CREDIT DEFAULT SWAPS AND EQUITY PRICES: THE iTRAXX CDS INDEX MARKET

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ABSTRACT. In this paper we provide some early evidence of a link between the iTraxx credit default swap (CDS) index market and the stock market. To our knowledge this is the first paper studying this relationship. Knowledge about the link between stock prices, stock return volatilities and CDS spreads is important not only for risk managers using credit default swaps for hedging purposes, but also to anyone trying to profit from arbitrage possibilities in the CDS market. For a sample of European sectoral iTraxx CDS indexes, a correlation study reveals a tendency for iTraxx CDS spreads to narrow when stock prices rise and vice versa. Furthermore, there is some evidence of firm-specific information being embedded into stock prices before it is embedded into CDS spreads. Stock price volatility is also found to be significantly correlated with CDS spreads and the spreads are found to increase (decrease) with increasing (decreasing) stock price volatilities. Finally, we find significant positive autocorrelation in the iTraxx market.

Keywords: credit default swap index; stock market index; stock return volatility
JEL classification codes: G33; C20

1. INTRODUCTION

Credit risk is the major source of risk for most commercial banks and it can be defined as the risk of loss resulting from failures of counterparties or borrowers to fulfill their obligations. Credit risk appears in almost all financial activities, and it is therefore important to measure, price and manage accurately.

Credit derivatives, a recent innovation in the credit risk market, can help investors with these issues. Credit derivatives are financial contracts that transfer the (credit) risk and return of an underlying asset from one counterparty to another without actually transferring the underlying asset. The credit derivatives market is growing rapidly and in June 2004 notional amounts for credit derivatives amounted to USD4.5 trillion, compared to USD0.7 trillion three years earlier (BIS (2004*b*)). Furthermore, the fact that global markets have much larger exposures to credit risk than to interest rate or currency risk indicates an almost unlimited growth potential for the credit derivatives market[1].

Contracts similar to credit derivatives, such as letters of credit and credit guarantees, have been around for centuries but credit derivatives are different in the sense that they are traded separately from the underlying assets; in contrast, the earlier arrangements were

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[1]The credit derivatives market is of course still small compared to the largest OTC derivatives markets in the world. Interest rate related OTC derivatives contracts constitute around USD177 trillion in notional amounts and foreign exchange related OTC derivatives make up about USD32 trillion (BIS (2004*b*)).

contracts between an issuer and a guarantor. Credit derivatives are therefore ideal risk reduction tools for any investor who wants to reduce the exposure to a particular counterparty but finds it costly to sell outright the claims on that counterparty. A related feature of credit derivatives is that credit risk is transferred without any funding actually changing hands. Only in case a credit event occurs does the buyer of credit risk provide funds *ex post* to the seller. This way of allowing financial institutions to manage credit risk separately from funding is an example of how modern financial markets divide financial claims into various building blocks (credit, interest rate, exchange rate etc.) that each can be traded in a standardized wholesale market that better meets the needs of investors.

The use of credit derivatives is not limited to commercial banks' risk management departments; commercial banks also use them for regulatory arbitrage, hedge funds are active users in order to hedge other trades, non-financial firms use credit derivatives to buy protection against credit extended to customers or suppliers and many investment banks bring together their various trading desks to encourage traders to identify arbitrage opportunities that arise between credit derivatives markets and their underlying bond- and stock markets.

The value of any credit derivative is linked to the probability of the underlying reference entity being exposed to a credit event (delayed payment, restructuring, bankruptcy etc.) at some point in the future, and for entities with traded equity the probability is often estimated using information from the stock market.[2] The (theoretical) link between stock prices and credit derivatives prices raises the question of whether there might be arbitrage possibilities available for investors who successfully exploit the link between the two markets. This is an example of a popular new line of business called capital structure arbitrage, or ”capital structure inbreeding” (Currie and Morris (2002)).

Currently, the three most important credit derivatives are credit default swaps, total-rate-of-return swaps, and credit-spread options. Among these, the credit default swap (CDS) market is the largest with about half the total credit derivatives trading volume. A credit default swap is essentially an insurance contract providing protection against losses arising from a credit event. With credit default swaps, investors can go both long and short in a particular credit without having to find the underlying asset. This makes them more accessible and easier to trade than their underlying reference entities. Recently, tradable CDS indexes have also been introduced that allow investors quick and easy ways to buy and sell market-wide or sectoral credit risk. In June 21, 2004, the two main CDS indexes, *iBoxx* and *Trac-x*, were merged into the *Dow Jones iTraxx* index that since has set a new standard when it comes to liquidity, transparency and diversification. Large exposures (negative or positive) to a diversified pool of credit risks is now much easier to gain and the liquidity of the iTraxx market has attracted new participants such as hedge funds and capital structure arbitrageurs.

This paper discusses the link between CDS spreads and equity prices as well as volatilities in the iTraxx market. The link between stock prices and CDS spreads has been studied before but as far as we know this is one of the first papers looking at the link between stock return volatilities and CDS spreads. Furthermore, we believe this to be the first statistical study of the iTraxx market. Earlier literature has studied either the link between corporate bond yields and stock prices (Kwan (1996)) or between single-name CDS spread changes and stock returns (Longstaff, Mithal and Neis (2003), Norden and Weber (2004), Blanco, Brennan and Marsh (2004), Yu (2004)). A few papers have discussed the important link between equity volatility and bond spreads (Collin-Dufresne, Goldstein and Martin (2001), Campbell and Taksler (2002)) and Blanco, Brennan and Marsh (2004) investigate the link in the CDS market. Knowledge about the link between stock volatilities and CDS spreads is crucial to arbitrageurs in the CDS market and in this paper we provide early evidence of such a link in the quickly growing iTraxx CDS index market.

[2]The most well known approach of calculating these probabilities using stock market information is the Merton (1974) model.

The rest of this paper is organized as follows. The second section gives a brief introduction to credit default swaps and the iTraxx CDS indexes. The third section discusses the link between the equity markets and credit default swap markets. The fourth section describes the data and the fifth section presents the results. Section six concludes the paper.

2. The CDS Index Market

A credit default swap is an insurance contract that protects against losses arising from some kind of pre-defined credit event involving a reference entity. In a CDS contract, the credit protection buyer pays the protection seller a periodic fee, the CDS spread, which is analogous to the spread between the yield on a typical defaultable bond and the risk-free interest rate. In case a credit event does strike the reference entity, the buyer typically delivers debt owed by the reference entity to the seller in return for a sum equal to the face value of the debt.

With the development of the CDS market, a new credit linked instrument without many of the problems in the traditional credit market was created. Credit default swaps allow investors to buy ”pure” credit risk because the CDS isolates the credit risk component from other possible risks, such as interest rate risk and foreign exchange risk. Furthermore, liquidity in the CDS market is promoted through the use of standardized contracts concentrated around certain maturities, as well as through the ease with which short positions can be taken. Finally, investors in the CDS market can buy or sell arbitrarily large positions in a particular credit for reasons of speculation, arbitrage or hedging without having direct exposure to the underlying reference entity. Therefore, investors are less constrained by whether the underlying entity decides to issue debt or not and by the readiness of other debt holders to sell their debt.

For speculators, taking long positions in credit default swaps without exposures to the underlying reference entity offers good upside potential in case of a deterioration of the underlying credit. Arbitrageurs can exploit unjustified spread differentials between the bond and the CDS market. And finally, for credit risk managers, one of the main contributions of the CDS market is to provide accurate credit quality assessments using readily available market data. In this context, some market participants even refer to the CDS market as an additional rating agency (CreditMagazine (2004)) and a study by the Bank for International Settlements (BIS) shows that CDS spreads tend to widen well before rating actions (BIS (2004*a*)).

Similar to the way a stock index is created as a portfolio of individual stocks, a CDS index is a portfolio of single-name credit default swaps. CDS indexes are fairly new instruments that provide investors with market-wide credit risk exposure. With the announcement of a merger between the two CDS indexes iBoxx and Trac-x into the Dow Jones iTraxx index in June 2004 it has become even more straightforward to gain exposure to a diversified portfolio of credits. The iTraxx index family consists of various indexes of the most liquid CDS contracts in Europe and Asia (in the US, since April 2004, a similar family of indexes is called *Dow Jones CDX*). In Europe, an index called iTraxx Europe, that is made up of 125 equally weighted European names selected by a dealer poll based on CDS volume traded over the previous six months, is used as a benchmark index. The European index is further split up into several *sector* indexes (*autos, financials*,...), a *corporate* index comprised of the largest non-financial names (from the 125 names), a *crossover* index comprising the 25 most liquid sub-investment grade non-financial names and a *HiVol* index that consists of the 30 names with the widest CDS spreads. The iTraxx indexes typically trade with 5 as well as 10-year maturities and new series are issued every 6 months. The indexes are managed and administrated by a newly created company called *International Index Company* that is owned by a group of the largest global investment banks.

Thanks to the different iTraxx indexes it is now easy to exploit market beliefs by executing relative-value trades between sectors, buying single-names versus their sector or perhaps construct tailored synthetic credit risky portfolios using risk-free covered bonds together with a position in a suitable iTraxx CDS index. Credit index trades can also be performed to reflect the slope of the credit spread term structure since 5 as well as 10-year maturities are traded. Various arbitrage strategies involving the CDS index, the constituent credit default swaps and corresponding stock and bonds are also possible. Overall, the introduction of liquid and easily tradable CDS indexes could open the door for a new generation of credit derivatives products based on these indexes and it is quite likely that the iTraxx CDS index could outperform standard single-name credit default swaps in popularity in the near future.[3]

3. CDS Index Spreads and Equity Prices

A crucial parameter in CDS pricing is the amount of credit risk associated with the underlying reference entity and to quantify this amount an investor can follow different paths. One is to rely on rating agencies that rate individual firms' capability of servicing and repaying their obligations (Moody's and Standard & Poor's are two of the better known rating agencies). An other is to rely on traditional scoring models that typically attempt to measure the amount of credit risk using accounting information. A third alternative is to extract information about credit risk from the market; if credit risk is acknowledged by the market then there must be ways of filtering the information contained in market prices to get measures of credit risk.

The most well known stock market based credit risk model is the Merton (1974) model. This model views a firm's liabilities (equity and debt) as contingent claims issued against the firm's underlying assets. By backing out asset values and volatilities from quoted stock prices and balance sheet information the Merton (1974) model produces instantaneous updates of a firm's default probability. The default probability in the Merton (1974) model is a nonlinear function (where the default probability has to be solved for iteratively) of the firm's stock price, stock price volatility and leverage ratio. Furthermore, in 2002, the risk management firm *RiskMetrics*^{TM} presented *CreditGrades*^{TM}, a commercial (but free) stock market based tool for default probability calculations that adds simplifying assumptions to the standard Merton model. In the simplified model the default probability is a simple function of the stock price volatility and the leverage ratio and Byström (2003) shows how the *CreditGrades*^{TM} model can be deduced from the Merton (1974) model. A further simplification of the default probability expression in *CreditGrades*^{TM} can actually be found in the earlier papers by Hall and Miles (1990) and Clare and Priestley (2002). In the Hall and Miles (1990) framework, the default probability is a simple function of the stock price volatility. For the link between these three stock market based default probability models we refer to Byström (2003).

Since the most important determinant of the CDS price is the likelihood that a credit event involving the underlying reference entity occurs, and since theory (Merton (1974), etc.) tells us that this probability should be linked to the stock market valuation as well as the stock return volatility of the reference entity it is natural to investigate empirically the link between the stock market and the CDS market. As mentioned, one group of investors that are particularly interested in this link are those involved in capital structure arbitrage (Currie and Morris (2002)). Basically, capital structure arbitrageurs try to detect inconsistencies between the stock market, the corporate bond market and the credit derivatives market. Those who can price the credits and credit sensitive derivatives accurately,

[3]The share of index-linked transactions in the overall credit derivatives market is predicted to increase from 11% in 2003 to 17% in 2006 according to the British Banker's Association.

i.e. those who are able to calculate default probabilities accurately, can then earn substantial arbitrage profits by taking positions in the CDS market and hedging them in the stock market or vice versa. Such a strategy is only the simplest example of capital structure arbitrage where accurate modelling of the linkage between stock markets and CDS markets is essential.

There are several earlier studies dealing with related issues. Fama and French (1993), for instance, finds some commonality in risk factors affecting the stock and the bond market. Kwan (1996) studies the relationship between the corporate bond market and the stock market and finds a negative correlation between bond yield changes and stock returns and indications of stocks leading bonds in reflecting firm-specific information. The US CDS market and its relationship with the US stock market is investigated in Longstaff, Mithal and Neis (2003) where both the CDS market and the stock market are found to lead the bond market. No clear lead-lag relationship is found between the stock market and the CDS market, however. Norden and Weber (2004) investigates the European CDS market and finds CDS spread changes to be negatively correlated with stock returns. Furthermore, stock returns seem to lead CDS spread changes. Campbell and Taksler (2002) is one of the first papers to look at the relationship between stock return volatilities and bond yields and it shows that firm-level volatility can explain much of the variation in US corporate bond yields.

The purpose of this paper is to study iTraxx CDS indexes and their relationship with the stock price movements of the underlying entities making up the indexes. The size of the CDS index spread (the level) and its empirical relationship with the value and volatility of the underlying stock portfolio is interesting because of the Merton (1974) model predictions. One would expect a large CDS index spread when the stock market valuation is low and the volatility is high and vice versa. Any relationship between CDS index spread changes (first differences) and stock portfolio returns, on the other hand, is interesting since it is a signal of profit possibilities arising from trading strategies involving the various markets.

We look at iTraxx indexes covering the European market, and the seven sectoral indexes that we include in our study are; *industrials, autos, energy, technology-media-telecommunications (TMT), consumers*, *senior financials* and *sub-ordinated financials*. Each index contains between 10 and 30 individual names. Corresponding portfolios of stocks are formed and both ordinary Pearson correlations and Spearman's rank correlations between the various CDS spreads, stock prices and stock volatilities are computed. We also estimate the degree of contemporaneous and cross-serial correlations between the iTraxx market and the stock market by estimating the following empirical model:[4]

$$rCDS_t = a_{0,t} + a_{1,t} rCDS_{t-1} + a_{2,t} r_t + a_{3,t} r_{t-1} + \varepsilon_t, \tag{3.1}$$

where

$$\begin{aligned} rCDS_t &= \text{change in iTraxx CDS index spread from } \textit{t-1} \text{ to } t \text{ (in \%)}, \\ r_t &= \text{stock index return from } \textit{t-1} \text{ to } t \text{ (in \%)}, \\ a_{i,t} &= \text{regression coefficients}, \\ \varepsilon_t &= \text{normally distributed error term}. \end{aligned}$$

Stock indexes and CDS indexes are expected to be contemporaneously but not cross-serially correlated if information is simultaneously embedded into security prices in the

[4]As opposed to earlier studies on bond markets we do not include the risk-free interest rate as an independent variable in the OLS regressions. The reason is that credit default swaps are pure credit exposures without interest rate risk. This minimizes the effect of non-credit related components of the spread between the treasury market and the credit risky market on the regression. Essentially, macro news is expected to have limited impact on CDS prices. However, just like the stock market, we expect the CDS market to react firmly to firm-specific information.

two markets. This is probably true for public information, but with private information informed traders could systematically prefer to trade in either the stock or the CDS market. If the private information is not simultaneously embedded into the stock and CDS markets, a lead-lag relationship between the prices in the two markets can be observed. The contemporaneous correlations therefore reflect the degree of common firm-specific information driving the stock portfolios and corresponding iTraxx indexes, and the cross-serial correlations reflect which of the two markets is more likely to be used by informed traders and to what degree one of the markets might drive the other.

4. Data

The data used in this study consists of daily closing quotes (the mid-points between quoted bid and ask quotes) for seven sectoral iTraxx CDS Europe indexes[5]. Each index is traded with 5 as well as 10-year maturities and is denominated in Euro.[6] The time period covered is June 21, 2004 to April 18, 2005, which is the very first 10 months in the history of the iTraxx market. The total number of mid-point CDS spread quotes in the panel is 1484. Compared to previous studies using credit default swap quotes our data series are very ”clean” in the sense that all observations are true market quotes, that all quotes are directly comparable to each other and that the quotes consistently are updated on a daily basis.

Most of the 125 names in the indexes are large multinationals and all have traded equity.[7] This makes it possible to construct sectoral stock indexes comprising the same names as the reference portfolios behind the sectoral iTraxx indexes. Since the iTraxx indexes are equally weighted in its underlying single-name CDS contracts the stock indexes are also constructed as equally weighted indexes. All stocks are converted into Euro on a daily basis and are adjusted for stock splits. The first day in the sample we construct equally weighted indexes (we invest equal amounts in each stock) and thereafter we do no re-balancing of our index portfolios. The actual weights of the individual stocks in the portfolios therefore change slightly over time but this investment strategy is more realistic than a daily re-balancing of the reference portfolios. Nevertheless, over our fairly short time period, the ”weight drift” was very limited.[8] Finally, the way the iTraxx indexes are defined means that slightly updated iTraxx reference portfolios are introduced every six months (IIC (2004)).

5. Empirical Results

This section presents our empirical findings. Since this is one of the first studies dealing with the iTraxx market we start with some descriptive statistics.

Descriptive Statistics. In order to investigate the link between the CDS market and the stock market we look at levels as well as % changes of CDS index spreads and stock prices. We start by applying the Phillips Perron test to our data series in order to find out whether the data is stationary or not. In Table 1 we present the results for iTraxx CDS indexes, stock indexes and stock index volatilities and most series are found to be stationary (with the exception of the stock index series that, not surprisingly, are stationary around a

[5]All index quotes have been made available by the *International Index Company*.
[6]We only present results for the 5-year maturity iTraxx indexes. However, an initial study of the 10-year maturities indicates very similar results to those presented for the 5-year maturities.
[7]An exception is Vattenfall AB that is a government owned group with a tightly held non-traded stock. Also, for some names (never more than 10% of the total number of names in each sector, respectively) there was no stock price data available in the *EcoWin* database.
[8]An alternative would be to model each stock separately and look at daily average returns as proxies for the index return. The contribution of each stock to the index would then be identical each day in the sample. This is not the usual way of investing in the stock market, however.

trend). Among the CDS index spreads, the *autos* sector stands out and the reason is the deterioration of the entire sector in the wake of the problems faced by General Motors (GM) towards the very end of the sample.[9] In fact, the *autos* CDS index series becomes stationary if only the last three observations (out of 212) were removed.

The size of the CDS spread, in basis points, varies somewhat over the time period as well as across the seven sectors. All the sectoral iTraxx indexes demonstrate a general narrowing of the spread over the first nine months of the ten-month sample period, however, followed by a sharp widening of the spread over the last month or so. Among the sectors, the *consumers* sector (supermarkets, airlines, clothing etc.) has the widest average spread and the *senior financials* sector (secured CDS contracts issued by financial firms) has the narrowest average spread as can be seen in Table 1. To the extent that the spread is a compensation for credit risk this indicates that the European consumers products and services sector of 2004-2005 was considered riskier by the market than the other European sectors. The variability of the spread is also much larger for the *consumers* sector than for the tranquil *senior financials* sector. Finally, the largest quoted spread of any index (87.2 bp) is quoted for the *autos* sector the very last day of the sample.

Turning to the (unconditional) distribution of daily CDS index spread changes and stock price returns we find the distribution of CDS index spread changes to be much more skewed and leptokurtic than the stock index return distribution. The iTraxx index is also at least two to three times as volatile (with a standard deviation equal to 30-40% on an annual basis) as the corresponding stock portfolio (with a standard deviation equal to 10-15% on an annual basis). The largest positive spread changes observed from one day to the next are as high as 20-25% for some of the iTraxx indexes and a mere 2-2.5% for the stock index returns. The same holds for the largest negative changes but while extreme positive and negative stock returns in this particular sample are of the same magnitude the most extreme positive CDS index spread changes are many times larger than the corresponding extreme negative changes. This observation, together with the much larger skewness for the iTraxx spread change distribution, is a possible indication of the CDS market reacting relatively more strongly to credit deteriorations than credit improvements compared to the stock market.

Last, but not least, we look at possible serial correlation in the CDS series. We find that while stock returns show no autocorrelation, as indicated by the small Ljung-Box test statistics in Table 1, the iTraxx CDS indexes all demonstrate significant (positive) autocorrelation. This is interesting since it indicates an inefficient CDS index market where predictable index changes could mean large profit possibilities for large investors. We investigate the magnitude of the autocorrelation further in the regression study below.

Correlations and Rank Correlations. In Table 2 we present correlations between stock index prices, CDS index spreads and stock volatilities. Correlations between spread changes and stock returns are also presented. In the latter case we also include cross-serial (lead-lag) correlations. In addition to ordinary (Pearson) correlations we compute Spearman rank correlations. Rank correlations look at the similarity of rankings, from the smallest to the largest observation, in two data series, and we present rank correlation coefficients because the various data comes from very different (non-normal) distributions.

[9]A downgrade of the giant automobile manufacturer GM's credit rating was expected for many weeks in April 2005 and finally GM's debt, together with Ford's, was downgraded to junk status on May 5 (two weeks after the last day of our sample). Much of this turbulence seems to have been spread across the Atlantic ocean to the European *autos* sector.

Stock index volatilities are calculated using various windows of historical stock returns and in the paper we present results for 1-month (1M), 3-month (3M) and 1-year (1Y) windows.[10]

The large negative correlations, around -0.5 for both the ordinary correlations and the rank correlations, between levels in the upper part of Table 2 indicate a strong negative relationship between CDS spread levels and stock price valuations; the spread of the credit default swap index is large when the value of the stock portfolio is low and vice versa. This is what we would expect from theory (Merton (1974)) and the results are robust across the various sectors.

Furthermore, a significant positive relationship between historical volatilities and CDS spread levels can also be found from inspection of the correlations in Table 2. The (positive) correlations between CDS spread levels and stock volatilities, particularly 3-month volatilities, are all highly significant. For some iTraxx sectors the correlations are as high as $0.6 - 0.8$. Although the link is strongest for volatility estimated using the 3-month window the results are similar for the other two window sizes. For some reason the link is weakest for the 1-month window and the only explanation we have is that window sizes as short as 1-month are too short for accurate volatility estimates, and that the majority of the investors therefore use at least 3 months of historical observations to estimate their volatilities. Overall, the positive relationship between CDS spreads and stock volatilities is in accordance with theory (Merton (1974)) and it is consistent across all the various sectors. Finally, throughout the study the rank correlations and the ordinary correlations in Table 2 are very similar to each other.

In Figure 1 we present results for the data averaged across all seven sectors (normalized to start at one) and the strong negative relationship between CDS spread levels and stock price valuations seen in Table 2 can also be observed in Figure 1. Stock prices clearly have a tendency to increase when CDS spreads decrease and vice versa. The significant link between CDS spread levels and the stock index volatility (the 3-month historical volatility) is also demonstrated in Figure 1. It is fairly clear that the spread widens with an increasing stock volatility and vice versa. The close relationships between CDS spreads, on one hand, and the stock prices and the stock return volatilities, on the other hand, are partly broken towards the last month of the sample where we can observe a significant widening of all the CDS spreads. The widening is most significant in the *autos* sector but all sectors suffer to various degrees. Both the stock price and the stock return volatility react in the expected way, compared to the CDS spread, but the size of the reaction is slightly delayed and much more modest. The lagged reaction in the case of the stock volatility is of course partly caused by the use of up to three months old observations and it is possible that implied volatilities from stock options markets would react much faster and much more distinctly to the apparent credit deterioration in the European CDS market.

If we turn to CDS spread changes, they are found in the lower part of Table 2 to be negatively correlated, at an average level of around -0.25, with contemporaneous stock index returns (Figure 1 shows further evidence of this). Furthermore, under the null hypothesis that the stock market and the CDS market are equally quick to incorporate firm-specific information, we would expect the cross-serial (as opposed to contemporaneous) correlations to be equal to zero. However, lagged (one day) stock returns are found to be almost as significantly (negatively) correlated with current CDS spread changes as current stock returns. Lagged CDS spread changes, on the other hand, are not at all related to current stock price changes. This one-way cross-serial correlation is interesting since it is a possible indication of information flowing *from* the stock market *to* the CDS market and not vice versa.

[10]We have also redone all calculations using 1-week, 2-month, 6-month and 3-year windows for a sub-sample covering the first five months of the sample. The results we get when we use these volatility estimates are overall similar to those presented in this paper.

Overall, the patterns for the various sectors are very similar. One slight but interesting exception to this, though, is the consistently larger correlation between the *subordinate financials* CDS index and the stock market than between the *senior financials* index and the stock market. This, we think, is in line with subordinate credit default swaps being more equity-like in their character than senior ones.

OLS-Regressions. In addition to correlation estimates we also regress daily CDS spread changes on yesterday's CDS spread changes and on today's and yesterday's stock returns. The regression results are presented in Table 3 and the earlier correlation based results are further strengthened. All the contemporaneous stock return coefficients are significant, indicating a strong negative link between CDS spread changes and stock returns, while roughly half of the lagged stock return coefficients are significant. This at least partly supports the earlier evidence from the correlation study of the stock market driving the CDS market, and this is important information for arbitrageurs and other cross-market investors. The $F_{[3,d.f.]}$ statistic is significant for all the sector regressions and the degree of explanation, R^2, varies between 0.07 and 0.25 with most R^2s lying in the range between 0.10 and 0.20.

When it comes to the possible autocorrelation in the CDS market the regressions in Table 3 seem to confirm the earlier evidence given by the significant Ljung-Box statistics in Table 1. While the Ljung-Box statistics, Q(6) and Q(12), look at the entire correlation structure up to 6 and 12 lags, respectively, the regressions in Table 3 indicate significant *positive first-order autocorrelation* in the European CDS market. Only for one sector, the *autos* sector, is the otherwise consistent pattern broken. Again, this is caused by the sudden and very significant spread widening in this sector towards the end of the sample. The significant positive autocorrelation across the various sectors is interesting since it is an indication of an inefficient European CDS market; predictable CDS spreads could mean large profit opportunities for investors who can take positions large enough to cover the transaction costs.

We can compare our results regarding the link between the CDS market and the stock market with those from earlier studies looking at single-name CDS contracts. Norden and Weber (2004), looking at credit default swaps from 58 firms from Europe, US and Asia, also finds stock returns to be negatively associated with CDS spread changes. Furthermore, they also find stock returns to lead CDS spread changes. Longstaff, Mithal and Neis (2003) looks at US firms and finds both the CDS market and the stock market to lead the bond market. They find no clear cut lead-lag relationship between the stock and the CDS market, however. The latter result can be a consequence of the US CDS market being more efficient than the European and Asian CDS markets. Blanco, Brennan and Marsh (2004) also investigates the determinants of CDS spreads and finds that stock returns have more of an impact on CDS spreads than they have on corporate bond spreads.

Our results are also similar to those of Kwan (1996) in their study of the relationship between corporate bonds and stocks. Kwan (1996) finds the same relationship between bonds and stocks that we find between credit default swaps and stocks; contemporaneous and lagged stock returns have a significant negative impact on credit spread changes.

The relationship between stock return volatilities and credit spreads were first investigated by Campbell and Taksler (2002) who finds that firm-level volatility can explain much of the variation in bond yields in the US. We dare claim that we find the same thing for historical volatilities in the European iTraxx CDS index market despite relying solely on sample correlations between stock return volatilities and CDS spread levels. Investigating credit markets in Europe and in the US, Blanco, Brennan and Marsh (2004) also finds a significant link between implied stock volatilities and CDS spreads but no link between implied volatilities and bond spreads. The latter is also found by Collin-Dufresne, Goldstein and Martin (2001) who finds only weak evidence of implied equity volatility (VIX) explaining corporate bond spreads in the US. Finally, touching at the issue of stock volatilities and CDS spreads, Berndt, Douglas, Duffie, Ferguson and Schranz (2004) finds that KMV Expected Default Frequencies (that are functions of stock volatilities) explain a large share of the cross-sectional variation in CDS spreads.

6. Conclusions

In this paper we have studied the European iTraxx CDS index market, particularly the relationship between iTraxx sectoral indexes and corresponding sectoral stock indexes. We believe knowledge regarding the link between the CDS market and the stock market to be important for anyone involved in hedging, speculation or arbitrage activities in the CDS market.

One interesting finding in this paper is the significant positive autocorrelation present in all the studied iTraxx indexes. This is possibly an indication of an inefficient iTraxx CDS index market where index changes are predictable. The economical significance of profits from trading strategies exploiting such regularities, however, is an interesting issue left for future research.

Moreover, significant correlations between iTraxx CDS index spreads and spread changes on the one hand and stock prices and stock returns on the other hand reveal a close link between the two markets. CDS spreads have a strong tendency to widen when stock prices fall and vice versa. Furthermore, in OLS regressions, both current and lagged stock returns are found to explain much of the variability in CDS spreads. This suggests that firm-specific information is embedded into stock prices before it is embedded into CDS spreads. Hence, the stock market seems to lead the CDS market in transmitting firm-specific information and this is important information for arbitrageurs and others. Again, it is a possible indication of an inefficient European CDS market.

Stock index return volatility is also found to be significantly correlated with iTraxx CDS index spreads; the spreads are found to increase (decrease) with increasing (decreasing) stock volatilities. The link is particularly strong for 3-month historical volatilities. These results are in line with the theoretical literature on credit risk that emphasizes the importance of stock volatility for default probability predictions and it is further evidence of the importance of volatility forecasting in credit risk modelling.

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TABLE 1. Descriptive statistics for 5-Year iTraxx CDS Index Spreads (levels and changes), Stock Indexes (levels and changes) and 3-Month Stock Index Return Volatilities over the time period June 21, 2004 to April 18, 2005. Skew indicates skewness and Kurt indicates excess kurtosis. PP indicates the Phillips Perron test for stationarity (with or without a trend and with four lags). Q(6) and Q(12) are Ljung-Box tests for autocorrelation. 1%, 5% and 10% significance levels are indicated by ***, ** and *, respectively.

CDS Index Spreads (basis points)

	industrials	autos	TMT	energy	consumers	senior financials	sub. financials
Mean	38.1	46.0	39.3	26.6	51.0	18.2	30.9
Stdev	6.2	6.1	6.4	3.2	5.8	2.0	4.5
Max	56.8	87.2	52.4	34.3	64.9	22.6	39.5
Min	27.3	37.0	27.4	20.7	38.9	14.0	24.3
PP (no trend)	-1.6	9.5	-5.0^{***}	-6.2^{***}	-5.5^{***}	-5.2^{***}	-4.5^{***}

CDS Index Spread Changes (daily log-returns)

	industrials	autos	TMT	energy	consumers	senior financials	sub. financials
Mean$\cdot 10^2$	0.080	0.231	-0.036	-0.014	0.016	0.005	-0.005
Stdev$\cdot 10^2$	2.63	2.99	2.52	2.22	1.97	1.91	2.11
Max$\cdot 10^2$	26.1	19.0	19.0	13.5	11.5	11.5	11.6
Min$\cdot 10^2$	-4.7	-15.8	-7.9	-5.9	-5.3	-6.8	-7.7
Skew	5.3	2.3	2.4	2.4	1.5	1.7	1.7
Kurt	46.9	18.9	17.6	11.7	6.6	9.5	9.0
PP (no trend)	-154.1^{***}	-227.0^{***}	-146.8^{***}	-170.2^{***}	-153.9^{***}	-175.5^{***}	-129.2^{***}
Q(6)	26.7^{***}	24.4^{***}	20.7^{***}	17.9^{***}	33.8^{***}	30.5^{***}	39.9^{***}
Q(12)	34.8^{***}	39.7^{***}	22.7^{**}	30.9^{***}	41.2^{***}	36.3^{***}	43.3^{***}

Stock Index Levels (normalized to start at one)

	industrials	autos	TMT	energy	consumers	senior financials	sub. financials
Mean	1.05	1.02	1.01	1.06	0.97	1.04	1.04
Stdev	0.06	0.05	0.05	0.05	0.04	0.07	0.07
Max	1.18	1.14	1.10	1.16	1.05	1.15	1.15
Min	0.96	0.94	0.90	0.98	0.90	0.92	0.92
PP (no trend)	-2.0	-3.8^{***}	-2.2	-1.8	-3.0	-1.1	-1.1
PP (trend)	-15.3^{***}	-9.7^{***}	-9.8^{***}	-19.0^{***}	-7.7^{***}	-14.0^{***}	-14.0^{***}

Stock Index Returns (daily log-returns)

	industrials	autos	TMT	energy	consumers	senior financials	sub. financials
Mean$\cdot 10^2$	0.048	0.023	0.017	0.052	0.005	0.046	0.046
Stdev$\cdot 10^2$	0.75	0.90	0.74	0.62	0.64	0.71	0.71
Max$\cdot 10^2$	2.5	2.1	2.5	1.6	1.8	1.8	1.8
Min$\cdot 10^2$	-3.1	-2.9	-2.6	-2.8	-2.5	-2.1	-2.1
Skew	-0.4	-0.2	0.1	-0.7	-0.4	-0.5	-0.5
Kurt	1.4	0.2	0.6	2.4	0.7	0.4	0.4
PP (no trend)	-206.9^{***}	-189.3^{***}	-197.8^{***}	-187.6^{***}	-188.4^{***}	-198.0^{***}	-198.0^{***}
Q(6)	5.2	3.1	3.8	5.9	6.5	2.6	2.6
Q(12)	10.1	8.3	12.2	11.0	8.8	5.0	5.0

Stock Index Return Volatility (3-Month, on a daily basis)

	industrials	autos	TMT	energy	consumers	senior financials	sub. financials
Mean$\cdot 10^2$	0.79	0.92	0.78	0.59	0.66	0.73	0.73
Stdev$\cdot 10^2$	0.15	0.13	0.12	0.09	0.08	0.13	0.13
Max$\cdot 10^2$	1.2	1.2	1.1	0.8	0.9	1.0	1.0
Min$\cdot 10^2$	0.58	0.69	0.60	0.45	0.53	0.53	0.53
PP (no trend)	-4.5^{***}	-2.8	-4.2^{***}	-2.6	-4.9^{***}	-3.0	-3.0

TABLE 2. Correlations between 5-Year iTraxx CDS Index Spreads (levels and changes), Stock Indexes (levels and changes) and Stock Index Return Volatilities over the time period June 21, 2004 to April 18, 2005. Correlation indicates ordinary Pearson correlation and Rank Correlation indicates Spearman rank correlation. 1%, 5% and 10% significance levels are indicated by ***, ** and *, respectively.

LEVELS

Correlation

	industrials	autos	TMT	energy	consumers	senior financials	sub. financials
CDS-Stock	-0.50^{***}	-0.28^{***}	-0.63^{***}	-0.35^{***}	-0.33^{***}	-0.40^{***}	-0.60^{***}
CDS-1MVol	0.15^{**}	0.15^{**}	0.26^{***}	-0.12^{**}	0.24^{***}	0.57^{***}	0.69^{***}
CDS-3MVol	0.68^{***}	0.45^{***}	0.78^{***}	0.60^{***}	0.74^{***}	0.58^{***}	0.76^{***}
CDS-1YVol	0.52^{***}	0.27^{***}	0.59^{***}	0.42^{***}	0.46^{***}	0.43^{***}	0.64^{***}

Rank Correlation

	industrials	autos	TMT	energy	consumers	senior financials	sub. financials
CDS-Stock	-0.56^{***}	-0.38^{***}	-0.59^{***}	-0.39^{***}	-0.26^{***}	-0.42^{***}	-0.59^{***}
CDS-1MVol	0.20^{***}	0.22^{***}	0.26^{***}	-0.01	0.24^{***}	0.62^{***}	0.74^{***}
CDS-3MVol	0.65^{***}	0.60^{***}	0.71^{***}	0.42^{***}	0.69^{***}	0.54^{***}	0.71^{***}
CDS-1YVol	0.53^{***}	0.44^{***}	0.61^{***}	0.11^{**}	0.51^{***}	0.43^{***}	0.60^{***}

CHANGES

Correlation

	industrials	autos	TMT	energy	consumers	senior financials	sub. financials
CDS-Stock	-0.29^{***}	-0.27^{***}	-0.23^{***}	-0.17^{***}	-0.22^{***}	-0.24^{***}	-0.29^{***}
CDS-Stock(lagged)	-0.19^{***}	-0.23^{***}	-0.27^{***}	-0.09	-0.17^{***}	-0.16^{**}	-0.28^{***}
CDS(lagged)-Stock	0.02	-0.03	-0.09	-0.03	-0.01	-0.09	-0.05

Rank Correlation

	industrials	autos	TMT	energy	consumers	senior financials	sub. financials
CDS-Stock	-0.32^{***}	-0.26^{***}	-0.21^{***}	-0.20^{***}	-0.20^{***}	-0.21^{***}	-0.21^{***}
CDS-Stock(lagged)	-0.30^{***}	-0.27^{***}	-0.26^{***}	-0.15^{**}	-0.19^{***}	-0.17^{***}	-0.24^{***}
CDS(lagged)-Stock	-0.04	0.08	-0.17^{**}	-0.05	-0.09	-0.06	-0.03

TABLE 3. OLS-Regressions: 5-Year iTraxx CDS Index Spread Changes regressed on lagged iTraxx CDS Index Spread Changes and current and lagged Stock Index Returns over the time period June 21, 2004 to April 18, 2005. 1%, 5% and 10% significance levels are indicated by ***, ** and *, respectively.

$$rCDS_t = a_{0,t} + a_{1,t} rCDS_{t-1} + a_{2,t} r_t + a_{3,t} r_{t-1} + \varepsilon_t$$

	industrials	autos	TMT	energy	consumers	senior financials	sub. financials
$a_{0,t}$	0.0015	0.0026	0.0001	0.0004	0.0003	0.0005	0.0008
$a_{1,t}$	0.28^{***}	0.07	0.25^{***}	0.19^{***}	0.28^{***}	0.20^{***}	0.35^{***}
$a_{2,t}$	-1.02^{***}	-0.84^{***}	-0.69^{***}	-0.58^{**}	-0.64^{***}	-0.58^{***}	-0.75^{***}
$a_{3,t}$	-0.42^{*}	-0.63^{***}	-0.72^{***}	-0.20	-0.33	-0.27	-0.55^{***}
R^2	0.18	0.12	0.17	0.07	0.15	0.11	0.25
$F_{[3,d.f.]}$	15.3^{***}	9.3^{***}	14.4^{***}	5.5^{***}	11.7^{***}	8.9^{***}	22.6^{***}

Figure 1 CDS-Index level, Stock Index level and Stock Index volatility