0.0000	9.1805*	0.0000	9.2954*	0.0000	7.2468*	0.0000	8.6932*	0.0000	8.7126*	0.0000	8.9515*	0.0000
		AR2	0.5509	0.5820	0.55092	0.5820	0.55091	0.5820	0.55091	0.5820	0.5509	0.5820	-0.34139	0.7336	-0.70888	0.4802	-0.66166	0.5099	-0.72447	0.4707	1.45898	0.1481	-0.09555	0.9241	0.00783	0.9938	-0.2321	0.8170
		Constant	6.89564*	0.0000	8.5212*	0.0000	10.1468*	0.0000	11.7724*	0.0000	14.2108*	0.0000	8.0810*	0.0000	10.6287*	0.0000	13.2837*	0.0000	16.5351*	0.0000	9.4638*	0.0000	14.0466*	0.0000	15.7669*	0.0000	18.5749*	0.0000
	5-lags with intercept	AR1	19.39341*	0.0000	19.3934*	0.0000	19.3934*	0.0000	19.3934*	0.0000	19.3934*	0.0000	8.7752*	0.0000	9.1416*	0.0000	9.0624*	0.0000	9.1681*	0.0000	7.0844*	0.0000	8.7867*	0.0000	9.2174*	0.0000	9.8818*	0.0000
		AR2	0.8628	0.3888	0.8628	0.3888	0.86281	0.3888	0.8628	0.3888	0.86281	0.3888	-0.67527	0.5013	-1.02852	0.3066	-0.68105	0.4977	-0.58767	0.5583	1.02552	0.3080	-0.42047	0.6752	-0.09686	0.9231	-0.12346	0.9020
		AR3	-1.5657	0.1182	-1.56567	0.1182	-1.56565	0.1182	-1.56581	0.1182	-1.56561	0.1182	0.52448	0.6013	0.71151	0.4787	0.14883	0.8820	-0.15957	0.8736	-0.00642	0.9949	-0.15984	0.8734	-0.81818	0.4155	-1.75325	0.0831
		AR4	0.1791	0.8580	0.179	0.8580	0.17894	0.8581	0.17924	0.8578	0.17887	0.8581	-0.32798	0.7437	-0.09819	0.9220	0.46644	0.6421	0.68861	0.4929	0.70924	0.4801	1.53759	0.1278	2.3433*	0.0214	3.0483*	0.0031
		AR5	1.3261	0.1856	1.32615	0.1856	1.32619	0.1855	1.32598	0.1856	1.32623	0.1855	0.37206	0.7108	-0.15327	0.8785	-0.6103	0.5433	-0.69072	0.4916	-0.83726	0.4047	-1.62864	0.1070	-2.5176*	0.0137	-2.8369*	0.0057
		Constant	6.50701*	0.0000	8.0197*	0.0000	9.5323*	0.0000	11.0449*	0.0000	13.3139*	0.0000	7.3201*	0.0000	10.2032*	0.0000	13.3460*	0.0000	16.6144*	0.0000	9.6544*	0.0000	14.4927*	0.0000	18.7466*	0.0000	22.9196*	0.0000
With Intercept, With Trend	2-lags with intercept with trend	AR1	19.43013*	0.0000	19.4301*	0.0000	19.4302*	0.0000	19.4301*	0.0000	19.4301*	0.0000	8.8143*	0.0000	9.1510*	0.0000	9.0610*	0.0000	9.2007*	0.0000	7.2055*	0.0000	8.6288*	0.0000	8.5563*	0.0000	8.7459*	0.0000
		AR2	0.5443	0.5866	0.54425	0.5866	0.54425	0.5866	0.54426	0.5866	0.54426	0.5866	-0.37001	0.7123	-0.75763	0.4507	-0.74517	0.4581	-0.80867	0.4209	1.44942	0.1507	-0.09597	0.9238	-0.00644	0.9949	-0.29027	0.7723
		Constant	4.51509*	0.0000	5.6464*	0.0000	6.7777*	0.0000	7.9089*	0.0000	9.6059*	0.0000	4.2081*	0.0001	5.6359*	0.0000	7.3466*	0.0000	9.3463*	0.0000	5.4448*	0.0000	7.6524*	0.0000	9.1246*	0.0000	11.4303*	0.0000
		Trend	0.3310	0.7408	0.33104	0.7408	0.33104	0.7408	0.33104	0.7408	0.33104	0.7408	0.55656	0.5792	0.72664	0.4694	0.93441	0.3526	0.84449	0.4007	-0.01359	0.9892	0.34424	0.7315	0.99293	0.3234	1.30511	0.1952
	5-lags with intercept with trend	AR1	19.36484*	0.0000	19.3649*	0.0000	19.3648*	0.0000	19.3648*	0.0000	19.3649*	0.0000	8.6967*	0.0000	9.0501*	0.0000	8.9401*	0.0000	9.0668*	0.0000	7.0400*	0.0000	8.7197*	0.0000	9.0501*	0.0000	9.6539*	0.0000
		AR2	0.8611	0.3897	0.86112	0.3897	0.86115	0.3897	0.86112	0.3897	0.86114	0.3897	-0.68334	0.4962	-1.03753	0.3024	-0.69807	0.4870	-0.60487	0.5469	1.02026	0.3105	-0.42163	0.6744	-0.10252	0.9186	-0.13232	0.8950
		AR3	-1.5664	0.1181	-1.56635	0.1181	-1.56641	0.1180	-1.56633	0.1181	-1.56636	0.1181	0.52792	0.5989	0.71323	0.4776	0.15315	0.8786	-0.15002	0.8811	-0.00728	0.9942	-0.15129	0.8801	-0.79333	0.4298	-1.72615	0.0879
		AR4	0.1819	0.8558	0.18181	0.8558	0.18189	0.8558	0.18179	0.8558	0.18182	0.8558	-0.35119	0.7263	-0.12676	0.8994	0.42652	0.6708	0.64548	0.5203	0.70601	0.4821	1.51901	0.1324	2.3007*	0.0238	2.9943*	0.0036
		AR5	1.3200	0.1876	1.32002	0.1876	1.31998	0.1876	1.32004	0.1876	1.32001	0.1876	0.3813	0.7039	-0.15175	0.8797	-0.62934	0.5308	-0.70631	0.4819	-0.83149	0.4080	-1.60921	0.1112	-2.4957*	0.0145	-2.8499*	0.0055
		Constant	4.35506*	0.0000	5.4324*	0.0000	6.5097*	0.0000	7.5871*	0.0000	9.2030*	0.0000	3.9230*	0.0002	5.4751*	0.0000	7.3924*	0.0000	9.3854*	0.0000	5.4876*	0.0000	7.7815*	0.0000	10.2079*	0.0000	13.2310*	0.0000
		Trend	0.3279	0.7432	0.3279	0.7432	0.3279	0.7432	0.3279	0.7432	0.3279	0.7432	0.5333	0.5952	0.6948	0.4890	0.9163	0.3621	0.8132	0.4184	-0.0488	0.9612	0.2994	0.7653	0.9353	0.3523	1.3388	0.1842

Table D-3 Unit Root Test in maturity segments

Panel A reports unit root tests in maturity segments of investment grade and high yield bond market. The Augmented Dickey-Fuller and Phillips-Perron test for unit root results are reported in this table. Intercept and trend are tested with 2,5,10 and 16 lags respectively. The Phillips-Perron unit root tests are conducted with structural break shift at February 2002 when the market was most volatile.

Panel A	Bond Market													
Levels	JULI13BST		JULI35BST		JULI57BST		JULI710BST		JULI10PLUSBST		JULIX13BST		JULIX35BST	
No Intercept, No Trend	ADF	PP	ADF	PP	ADF	PP	ADF	PP	ADF	PP	ADF	PP	ADF	PP
2 lags	-0.7313		-0.659		-0.6178		-0.4969		-0.3469		-1.2895		-0.9476	
5 lags	-0.6213		-0.5517		-0.6054		-0.5577		-0.4707		-1.3125		-0.7354	
10 lags	-0.5956		-0.5922		-0.6603		-0.7019		-0.6653		-1.09		-0.7452	
16 lags	-0.6483		-0.7811		-0.8253		-0.9728		-0.998		-1.1153		-1.1435	
Intercept, No Trend														
2 lags	-1.839	-1.4402	-1.8472	-1.931	-1.5206	-1.6939	-1.5157	-1.2118	-1.9308	-1.4349	-2.9331*	-2.3651	-2.9461*	-3.105*
5 lags	-1.6126	-1.3891	-1.5753	-1.6332	-1.4523	-1.6367	-1.3759	-1.1421	-1.6816	-1.3021	-3.1239*	-2.3486	-2.579	-3.1039*
10 lags	-1.5164	-1.4299	-1.4598	-1.5349	-1.351	-1.5665	-1.3976	-1.2372	-1.7823	-1.51	-2.6219	-2.3825	-2.5628	-3.2358*
16 lags	-1.468	-1.2175	-1.5996	-1.7686	-1.4656	-1.7508	-1.6181	-1.634	-2.0725	-2.0094	-2.5493	-2.4557	-2.4212	-2.3728
Intercept and Trend														
2 lags	-2.4368	-1.5569	-2.6062	-1.7076	-2.4745	-1.5939	-2.4346	-1.3154	-3.3032	-1.5248	-3.2913	-2.7549	-3.3206	-2.0287
5 lags	-2.0918	-1.4901	-2.1413	-1.4522	-2.3945	-1.537	-1.9854	-1.2079	-2.6519	-1.3782	-3.597*	-2.6792	-2.947	-1.9237
10 lags	-1.9183	-1.5109	-1.7638	-1.4503	-2.0838	-1.497	-1.7132	-1.2595	-2.5336	-1.5501	-3.0096	-2.5768	-2.9676	-1.9794
16 lags	-1.8325	-1.3281	-1.8246	-1.7048	-2.0195	-1.688	-1.6439	-1.6386	-2.4105	-1.9937	-2.9071	-2.5541	-2.287	-1.7081
1st Difference														
No Intercept, No Trend														
2 lags	-9.3834		-9.7171		-9.9424		-10.0806		-10.3297		-10.4941		-10.4566	

Panel A	Bond Market															
Levels	JULIX57BST		JULIX710BST		JULIX10PLUSBST		JPMHY13STW		JPMHY35STW		JPMHY57STW		JPMHY710STW		JPMHY10PLUSSTW	
No Intercept, No Trend	ADF	PP	ADF	PP	ADF	PP	ADF	PP	ADF	PP	ADF	PP	ADF	PP	ADF	PP
2 lags	-1.0873		-0.9491		-0.8199		-1.6398		-0.6229		-0.6502		-0.6318		-0.5622	
5 lags	-0.7357		-0.9749		-0.6413		-1.8311		-0.6974		-0.6386		-0.6656		-0.5978	
10 lags	-0.5889		-1.0708		-0.6971		-0.9865		-0.6895		-0.7087		-0.7451		-0.7548	
16 lags	-0.6654		-0.9329		-0.6013		-0.8729		-0.8046		-0.6928		-0.7424		-0.8823	
Intercept, No Trend																
2 lags	-4.2356*	-3.0129*	-3.012*	-1.5343	-3.3493*	-2.4708	-1.7769	-1.874	-1.1535	-0.8955	-1.0476	-0.8448	-1.3223	-1.1075	-1.3359	-0.973
5 lags	-2.865*	-2.7548	-3.0383*	-1.7363	-2.9716*	-2.0224	-2.1136	-2.0235	-1.2953	-1.0313	-1.092	-0.9255	-1.3699	-1.114	-1.3765	-1.1167
10 lags	-2.7083	-2.554	-3.3396*	-2.084	-3.2516*	-2.3981	-1.1853	-0.9184	-1.1364	-0.8412	-1.0802	-1.0419	-1.2073	-1.0326	-1.5901	-1.363
16 lags	-2.3337	-3.133	-2.8528	-1.861	-2.7245	-2.1787	-1.3244	-0.9856	-1.3075	-1.0922	-1.1065	-1.039	-1.2668	-1.0836	-1.9671	-1.604
Intercept and Trend																
2 lags	-4.5549*	-3.3623*	-3.4322*	-1.8294	-3.4157*	-2.7186	-1.8441	-2.0529	-3.1037	-1.5215	-2.6889	-1.384	-2.9987	-1.7675	-2.3865	-1.3116
5 lags	-3.0459	-2.9565	-3.4706*	-2.1353	-3.0498	-2.2096	-2.1659	-2.3085	-3.2736	-1.6501	-2.8781	-1.4621	-3.1385	-1.7565	-2.4174	-1.4744
10 lags	-2.9679	-2.8579	-3.8891*	-2.6063	-3.3579	-2.681	-1.7252	-1.6158	-3.2432	-1.4142	-2.7926	-1.5029	-2.7133	-1.5142	-2.577	-1.6243
16 lags	-2.4498	-3.3507*	-3.4455*	-2.1942	-2.8185	-2.4293	-2.0918	-1.8741	-3.3269	-1.6128	-2.9785	-1.5792	-2.9667	-1.6402	-2.9104	-1.8448
1st Difference																
No Intercept, No Trend																
2 lags	-11.1698		-10.7370		-10.8280		-13.3985		-10.0028		-9.5975		-10.3557		-10.5997	

Table D-3 - Continued

Panel B reports unit root tests in maturity segments of equity market and credit default swap market. The Augmented Dickey-Fuller and Phillips-Perron test for unit root results are reported in this table. Intercept and trend are tested with 2,5,10 and 16 lags respectively. The Phillips-Perron unit root tests are conducted with structural break shift at February 2002 when the market was most volatile.

Panel B	Equity Market									
Levels	DD13		DD35		DD57		DD710		DD10PLUS	
No Intercept, No Trend	ADF	PP	ADF	PP	ADF	PP	ADF	PP	ADF	PP
2 lags	-0.0941		0.1206		0.1536		0.1769		0.2013	
5 lags	0.0812		0.219		0.2448		0.2629		0.2818	
10 lags	0.0009		-0.0814		-0.0511		-0.0296		-0.0071	
16 lags	-0.0731		0.0342		0.0643		0.0855		0.1077	
Intercept, No Trend										
2 lags	-1.1821	-0.9156	-1.0272	-0.7607	-1.0272		-1.0272	-0.7607	-1.0272	-0.7607
5 lags	-0.8742	-0.7102	-0.7849	-0.5245	-0.7849		-0.7849	-0.5245	-0.7849	-0.5245
10 lags	-0.8516	-1.2879	-0.9861	-0.3868	-0.9861		-0.9861	-0.3868	-0.9861	-0.3868
16 lags	-1.0394	-1.04	-0.9753	-0.3818	-0.9753		-0.9753	-0.3818	-0.9753	-0.3818
Intercept and Trend										
2 lags	-1.5911	-1.2818	-1.3992	-1.3761	-1.3992		-1.3992	-1.3761	-1.3992	-1.3761
5 lags	-1.3048	-1.0786	-1.1994	-1.1568	-1.1994		-1.1994	-1.1568	-1.1994	-1.1568
10 lags	-1.3879	-1.4268	-1.6	-1.3643	-1.6		-1.6	-1.3643	-1.6	-1.3643
16 lags	-1.6087	-1.4341	-1.5446	-1.3184	-1.5446		-1.5446	-1.3184	-1.5446	-1.3184
1st Difference										
No Intercept, No Trend										
2 lags	-12.4833		-12.4833		-12.4833		-12.4833		-12.4833	

Panel B	Credit Derivative Markets															
Levels	CDXIG3YSM		CDXIG5YSM		CDXIG7YSM		CDXIG10YSM		CDXHY3YSM		CDXHY5YSM		CDXHY7YSM		CDXHY10YSM	
No Intercept, No Trend	ADF	PP	ADF	PP	ADF	PP	ADF	PP	ADF	PP	ADF	PP	ADF	PP	ADF	PP
2 lags	-0.5117		-0.3829		-0.3703		-0.3471		-0.42		-0.1425		0.0565		0.0117	
5 lags	-0.4076		-0.3331		-0.3455		-0.3725		-0.6949		-0.1719		-0.0752		-0.1768	
10 lags	0.1918		0.2467		0.2211		0.2093		-0.3594		0.1047		0.0858		0.2299	
16 lags	0.2682		0.7453		0.8755		0.8113		-0.0767		0.3335		0.455		0.5843	
Intercept, No Trend																
2 lags	-1.9132	-1.7928	-1.9239	-1.5101	-2.0225	-1.559	-2.0331	-1.9279	-1.7201	-1.6178	-1.7594	-2.4149	-1.7982	-2.6121	-2.0962	-2.5596
5 lags	-1.8884	-1.274	-2.0104	-1.1837	-2.1254	-1.5745	-2.2137	-1.9138	-2.3012	-2.0425	-2.0688	-2.3751	-2.2197	-2.734	-2.6875	-3.2754*
10 lags	-1.5956	-2.2296	-1.5741	-2.6453	-1.731	-3.0488	-1.6411	-2.8681	-1.983	-1.6701	-1.72	-2.1865	-2.0552	-2.6831	-1.9612	-2.5861
16 lags	-1.112	-2.3504	-0.6468	-2.7556	-0.5224	-2.93	-0.8029	-2.5931	-1.6604	-1.614	-1.5404	-2.0567	-1.8329	-2.6032	-1.8667	-2.4837
Intercept and Trend																
2 lags	-2.151	-2.1095	-2.1961	-1.9082	-2.3302	-1.8668	-2.3297	-1.8989	-1.7033	-2	-1.8154	-2.6444	-1.9498	-2.643	-2.2928	-2.5601
5 lags	-2.0732	-1.9457	-2.2533	-1.8617	-2.4139	-1.9031	-2.4717	-1.9009	-2.2761	-2.392	-2.087	-2.6974	-2.324	-2.7649	-2.8414	-3.1299*
10 lags	-1.2575	-2.5033	-1.3946	-2.4372	-1.8527	-2.3311	-1.8289	-2.2307	-1.9568	-2.3671	-1.6502	-2.6251	-2.0767	-2.763	-2.0733	-2.613
16 lags	0.5374	-2.7417	0.9006	-2.5851	0.5889	-2.4462	-0.0739	-2.2937	-1.509	-2.4297	-1.3174	-2.56	-1.7763	-2.6339	-1.8408	-2.1205
1st Difference																
No Intercept, No Trend																
2 lags	-5.9517		-5.8024		-5.8855		-5.9579		-6.0928		-6.3007		-6.0954		-6.2083	

Table D-4 Long term credit risk price discovery between two markets (Pair-wise) in same maturity segment – Cointegration tests

Table D-4 reports results of the Johansen trace test for cointegration between two markets (pair-wise) in same maturity segments. The Johansen cointegration tests are conducted without structural break and with structural break at February 2002. Intercept and trend with 1,2,5 lags are tested respectively.

Panel A	**Without Break**						**With Break**					
	Intercept			**Intercept and Trend**			**Intercept**			**Intercept and Trend**		
Likelihood Ration (LR) r=0	**1 lag**	**2 lags**	**5 lags**	**1 lag**	**2 lags**	**5 lags**	**1 lag**	**2 lags**	**5 lags**	**1 lag**	**2 lags**	**5 lags**
Stock Market-Bond Market												
DD13-JULI13BST	6	9.55	19.15	8.88	12.76	20.78	14.71	17.76	28.7*	23.05	20.76	29.37*
DD35-JULI35BST	7.42	11.82	21.91*	11.11	16.55	25.12	8.95	13.41	23.01	17.5	22.22	29.64*
DD57-JULI57BST	9.15	12.01	18.87	12.24	15.06	22.62	23.32	24.47	38.57*	25.96	25.81	38.03*
DD710-JULI710BST	7.11	10.58	15.72	12.08	16.44	22.75	17.21	20.36	29.87*	17.93	20.93	30.9*
DD10PLUS-JULI10PLUSBST	8.34	12.26	16.54	22.22	21.82	22.22	29.78*	29.56*	28.43*	30.14*	29.97*	28.92
DD13-JULIX13BST	9.54	11.84	21.35*	13.71	16.62	26.44*	10.3	12.84	22.92	20.2	23.47	32.5*
DD35-JULIX35BST	8.9	10.44	13.59	13.99	16.15	19.01	9.97	11.72	14.82	19.13	21.64	23.89
DD57-JULIX57BST	22.12*	22.52*	12.79	27.81*	28.83*	19.11	25.23*	25.84*	15.13	34.02*	35.25*	22.91
DD710-JULIX710BST	9.17	10.34	18.84	16.27	16.8	23.71	24.12	22.83	24.97	30.23*	26.57	25.52
DD10PLUS-JULIX10PLUSBST	10.98	12.94	11.94	15.39	17.91	17.39	22.27	23.78	19.56	36.78*	36.01*	25.69
DD13-JPMHY13STW	9.48	8.58	16.3	13.88	12.8	18.67	17.31	15.91	24.87	17.54	16.52	26.6
DD35-JPMHY35STW	5.98	7.48	12.39	14.56	14.78	20.86	24.47	20.12	22.37	24.42	20.54	25.69
DD57-JPMHY57STW	6.05	8.13	12.09	10.07	11.27	15.89	16.14	15.1	18.56	16.17	15.05	20.56
DD710-JPMHY710STW	7.28	10.47	15.65	12.94	16.3	22.99	18.84	21.32	26.18*	18.89	22.02	29.55*
DD10PLUS-JPMHY10PUSSTW	5.25	6.97	9.3	10.59	11.51	13.22	16.42	18.51	17.24	16.78	18.42	17.37
Stock Market- Credit Derivative Market												
DD13-CDXIG3YSM	10.48	12.32	11.5	17.61	16.67	11.76	14.72	19.87	28.14*	19.44	22.3	30.41*
DD35-CDXIG5YSM	11.52	14.3	12.16	17.46	17.25	11.93	26.06*	31.38*	17.55	31.96*	35.2*	21.36
DD57-CDXIG7YSM	11.82	15.61	13.01	18.02	19.05	12.52	20.43	26.25*	22.75	26.71	30.61*	25.19
DD710-CDXIG10YSM	12.26	16.88	13.15	18.95	20.64	13.1	16.63	21.69	26.61*	23.4	26.77	29.24
DD10PLUS-CDXIG10YSM	12.26	16.88	13.15	18.95	20.64	13.1	16.63	21.69	26.61*	23.4	26.77	29.24
DD13-CDXHY3YSM	9.12	8.93	9.56	17.04	13.59	10.27	21.95	12.97	16.38	29.57*	18.93	19.94
DD35-CDXHY5YSM	11.83	9.85	9.88	19.98	14.54	10.99	27.79*	20.45	18.88	35.95*	26.11	23.59
DD57-CDXHY7YSM	10.76	9.65	11.29	19.67	15.7	11.32	19.83	14.28	21.63	31.24*	23.17	25.27
DD10PLUS-CDXHY10YSM	11.42	10.64	13.26	21.69	17.59	14.06	17.05	12.99	23.08	30.55*	23.3	27.48

Table D-4 -Continued

Table D-4 reports results of the Johansen trace test for cointegration between two markets (pair-wise) in same maturity segments. The Johansen cointegration tests are conducted without structural break and with structural break at February 2002. Intercept and trend with 1,2,5 lags are tested respectively

Panel B	**Without Break**						**With Break**					
	Intercept			**Intercept and Trend**			**Intercept**			**Intercept and Trend**		
Likelihood Ration (LR) r=0	**1 lag**	**2 lags**	**5 lags**	**1 lag**	**2 lags**	**5 lags**	**1 lag**	**2 lags**	**5 lags**	**1 lag**	**2 lags**	**5 lags**
Bond Market - Credit Derivative Market												
CDXIG3YSM-JULI13BST	41.89*	28.33*	12.98	66.54*	63.62*	42.41*	86.06*	80.46*	87.99*	102.66*	103.55*	107.22*
CDXIG5YSM-JULI35BST	62.36*	35.19*	15.13	84.75*	63.53*	27*	103.04*	78.36*	64.03*	118.48*	95.9*	68.83*
CDXIG7YSM-JULI57BST	71.01*	54.59*	19.97	74.65*	60.22*	22.63	95.91*	73.45*	36.18*	97.74*	76.21*	36.33*
CDXIG10YSM-JULI710BST	56.43*	51.89*	19.73	60.32*	57.75*	25.95*	81.06*	66.2*	50.01*	80.33*	66.78*	53.48*
CDXIG10YSM-JULI10PLUSBST	33.92*	30.85*	19.52	36.62*	33.82*	24.42	51.55*	44.09*	43.39*	51.38*	44.04*	49.69*
CDXIG3YSM-JULIX13BST	15.6	23.68*	13.28	20.01	29.3*	18.07	33.21*	39.2*	26.5*	48.09*	58.21*	26.12
CDXIG5YSM-JULIX35BST	15.59	22.9*	21.67*	21.96	33.01*	35.82*	28.81*	36.93*	44.35*	50.67*	61.07*	67.11*
CDXIG7YSM-JULIX57BST	17.65	28.99*	27.3*	20.74	32.34*	36.01*	25.32*	35.55*	40.4*	42.93*	56.17*	48.06*
CDXIG10YSM-JULIX710BST	13.65	14.18	18.93	14.57	15.02	20.27	17.87	17.73	35.34*	19.71	18.73	36.76*
CDXIG10YSM-JULIX10PLUSBST	11.65	16.31	13.18	14	19.65	21.21	14.72	19.04	24.97	22.81	26.05	31.97*
CDXHY3YSM-JULIX13BST	21.95*	19.41	14.44	21.97	19.68	14.45	25.68*	23.28	17.1	39.19*	35.73*	28.6
CDXHY5YSM-JULIX35BST	21.09*	18.11	18.5	21.62	18.59	19.77	26.51*	22.62	19.91	47.26*	41.08*	50.53*
CDXHY7YSM-JULIX57BST	20.45*	21.64*	18.87	21.41	21.57	19.97	23.51	25.95*	16.52	40.46*	43.36*	24.09
CDXHY10YSM-JULIX710BST	27.97*	22*	24.79*	30.82*	23.79	29.38*	28.77*	24.76	31.88*	34.24*	29.25	36.07*
CDXHY10YSM-JULIX10PLUSBST	13.64	14.86	12.94	17.64	16.66	17.05	14.86	17.44	15.9	24.95	25.5	24.98
CDXHY3YSM-JPMHY13STW	25.36*	19.96	18.87	25.53	20.4	19.39	29.99*	23.83	23.16	35.89*	25.56	23.8
CDXHY5YSM-JPMHY35STW	21.76*	21.21*	14.13	31.54*	30.63*	26.36*	26.91*	25.48*	19.38	44.92*	39.37*	31.87*
CDXHY7YSM-JPMHY57STW	33.54*	33.36*	27.29*	33.98*	33.61*	27.37*	41.46*	38.7*	30.18*	50.6*	46.26*	33.67*
CDXHY10YSM-JPMHY710STW	27.67*	26.57*	27.09*	28.81*	27.7*	28.4*	35.55*	30.3*	41.48*	36.97*	31.17*	41.76*
CDXHY10YSM-JPMHY10PUSSTW	21.49*	22.31*	22.31*	22.24	22.61	22.33	29.92*	27.45*	25.08	40.03*	35.38*	28.9

Table D-5 Long term credit risk price discovery among three markets in same rating segment– Cointegration tests

Table D-5 reports results of the Johansen trace test for cointegration among equity, bond and credit derivative markets in same maturity segments. The Johansen cointegration tests are conducted without structural break and with structural break at February 2002. Intercept and trend with 1, 2, 5 lags are tested respectively.

Stock Market-Bond Market-Credit Derivative Market	Without Break												With Break											
	Intercept						Intercept and Trend						Intercept						Intercept and Trend					
	1 lag		2 lags		5 lags		1 lag		2 lags		5 lags		1 lag		2 lags		5 lags		1 lag		2 lags		5 lags	
	r=0	r=1	r=0	r=1	r=0	r=1	r=0	r=1	r=0	r=1	r=0	r=1	r=0	r=1	r=0	r=1	r=0	r=1	r=0	r=1	r=0	r=1	r=0	r=1
DD13-JULI13BST-CDXIG3YSM	67.7*	12.64	61.6*	12.79	40.7*	14.18	79.98*	18.01	75.37*	16.05	51.7*	14.12	102.16*	46.07*	102.36*	41.19*	108.78*	41.69*	115.38*	53.56*	116.12*	50.02*	134.67*	45.1*
DD35-JULI35BST-CDXIG5YSM	87.35*	12.68	63.78*	14.05	32.34	14.11	98.02*	17.35	74.98*	15.62	38.52	16.98	113.77*	44.57*	94.6*	43.93*	85.02*	34.57*	129.7*	51.36*	109.62*	52.54*	91.49*	40.43*
DD57-JULI57BST-CDXIG7YSM	80.04*	12.69	67.54*	15.68	32.57	15.45	87.65*	17.8	75.13*	17.24	35.78	13.88	101.3*	34.16*	84.05*	31.9*	57.77*	22.38	110.45*	39.65*	92.68*	35.64*	59.6*	21.79
DD710-JULI710BST-CDXIG10YSM	66.99*	15.17	66.79*	19.06	38.68*	19.87	76.27*	19.93	78.71*	19.3	43.95*	20.33	85.79*	35.3*	78.27*	36.72*	77.45*	35.17*	101.47*	40.86*	96.1*	37.2*	78.96*	35.08*
DD10PLUS-JULI10PLUSBST--CDXIG10YSM	42.62*	13.09	43.48*	15.12	33.67	19.46	51.4*	18.88	50.76*	17.78	34.74	17.68	55.47*	26.85*	54.42*	26.3*	71.94*	30.14*	66*	33.75*	63.24*	33.58*	70.19*	27.88
DD13-JULIX13BST--CDXIG3YSM	23.85	9.23	33.27	11.25	23.9	12.01	35.06	16.03	44.49*	16.3	37.28	12.37	44.37*	15.32	52.77*	19.41	44.61*	23.23	62*	28.16	71.94*	36.5*	52.82*	26.87
DD35-JULIX35BST-CDXIG5YSM	27.19	9.63	38.3*	13.16	39.58*	14.47	34.28	15.69	43.91*	16.29	47.75*	16.23	45.28*	20.32	52.77*	25.54*	66.25*	29.18*	60.94*	26.65	69.98*	35.56*	83.11*	37.82*
DD57-JULIX57BST-CDXIG7YSM	27.06	11	41.02*	14.58	38.79*	14.56	33.71	17.55	46.76*	20.61	45.15*	19.87	38.16	18.64	50.49*	23.78	57.15*	25.44*	55.67*	23.84	72.29*	36*	65.95*	34.35*
DD710-JULIX710BST-CDXIG10YSM	23.07	8.85	28.33	9.63	32.51	15.26	36.53	14.49	37.26	14.85	33.82	11.39	29.46	12.95	33.42	13.27	60.87*	24.77	45.61*	20.12	44.72	21.61	59.4*	21.39
DD10PLUS-JULIX10PLUSBST-CDXIG10YSM	21.16	8.42	32.48	10.2	26.49	13.53	27.97	15.74	37.66	16.84	30.83	16.21	24.29	11.56	34.44	11.83	46.89*	18.33	38.21	19.14	49.09*	25.7	53.22*	21.84
DD13-JULIX13BST--CDXHY3YSM	27.64	8.33	27.76	9.55	26.92	8.72	38.54	15.59	34.61	14.97	38.12	11.46	31.32	11.59	29.45	9.58	38.06	17.92	54.66*	19.75	55.26*	17.18	58.89*	24.26
DD35-JULIX35BST-CDXHY5YSM	27.92	11.35	24.35	9.89	33.39	10.73	37.39	18.55	29.92	14.36	40.98	12.6	40.3	16.64	33.17	12.41	41.55	17.69	58.68*	23.36	53.14*	17.18	69.67*	23.93
DD57-JULIX57BST-CDXHY7YSM	27.03	11.37	27.23	9.94	29.87	10.97	39.74	19.26	36.86	18.81	40.04	15.66	34.39	14.8	37.55	11	32.05	17.84	56.5*	21.83	65.08*	20.11	41.52	18.81
DD710-JULIX710BST-CDXHY10YSM	37.28*	11.15	29.53	11.22	41.19*	17.57	47.28*	21.14	35.57	17.31	41.15	17.58	73.12*	21.52	79.94*	23.74	72.84*	36.88*	78.64*	26.39	78.42*	20.41	65.9*	26.86
DD10PLUS-JULIX10PLUSBST-CDXHY10YSM	21.78	9.09	22.31	8.6	21.37	10.78	39.42	16.16	35.11	16.8	39.09	12.99	22.89	9.97	29.33	9.66	32.98	18.44	48.07*	17.03	58.74*	18.15	43.97*	18.73
DD13-JPMHY13STW-CDXHY3YSM	29.17	8.93	26.56	9.95	25.69	10.12	37.37	17.22	33.24	16.79	28.21	12.78	35.53	12.45	32.08	11.1	36.72	18.83	46.8	23.77	43.95	21.73	38.86	18.74
DD35-JPMHY35STW-CDXHY5YSM	37.33*	9.49	35.79*	9.47	36.12*	12.8	46.37*	18.41	41.27	14.5	41.56	18.89	46.43*	15.09	44.81*	11.58	46.95*	19.88	60.66*	25.88	58.5*	18.85	47.92*	21.87
DD57-JPMHY57STW-CDXHY7YSM	39.9*	13.25	40.43*	12.7	40.22*	17.37	47.77*	20.95	46.19*	18.61	44.11*	21.08	52.77*	19.25	54.09*	16.44	53.64*	29.49*	61.28*	26.52	61.19*	22.77	51.16*	26
DD710-JPMHY710STW-CDXHY10YSM	34.62	16.02	33.68	17.37	40.93*	16.52	42.56	23.26	39.45	22.87	44.99*	16.9	40.46	19.11	38.96	20.75	64.73*	22.9	49.24*	26.86	46.56	27.67	58.03*	16.93
DD10PLUS-JPMHY10PUSSTW-CDXHY10YSM	49.16*	15.92	41.96*	17.4	41.48*	21.02	56.15*	23.13	46.15*	21.64	42.39	20.74	40.58	12.84	40.83	16.88	44.31*	18.87	54.16*	20.94	53.35*	24.96	44.32	15.89

Table D-6 Short term credit risk price discovery in same maturity segments– Lead-lag relationship tests

Table D-6 Panel A reports the lead-lag relationship (Engle-Granger causality) test results for stock market and bond market at same maturity segments. The short term credit risk price discovery-Lead-lag relationship is tested using bivariate Engle-Granger causality test within a vector autoregression (VAR) model or a vector error correction (VECM) model if the two markets are cointegrated.

Panel A	Intercept			Intercept and Trend		
Stock Market & Bond Market	1 lag	2 lags	5 lags	1 lag	2 lags	5 lags
DD13-->JULI13BST	13.8394* 0.0000	12.5032* 0.0000	6.2686* 0.0000	13.2909* 0.0000	12.1099* 0.0000	6.195* 0.0000
JULI13BST-->DD13	1.4811 0.2280	1.0698 0.361	1.3499 0.2324	1.5209 0.2192	1.1177 0.3410	1.3734 0.2226
DD35-->JULI35BST	11.4206* 0.0000	8.2305* 0.0000	5.2122* 0.0000	10.7958* 0.0000	7.9282* 0.0000	5.2125* 0.0000
JULI35BST-->DD35	1.8725 0.1544	2.3261 0.0734	1.3209 0.2451	1.9719 0.1399	2.4536 0.0621	1.3923 0.2149
DD57-->JULI57BST	9.1707* 0.0001	6.7656* 0.0002	4.1607* 0.0004	8.8191* 0.0002	6.7090* 0.0002	4.2222* 0.0003
JULI57BST-->DD57	0.4993 0.6072	0.3798 0.7676	0.3318 0.9203	0.5421 0.5817	0.4243 0.7356	0.3489 0.9107
DD710-->JULI710BST	6.6707* 0.0013	4.4261* 0.0043	3.0236* 0.0063	6.2761* 0.0020	4.2408 0.0055	2.9952* 0.0067
JULI710BST-->DD710	0.9263 0.3964	0.7988 0.4947	0.3439 0.9135	0.9899 0.3721	0.8319 0.4765	0.3944 0.8828
DD10PLUS-->JULI10PLUSBST	9.4149* 0.0001	6.6362* 0.0002	3.8704* 0.0008	9.0158* 0.0001	6.4953* 0.0002	3.8585* 0.0008
JULI10PLUSBST-->DD10PLUS	0.0572 0.9444	0.4539 0.7146	0.4253 0.8624	0.1331 0.8754	0.4812 0.6954	0.5455 0.7737
DD13-->JULIX13BST	3.9249 0.0201	9.9188* 0.0000	7.6789* 0.0000	3.4993* 0.0307	9.3012* 0.0000	7.4435* 0.0000
JULIX13BST-->DD13	2.5808 0.0764	2.1267 0.0954	2.3631 0.0287	2.4168 0.0899	1.9621 0.1182	2.3247 0.0007
DD35-->JULIX35BST	9.275 0.0001	9.5387* 0.0000	5.3532* 0.0000	8.6909* 0.0002	8.9118* 0.0000	5.1294* 0.0000
JULIX35BST-->DD35	0.2504 0.7786	0.1752 0.9132	0.5534 0.7675	0.2748 0.7598	0.1434 0.9339	0.5749 0.7506
DD57-->JULIX57BST	1.7373 0.1767	4.2106* 0.0057	3.0491* 0.0059	1.3718 0.2543	3.8391* 0.0096	2.8693* 0.0090
JULIX57BST-->DD57	0.3987 0.6713	0.3722 0.7731	0.8124 0.5604	0.3725 0.6892	0.3234 0.8085	0.9313 0.4716
DD710-->JULIX710BST	16.1772* 0.0000	16.2804* 0.0000	9.0751* 0.0000	15.068* 0.0000	15.3309* 0.0000	8.5919* 0.0000
JULIX710BST-->DD710	0.4279 0.6520	0.2196 0.8828	0.7726 0.5916	0.599 0.5496	0.3614 0.7809	0.9154 0.4830
DD10PLUS-->JULIX10PLUSBST	7.4862* 0.0006	11.8324* 0.0000	6.9139* 0.0000	7.2384* 0.0008	11.5987* 0.0000	6.7755* 0.0000
JULIX10PLUSBST-->DD10PLUS	0.5761 0.5623	0.4211 0.7379	1.0155 0.4138	0.6124 0.5423	0.4598 0.7104	1.0528 0.3897
DD13-->JPMHY13STW	7.9958* 0.0004	5.5017 0.0010	4.8274* 0.0001	7.6545* 0.0005	5.2769* 0.0013	4.6463* 0.0001
JPMHY13STW-->DD13	2.1356 0.1189	2.6927 0.0452	2.4694* 0.0226	2.1199 0.1207	2.6415* 0.0483	2.4177* 0.0254
DD35-->JPMHY35STW	8.72* 0.0002	7.4641* 0.0001	6.0086 0.0000	8.8415* 0.0002	7.8634 * 0.0000	6.6372* 0.0000
JPMHY35STW-->DD35	0.4964 0.6089	0.1594 0.9236	1.0890 0.3672	0.611 0.5431	0.2529 0.8593	1.1262 0.3450
DD57-->JPMHY57STW	10.2763* 0.0000	8.4703* 0.0000	5.1698* 0.0000	10.0724	8.485* 0.0000	5.3002* 0.0000
JPMHY57STW-->DD57	1.5049 0.2227	0.9227 0.4293	0.8957 0.4973	0	1.0568 0.3667	0.9399 0.4655
DD710-->JPMHY710STW	7.3242* 0.0007	5.5233* 0.0009	4.1022* 0.0005	7.1234 * 0.0009	5.5329* 0.0009	4.3173* 0.0003
JPMHY710STW-->DD710	0.6078 0.5448	0.8196 0.4832	0.5609 0.7616	0.7595 0.4682	0.9973 0.3935	0.6373 0.7004
DD10PLUS-->JPMHY10PUSSTW	9.7598* 0.0001	9.2497* 0.0000	5.5471* 0.0000	9.3306* 0.0001	8.9142* 0.0000	5.3883* 0.0000
JPMHY10PUSSTW-->DD10PLUS	1.9913 0.1372	1.4874 0.2166	1.0438 0.3954	2.1297 0.1196	1.5465 0.2011	1.0733 0.3768

Table D-6 -Continued

Table D-6 Panel B reports the lead-lag relationship (Engle-Granger causality) test results for stock market and credit default swap market at same maturity segments. The short term credit risk price discovery-Lead-lag relationship is tested using bivariate Engle-Granger causality test within a vector autoregression (VAR) model or a vector error correction (VECM) model if the two markets are cointegrated.

Panel B	**Intercept**			**Intercept and Trend**		
Stock Market & Credit Derivatives Market	1 lag	2 lags	5 lags	1 lag	2 lags	5 lags
DD13-->CDXIG3YSM	0.0837 0.9197	0.566 0.6382	0.6752 0.6699	0.2568 0.7738	0.7731 0.5107	0.8855 0.5074
CDXIG3YSM-->DD13	1.5042 0.2252	2.3278* 0.0766	2.5332* 0.0232	2.0772 0.1286	3.2839* 0.0224	3.3209* 0.0044
DD35-->CDXIG5YSM	0.5472 0.5796	0.8536 0.4666	1.2386 0.2901	0.9327 0.3956	1.1787 0.3197	1.5089 0.1795
CDXIG5YSM-->DD35	1.8599 0.1589	1.2839 0.2818	1.7025 0.1246	2.3667 0.0970	1.8220 0.1453	2.1883* 0.0476
DD57-->CDXIG7YSM	0.9593 0.3853	0.9831 0.4023	1.2624 0.2786	1.5537 0.2146	1.4100 0.2419	1.5086 0.1796
CDXIG7YSM-->DD57	1.0692 0.3456	0.8394 0.4741	1.4714 0.1921	1.5158 0.2227	1.3018 0.2758	1.8566* 0.0925
DD710-->CDXIG10YSM	1.3645 0.2584	1.1650 0.3249	1.4215 0.2104	2.1896 0.1152	1.7531 0.1584	1.7605 0.1115
CDXIG10YSM-->DD710	1.3637 0.2586	1.0501 0.3721	1.3506 0.2388	1.6784 0.1899	1.4011 0.2445	1.6660 0.1337
DD10PLUS-->CDXIG10YSM	1.3645 0.2584	1.165 0.3249	1.4215 0.2104	2.1896 0.1152	1.7531 0.1584	1.7605 0.1115
CDXIG10YSM-->DD10PLUS	1.3637 0.2586	1.0501 0.3721	1.3506 0.2388	1.6784 0.1899	1.4011 0.2445	1.6660 0.1337
DD13-->CDXHY3YSM	0.741 0.4782	1.0602 0.3677	1.423 0.2098	1.489 0.2286	1.6396 0.1824	1.5367 0.1705
CDXHY3YSM-->DD13	1.0986 0.3358	0.6468 0.5861	0.5337 0.7820	1.1615 0.3156	0.7526 0.5224	0.7803 0.5867
DD35-->CDXHY5YSM	5.2522* 0.0061	3.3723* 0.0200	3.0831* 0.0072	6.233* 0.0025	4.0334* 0.0085	3.5026* 0.0029
CDXHY5YSM-->DD35	2.6763 0.0718	1.4004 0.2447	1.6005 0.1512	3.0780 0.0487	1.7394 0.1611	2.0077 0.0685
DD57-->CDXHY7YSM	2.5973 0.0775	2.0647 0.1070	2.7104* 0.0160	3.7169* 0.0264	2.7664* 0.0437	2.9473* 0.0097
CDXHY7YSM-->DD57	1.8335 0.1631	0.9978 0.3955	1.7108 0.1226	2.1974 0.1144	1.2053 0.3097	2.1599 0.0504
DD710-->CDXHY10YSM	1.3645 0.2584	1.165 0.3249	1.4215 0.2104	2.1896 0.1152	1.7531 0.1584	1.7605 0.1115
CDXHY10YSM-->DD710	1.3637 0.2586	1.0501 0.3721	1.3506 0.2388	1.6784 0.1899	1.4011 0.2445	1.6660 0.1337
DD10PLUS-->CDXHY10YSM	3.1431 0.0457	2.0141 0.1141	2.3367* 0.0350	4.1445* 0.0175	2.7704* 0.0435	2.4467* 0.0279
CDXHY10YSM-->DD10PLUS	2.3450 0.0990	1.5363 0.2072	1.6347 0.1418	2.9649 0.0543	1.9379 0.1257	2.2339* 0.0433

Table D-6 - Continued

Table D-6 Panel C reports the lead-lag relationship (Engle-Granger causality) test results for bond market and credit default swap market at same maturity segments. The short term credit risk price discovery-Lead-lag relationship is tested using bivariate Engle-Granger causality test within a vector auto-regression (VAR) model or a vector error correction (VECM) model if the two markets are cointegrated.

Panel C	Intercept			Intercept and Trend		
	1 lag	2 lags	5 lags	1 lag	2 lags	5 lags
Bond Market & Credit Derivatives Market						
CDXIG3YSM-->JULI13BST	3.2099* 0.0429	10.9363* 0.0000	13.3773* 0.0000	19.7127* 0.0000	25.9827* 0.0000	16.3839* 0.0000
JULI13BST-->CDXIG3YSM	2.4692 0.0878	2.2618 0.0833	1.124 0.3514	2.7954 0.0640	2.7512 0.0446	1.8441 0.0948
CDXIG5YSM-->JULI35BST	4.9569* 0.0081	3.1769* 0.0257	4.1243* 0.0008	17.5008* 0.0000	8.6297* 0.0000	5.7155* 0.0000
JULI35BST-->CDXIG5YSM	2.2394 0.1097	3.4334* 0.0185	0.8916 0.5029	2.0808 0.1281	2.2317 0.0866	0.9347 0.4722
CDXIG7YSM-->JULI57BST	7.8766* 0.0005	4.4383* 0.0050	4.3109* 0.0005	9.9157* 0.0001	5.6462* 0.0011	4.7213* 0.0002
JULI57BST-->CDXIG7YSM	0.2185 0.8039	1.0438 0.3748	1.6802 0.1300	0.1483 0.8623	0.6678 0.5730	1.9549 0.0762
CDXIG10YSM-->JULI710BST	1.8759 0.1564	1.3995 0.2450	4.1828 0.0007	2.3221 0.1013	1.5996 0.1917	4.6489* 0.0002
JULI710BST-->CDXIG10YSM	0.7768 0.4615	0.8667 0.4597	1.81 0.1012	0.2926 0.7467	0.2574 0.8560	2.3710* 0.0327
CDXIG10YSM-->JULI10PLUSBST	1.915 0.1506	1.3873 0.2487	3.9324* 0.0011	1.7111 0.1839	1.2099 0.3080	3.7308* 0.0018
JULI10PLUSBST-->CDXIG10YSM	0.0009 0.9991	0.0367 0.9906	1.272 0.2740	0.0199 0.9803	0.0756 0.9730	1.5438 0.1682
CDXIG3YSM-->JULIX13BST	0.402 0.6697	2.1225 0.0995	2.0068 0.0686	0.159 0.8531	2.1235 0.0994	1.8846 0.0875
JULIX13BST-->CDXIG3YSM	3.4482* 0.0341	2.3861 0.0711	1.4336 0.2058	3.9242* 0.0216	2.9628* 0.0339	1.6052 0.1500
CDXIG5YSM-->JULIX35BST	0.0399 0.9609	1.6 0.1915	1.6946 0.1265	0.5683 0.5676	2.3629 0.0733	1.8444 0.0947
JULIX35BST-->CDXIG5YSM	1.0733 0.3442	1.0278 0.3819	0.3837 0.8885	1.2945 0.2768	1.017 0.3868	0.6488 0.6910
CDXIG7YSM-->JULIX57BST	0.3078 0.7355	0.2569 0.8563	0.2841 0.9437	0.2909 0.7480	0.2535 0.8587	0.28 0.9456
JULIX57BST-->CDXIG7YSM	2.269 0.1066	1.8161 0.1464	0.7849 0.5831	2.3386 0.0997	1.8739 0.1362	0.9697 0.4481
CDXIG10YSM-->JULIX710BST	0.3078 0.7355	0.2569 0.8563	0.2841 0.9437	0.2909 0.7480	0.2535 0.8587	0.28 0.9456
JULIX710BST-->CDXIG10YSM	2.269 0.1066	1.8161 0.1464	0.7849 0.5831	2.3386 0.0997	1.8739 0.1362	0.9697 0.4481
CDXIG10YSM-->JULIX10PLUSBST	0.0967 0.9079	0.1536 0.9272	0.7957 0.5748	0.0701 0.9324	0.081 0.9703	1.2812 0.2698
JULIX10PLUSBST-->CDXIG10YSM	1.9263 0.1489	1.2638 0.2887	0.5415 0.7759	1.8718 0.1571	1.1265 0.3401	0.6115 0.7208
CDXHY3YSM-->JULIX13BST	0.4432 0.6427	0.929 0.4282	2.9718* 0.0092	0.4512 0.6376	0.9272 0.4291	2.8681* 0.0115
JULIX13BST-->CDXHY3YSM	1.195 0.3053	0.8819 0.4519	1.3169 0.2534	1.1941 0.3056	0.8896 0.4479	1.346 0.2408
CDXHY5YSM-->JULIX35BST	3.2763* 0.0402	3.4697* 0.0176	3.7489* 0.0017	3.2703* 0.0405	3.4779* 0.0174	3.7132* 0.0019
JULIX35BST-->CDXHY5YSM	0.5534 0.5760	0.5728 0.6337	1.2117 0.3037	0.5374 0.5853	0.5548 0.6457	1.2098 0.3048
CDXHY7YSM-->JULIX57BST	3.4264* 0.0348	2.7296* 0.0458	2.5421* 0.0228	3.5262* 0.0317	2.8784* 0.0378	2.5648* 0.0218
JULIX57BST-->CDXHY7YSM	0.8445 0.4316	0.8741 0.4559	0.7596 0.6029	0.812 0.4457	0.8662 0.4600	0.753 0.6081
CDXHY10YSM-->JULIX710BST	5.6029* 0.0044	4.814* 0.0031	2.8005* 0.0132	5.9267* 0.0033	5.4866* 0.0013	3.1534* 0.0062
JULIX710BST-->CDXHY10YSM	0.2525 0.7771	0.0256 0.9944	0.5505 0.7689	0.2279 0.7965	0.0209 0.9959	0.6461 0.6932
CDXHY10YSM-->JULIX10PLUSBST	1.7076 0.1845	1.1282 0.3394	1.6355 0.1415	2.05 0.1320	1.4612 0.2273	1.8809 0.0882
JULIX10PLUSBST-->CDXHY10YSM	0.6264 0.5358	0.3618 0.7807	0.3879 0.8858	0.6563 0.5201	0.2893 0.8331	0.4673 0.8316
CDXHY3YSM-->JPMHY13STW	3.1115* 0.0471	1.7369 0.1616	2.4632* 0.0269	3.0669* 0.0492	1.6735* 0.1749	2.4682* 0.0267
JPMHY13STW-->CDXHY3YSM	1.0812 0.3416	0.6376 0.5919	0.4135 0.8692	1.1509 0.3189	0.6908 0.5589	0.4026 0.8763
CDXHY5YSM-->JPMHY35STW	5.3153* 0.0058	3.0826* 0.0290	1.6328 0.1423	8.1468* 0.0004	4.6924* 0.0036	3.0971* 0.0070
JPMHY35STW-->CDXHY5YSM	0.6506 0.5231	0.4713 0.7027	0.5757 0.7492	0.8119 0.4458	0.7573 0.5197	0.7916 0.5780
CDXHY7YSM-->JPMHY57STW	5.8486* 0.0035	3.4082* 0.0191	2.6414* 0.0185	5.6741* 0.0041	3.417* 0.0189	2.6283* 0.0191
JPMHY57STW-->CDXHY7YSM	1.0808 0.3417	1.6503 0.1800	1.1490 0.3373	1.0815 0.3415	1.6899 0.1714	1.1470 0.3384
CDXHY10YSM-->JPMHY710STW	0.0475 0.9536	0.3892 0.7609	1.1247 0.3510	0.1018 0.9032	0.4284 0.7329	1.2067 0.3064
JPMHY710STW-->CDXHY10YSM	1.4307 0.2421	1.4472 0.2311	0.8016 0.5702	1.4334 0.2415	1.3725 0.2532	0.9065 0.4922
CDXHY10YSM-->JPMHY10PUSSTW	0.5089 0.6021	1.2005 0.3115	1.6421 0.1398	0.5086 0.6023	1.2847 0.2816	1.8029 0.1027
JPMHY10PUSSTW-->CDXHY10YSM	0.4809 0.6191	0.199 0.8969	1.5496 0.1663	0.4793 0.6201	0.221 0.8817	1.5486 0.1667

Table D-7 Credit risk price discovery contribution tests in maturity segments

Table D-7 Panel A reports short maturity segment of equity, bond and credit default swap market's price discovery contribution to credit risk. Gonzalo and Granger (1996) common factor component price discovery contribution methodology are used to test the credit risk price discovery contribution of stock market, bond market and credit derivatives market.

Panel A: Short Maturity		**Intercept and Trend**			
Market 1	**Market 2**	**λ1(t-value)**	**λ2(t-value)**	**GG1(Market1)**	**GG2(Market2)**
Stock Market	**Bond Market**				
DD13	JULI13BST	0.000(-0.170)	0.664*(2.920)	**100%	0.0%
DD35	JULI35BST	-0.002(-0.466)	2.016*(3.587)	**100%	0.0%
DD13	JULIX13BST	-0.000(-0.320)	2.764*(3.503)	**100%	0.0%
DD35	JULIX35BST	-0.001(-0.737)	3.370*(3.443)	**100%	0.0%
DD13	JPMHY13STW	-0.008(-1.083)	-21.53(-2.753)	0.0%	0.0%
DD35	JPMHY35STW	0.001(0.721)	-4.341(-3.290)	0.0%	0.0%
Stock Market	**Credit Derivatives Market**				
DD13	CDXIG3YSM	0.001(0.578)	-0.234(-3.864)	0.0%	0.0%
DD35	CDXIG5YSM	-0.000(-0.646)	-0.122(-2.713)	0.0%	0.0%
DD13	CDXHY3YSM	0.000(0.017)	-1.097(-3.356)	0.0%	0.0%
DD35	CDXHY5YSM	0.001(0.635)	-5.793(-4.028)	0.0%	0.0%
Credit Derivatives Market	**Bond Market**				
CDXIG3YSM	JULI13BST	-0.079*(-3.806)	-0.011(-0.233)	0.0%	**100%
CDXIG5YSM	JULI35BST	-0.063*(-3.436)	0.047(1.347)	0.0%	**100%
CDXHY3YSM	JPMHY13STW	-0.068*(-3.341)	0.018(0.145)	0.0%	**100%
CDXHY5YSM	JPMHY35STW	-0.065*(2.880)	0.072*(3.138)	*54.5%	45.5%

Table D-7 -Continued

Table D-7 Panel B reports long maturity segment of equity, bond and credit default swap market's price discovery contribution to credit risk. Gonzalo and Granger (1996) common factor component price discovery contribution methodology are used to test the credit risk price discovery contribution of stock market, bond market and credit derivatives market.

Panel B: Long Maturity		Intercept and Trend			
Market 1	**Market 2**	**λ1(t-value)**	**λ2(t-value)**	**GG1(Market1)**	**GG2(Market2)**
Stock Market	**Bond Market**				
DD57	JULI57BST	-0.001(-0.358)	2.442*(3.455)	**100%	0.0%
DD710	JULI710BST	-0.003(-0.618)	3.741*(3.956)	**100%	0.0%
DD10PLUS	JULI10PLUSBST	-0.003(-0.863)	4.027*(4.455)	**100%	0.0%
DD57	JULIX57BST	0.004(1.202)	-22.536(-5.019)	0.0%	0.0%
DD710	JULIX710BST	-0.001(-0.818)	4.690*(3.377)	**100%	0.0%
DD10PLUS	JULIX10PLUSBST	0.001(0.551)	-4.124(3.380)	0.0%	0.0%
DD57	JPMHY57STW	-0.003(-1.331)	3.887*(2.837)	**100%	0.0%
DD710	JPMHY710STW	-0.003(-1.008)	8.240*(3.565)	**100%	0.0%
DD10PLUS	JPMHY10PUSSTW	-0.003(-1.482)	3.664*(2.265)	**100%	0.0%
Stock Market	**Credit Derivatives Market**				
DD57	CDXIG7YSM	0.001(0.768)	-0.423(-4.164)	0.0%	0.0%
DD710	CDXIG10YSM	0.000(0.099)	-0.853(-3.942)	0.0%	0.0%
DD10PLUS	CDXIG10YSM	0.000(0.099)	-1.109(-3.942)	0.0%	0.0%
DD57	CDXHY7YSM	-0.001(-0.328)	2.503*(3.952)	**100%	0.0%
DD710	CDXHY10YSM	-0.001(-0.400)	3.802*(4.458)	**100%	0.0%
DD10PLUS	CDXHY10YSM	-0.001(-0.400)	4.545*(4.458)	**100%	0.0%
Credit Derivatives Market	**Bond Market**				
CDXIG7YSM	JULI57BST	0.003(1.105)	0.150*(4.697)	**100%	0.0%
CDXIG10YSM	JULI710BST	-0.076*(-3.996)	-0.053(-1.570)	0.0%	**100%
CDXIG10YSM	JULI10PLUSBST	-0.060*(-3.752)	-0.087(-2.907)	0.0%	**100%
CDXHY7YSM	JPMHY57STW	-0.069*(-3.371)	0.074(1.818)	0.0%	**100%
CDXHY10YSM	JPMHY710STW	-0.075*(-3.711)	0.096(2.232)	0.0%	**100%
CDXHY10YSM	JPMHY10PUSSTW	-0.080*(-4.098)	0.049(1.279)	0.0%	**100%

* Significant at 95% confidence level for credit risk price discovery contribution

**The market which has a bigger price discovery contribution

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