Exploring for the Determinants of Credit Risk in Credit Default Swap Transaction Data.

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Comments Welcome

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Abstract

We investigate the influence of various fundamental variables on a cross-section of credit default swap rates. Credit default swap rates can be seen as an alternative proxy for credit risk. Therefore our findings are relevant not only for the understanding of credit default swaps but for credit risk in general. The fundamental variables include ratings, interest rate data and stock market related information such as variance and leverage (so called " structural variables "). We test for the stability of the influence of the different fundamental variables along several lines. We find evidence that most of the variables predicted by credit risk pricing theories have a significant impact on the observed levels of credit default prices. We also provide an international analysis of corporate credit risk, as half of our corporate sample is not US based, as well as some results on sovereign credit risk. Using this information we are able to explain a significant portion of the cross-sectional variation in our sample with adjusted R^2 reaching 82% using the variables predicted by classical theoretical models. However there are important behavioral differences between high rated and low rated underlyings, sovereign and corporate underlyings and underlyings from different markets (US vs no US). We analyze these differences. Strong results show the importance of considering so called "structural variables " as well as stochastic interest rates along with classical ratings when pricing credit risk overall.

1 Introduction

Credit risk has received much attention in the academic literature. The bulk of the work has focused on theoretical valuation issues. There is far less research on the empirical side. Nearly all of the empirical work investigating credit risk has focused on the bond market. The main approach was to explain the determinants and the dynamics of the credit spread, hence the difference between the yield on a bond of a risky counterparty and a government bond. Government and corporate bonds differ in a variety of ways, which makes the credit spread an imperfect proxy for credit risk. Some of the issues are addressed in Duffee (1998). Financial innovation has led to the emergence of a new kind of derivative written directly on a credit risk, credit derivatives. The Credit Default Swap (CDS) is the most used Credit Derivative. A Credit Default Swap is an instrument that provides its buyer with a lump sum payment made by the seller in the case of default (or other " credit event ") of an underlying reference entity against the periodic payment made by the buyer. This periodic payment expressed as a function of its notional value is the CDS rate. No academic study that we know of has investigated the empirical behavior of credit default swap rates. Such a study has strong implications for our understanding of credit risk behavior. It represents an opportunity to study credit risk from another instrument than the fixed income instruments (bonds, swaps) analyzed previously.

We test for the influence of the theoretical factors predicted by the reduced and the structural form literature. Moreover, we test for the stability of the influences by using a cross-section of credit default swap rates on a variety of underlyings.

Our study differs from all existing studies done on factors influencing credit risk in some respect. Credit derivatives have been around for some years but they have only in the recent past begun to be used widely in the market. Credit default swaps are supposed to allow the transfer of pure credit risk from one counterparty to another. They can be designed to provide protection against consequences of default in a variety of ways. In the purest form they provide a pre-specified payment in the event of default. If this is a fixed payment then the value of the credit default swap is only influenced by the occurrence of default. The payment can be specified in terms of an otherwise risk free bond, which makes it dependent on the term structure of

interest rates. In this case the following relationship has to hold

$$Credit\ risky\ bond + Credit\ default\ swap = Riskfree\ bond$$

Due to this fundamental relationship we can use the prices of credit default swaps, respectively their swap rate, in order to analyze indirectly the factors influencing the credit risk of the underlying parties of the credit default swaps. This approach has many advantages. It is not subject to some of the flaws of previous studies investigating credit risk as measured by the spread of the risky bond yield relative to the risk free rate. As the contracts are written directly on a credit event they are not subject to the distortion of call features and other covenants. Furthermore, credit default swaps are not interest rate based instruments (while other credit risk instruments such as bonds and swaps are). They allow for a direct analysis of credit risk (and the influence of interest rates thereupon), rather than for an indirect analysis of credit risk as embedded in an interest-rate based security. Finally, they present a somewhat standardized instrument to study and compare credit risk in different countries, as well as credit risk coming from corporates versus sovereigns. However they are also subject to some disadvantages which are linked to their nature as OTC contracts. The main disadvantage is their lack of liquidity and of a secondary market. We only observe the prices at initiation of the contract. Secondary trading or a closing of the position is done directly in-between the counterparties or with another broker. Moreover some of the refinements of the contract like exact specification of the payment in case of default as well as the exact definition of default can and do vary slightly from contract to contract.

We proceed with a brief literature review of empirical studies of credit risk before addressing how classical theoretical models would price credit default swaps. We then describe our data and the variables we considered based on the theoretical and empirical literature. The empirical investigation that follows provides results on the impact of these variables as well as on international differences and other underlying differences.

2 Literature review

The literature on such a recent instrument as the Credit Default Swap is by necessity scarce. Nonetheless, several papers have addressed the theoretical pricing of credit derivatives during the last few years. Longstaff and Schwartz (1995) present the pricing of credit spread options based on an exogenous mean-reverting process for credit spreads. Das (1995) uses a structural-form compound option model to price credit derivatives in a stochastic interest environment. The structure used corresponds more to credit spread options though than to credit default swaps. Duffie (1999) presents a simple argumentation for the replication of Credit Default Swaps as well as a simple reduced form model of the instrument.

Hull and White (2000 a and b) develop a reduced-form type pricing model, with an extension to several underlyings and non perfectly correlated default. They calibrate their model based on the traded bonds of the underlying on a time series of credit default swap prices on one underlying.

While the literature on Credit Default Swaps is scarce and no complete empirical analysis has been produced yet that we know of, there is a more significant empirical literature on credit risk in general.

Some papers have concentrated on a direct analysis of credit ratings as provided by the big rating agencies. These ratings are important as they are used extensively in practice as a proxy for credit risk. Some theoretical models also rely on ratings and rating transitions like Jarrow et alii (1997). Moon and Stotsky (1993)\ evaluate the determinants of ratings by each rating agency in a systematic econometric analysis. Hite and Warga (1997) analyze changes in ratings during the life of a bond and find some information content for down grades at announcement, and little or none for upgrades. The earlier studies by Katz (1974), Hettenhouse and Sartoris (1976), Weinstein (1977) and Pinches and Singleton (1978) all concluded that there is a lag between the arrival of new information and rating changes. Hence ratings do not necessarily provide much new information, except for small not very frequently traded firms. Further evidence on the changing of ratings through time is provided by Lucas and Lonski (1993). They find a trend towards lower rate debt issues combined with a higher rating volatility in the bond market during 1970-1990. Some more evidence on the quality of ratings is provided by Cantor et al. (1997) by analyzing the influence of split rating on pricing. Finally Nickel et al. (2000) analyze the stability of rating transitions. The

work of Altman and Kishore (1996a) and Izvorski (1997) provide some more evidence on default and recovery rates. Altman and Kishore (1996a) find that history of default and the resulting default rates are sensitive to some specific issues and that ratings have no explanatory power on recovery rates once seniority is taken into account. Izvorski (1997) concludes that maturity, seniority and the state of the economy are the main determinants of the value of firm specific contracts. The influence of maturity is a debated issue as there is no general consensus among the different modelling approaches on its influence on credit risk pricing particularly for below investment grade issues.

There are only a few studies investigating the determinants of credit spreads. Duffee (1998) finds that the credit spread is negatively related to the level of interest rates and the term spread. He also finds that the sensitivity to changes in the term structure is more pronounced for lower rated bonds. He observes further that changes in bond values might be due to the influence of the call feature present in a bond. Allessandrini (1998) confirms these findings and concludes further that the business cycle effect is mainly captured by the changes in long-term interest rates. The study by Friedson and Garman (1998) differs from the previous by using new issues of high-yield bonds to analyze the factors that influence the pricing. They find that changes in the risk free rate, credit spreads and the slope of the yield curve influence the pricing. The more recent study by Collin-Dufresne et al. (1999) uses time series of quoted bond prices to analyze the influence of various financial variables that should in theory influence changes in yield spreads. They find that these variables have only limited explanatory power. Moreover the residuals of the regressions are highly cross-correlated pointing to the influence of an unobserved common factor. Some further evidence for co-movements of credit spreads is provided by Batten et al. (1999) in their study on Australian Eurobonds.

Some studies have analyzed credit risk from other instruments, notably on Swaps like Sun and Sundaresan (1993) on Swap quotes and Cossin and Pirotte (1997) on swap transaction data. Their results tend to be less advanced on credit risk issues than the previously quoted studies on bond spreads.

There is a different group of studies that focus on sovereign debt. Analogous to the literature on corporate ratings, sovereign ratings were subject to

close examination. Cantor and Packer (1996) find that the public information is contained in ratings and that rating changes do have a significant effect on the prices of outstanding debt. Classens and Penacchi (1996) construct a model that takes into account a number of issuer specific factors. They calibrate their model to the observed prices of Mexican Brady bonds. Kamin and Kleist (1999) analyze the determinants and the evolution of emerging market spreads during the 1990s. They find a strong relationship of credit ratings, maturity and currency denomination with emerging market instruments spreads. They also find evidence for a changing risk premium during the time span under consideration. Cumby and Evans (1997) and Dungey et al. (1999) consider credit quality to be some unobservable random variable. Dungey et al. (1999) provide a decomposition of international spread changes in a Kalman filter framework. Their main result is that for the Commonwealth countries the first of their three factors (the common factor) displays long-swings that explains most of the changes in credit spreads. For other countries some country specific influences seem to be more important. A significant improvement within those studies is presented by Eichengreen and Mody (1998). They consider the determinants of emerging market debt values by taking into account a possible selectivity bias as some low rated countries might have been unable to issues bonds following the emerging market turbulences. Their findings confirm that higher quality translates into a higher probability of issue and a lower spread. However fundamental information can only explain a fraction of the overall variation in their sample.

There has not been any advanced study we are aware of that bear on Credit Risk as reflected in Credit Derivatives. We next analyze how different models would price Credit Default Swaps in order to understand what variables are important to consider in our empirical analysis and how those variables will affect Credit Default Swap rates. We will not fit a specific model to our data here (as this goes beyond the scope of this paper) but rather uncover stylized facts about different variables in order to make our empirical analysis more clear and pertinent.

3 The factors influencing credit risk

3.1 The pricing of a credit default swap

In this section we want to derive the general structure of the pricing of a credit default swap and illustrate the differences in pricing among various possible theoretical approaches. Two strands dominate the theoretical literature on credit risk today: the structural and the reduced form ones. We will work out the explicit pricing for a structural form model and for a reduced form model in order to show the influence of the various parameters analyzed in the subsequent sections. The pricing is done from the buyers point of view. The buyer will have to make periodic payments as long as there is no default of the underlying party. On the other hand he will receive some payment in the case of default. This payment can be specified in a variety of ways. The payment could be defined as a fixed amount in the simplest case. It can be the difference between the pre-default value and the recovery value of a bond. The most common definition is to define it as the difference between the face value of the bond and the recovery value after default. The payout is sometimes corrected for accrued interest and implied interest payments. The value of a default swap to the buyer of protection is thus given by

$$Value\ of\ a\ credit\ default\ swap =$$

$$I\!E_0[-\sum_{i=1}^{N} \exp\left(-\int_0^{t_i} r\left(u\right)du\right) \cdot \Pr ob\left(no\ default\ until\ time\ t_i\right) \cdot Swap\ rate$$

$$\cdot Notional + \exp\left(-\int_0^{\tau} r\left(u\right)du\right) \Pr ob\left(default \cdot at \cdot time \cdot \tau\right) \cdot Payment]$$

$$(1)$$

where i is the index of the payments, N is the number of payments until maturity and r(u) is the interest rate. The expectations operator in the above equation is needed as the interest rate could be stochastic and correlated with the variables influencing the probability of default.Various models will differ on how they determine the probabilities and the payment at default.

3.2   A simple structural analysis of Credit Default Swaps

In a first step we will develope the pricing for a structural model, with non stochastic interest rates. It is clear that this model is only applicable directly for corporate underlyings. Some evolution of the model could be used for sovereigns in the spirit of Classens and Penacchi (1996). Following the basic Merton (1974) framework we assume that the firm value V follows a geometric Brownian motion given by

$$dV/V = (r - d) \cdot dt + \sigma_v \cdot dz \tag{2}$$

where r is the instantaneous risk-free rate, d is the continuous dividend yield and σ_v is the volatility of the firm value process. The firm will default if this value breaches some pre-specified default level denoted H. We will assume that this default level is an exogenously fixed constant. It could be a deterministic function of time. Black and Cox (1977) use a deterministic exponential barrier to model the effect of bond indenture provisions on the value of risky debt. We could use a similar functional form to model the default boundary. Another possible extension would be in the spirit of Leland (1994) and Leland and Toft(1996). In their model the default boundary is determined endogenously by maximizing the value of equity respectively to the value of the firm. For simplicity we maintain the assumption of a fixed constant default boundary. The value of the credit default swap is comparable to the sum of a number of barrier options on the firm value. The methodology and notation we use for the pricing of the barrier options follows the work of Rich (1994). The probability of no default until time i is obtained as

$$\Pr ob\,(no\ default\ until\ time\ i) \tag{3}$$
$$= \Pr ob\,(V_{T_i} > H, \inf\ V_t > H)$$
$$= \Pr ob\,(V_{T_i} > H) - \Pr ob\,(V_{T_i} > H, \inf\ V_t < H)$$
$$= N\left(\frac{-H/V_0 + \mu \cdot (t_i)}{\sigma \cdot \sqrt{t_i}}\right) - \exp\left(\frac{2 \cdot H/V_0 \cdot \mu}{\sigma^2}\right) N\left(\frac{-H/V_0 - \mu \cdot t_i}{\sigma \cdot \sqrt{t_i}}\right)$$

$where$:

V_t $=$ $firm\ value\ process$

H $=$ $default\ boundary\ (possibly\ the\ face\ value\ of\ debt)$

μ $=$ $r - d - \dfrac{\sigma^2}{2}$

$for\ all\ t\ from\ 0\ to\ T_i$

With these probabilities we can price one leg of the credit default swap. The value of the periodic payments is obtained as

$$Part1 = Swap\ rate \cdot Notional \cdot$$

$$\sum_{i=1}^{N} N\left(\frac{-H/V_0 + \mu \cdot (t_i)}{\sigma \cdot \sqrt{t_i}}\right) - \exp\left(\frac{2 \cdot H/V_0 \cdot \mu}{\sigma^2}\right) N\left(\frac{-H/V_0 - \mu \cdot t_i}{\sigma \cdot \sqrt{t_i}}\right) \quad (4)$$

Now we proceed to the pricing of the second leg of the default swap, which is the payment in the case of default. We assume that the recovery value is just a discount on the face value. This is not an unreasonable assumption if the recovery rate can be estimated ex-ante with some degree of certainty. We could make the recovery rate a function of time. The valuation could always be done by solving numerically the integral given in equation number 1. On the other hand the recovery rate could be a function of the value of the assets at time of default. However this value is known to us as default is triggered when the firm value crosses the level H as long as default occurs at any time before maturity. Therefore the assumption that the recovery rate is a function of the asset value at the time of default, would just make it dependent on H contrarily to Merton (1974) where a European type setting is used. If the underlying firm value process is a jump-diffusion process, the modelling of a recovery rate that depends on the asset values of the firm at default would be more complicated. Under the above assumptions the value of the second part is given by

$$
\begin{aligned}
Part2 &= I\!\!E_0\left[\exp\left(-r \cdot \tau\right) \Pr ob\left(default \cdot at \cdot time \cdot \tau\right) \cdot Payment\right] \\
&= \int_0^T Payment\left(H, \tau\right) \cdot \exp\left(-r \cdot \tau\right) \cdot h\left(\tau\right) d\tau \\
where &: \\
h\left(\tau\right) &= first\ passage\ time\ density\ of\ the\ process\ v\ at\ the\ level\ H \\
h\left(\tau\right) &= \frac{-\ln\left(\frac{H}{V_0}\right)}{\sigma\sqrt{\tau^3}} n\left(x - \sigma\sqrt{\tau}\right) \\
x &= \frac{\ln\left(\frac{V_0}{H}\right) + \left(\mu + \sigma^2\right)\tau}{\sigma\sqrt{\tau}}
\end{aligned}
\quad (5)
$$

Under the assumption that the recovery rate is a function of H or the face

value we can simplify the above integral to

$$Part2 = Payment \cdot \left((H/V_0)^{a+m} \cdot N(w) + (H/V_0)^{a-m} N\left(w - 2m\sigma\sqrt{T}\right) \right)$$

$$where \quad :$$

$$a = \frac{\mu}{\sigma^2}$$

$$m = \frac{\sqrt{\mu^2 + 2 \cdot \ln(r) \cdot \sigma^2}}{\sigma^2}$$

$$w = \frac{\ln\left(\frac{H}{V_0}\right) + m \cdot \sigma^2 \cdot T}{\sigma \cdot \sqrt{T}} \tag{6}$$

The valuation equation would be more complicated if the interest rate were considered stochastic and correlated with the firm value process. We might not be able to obtain a closed form solution for this case depending on the choice of the process for the stochastic interest rate.

Because the value of the firm follows a diffusion process the probability of default goes to zero as the maturity of the contract goes to zero. Therefore the credit spread on a risky bond implied by such a model goes to zero as well. Empirically however default spreads do not go to zero with decreasing maturity but they remain positive. One possibility to take into account that firm value can drop suddenly is to model the firm value process as a jump-diffusion process. Zhou (1997) follows this path and obtains a closed form solution for the value of a bond under some restrictions and proposes the use of the Monte Carlo methodology for the valuation in the general case.

The factors that influence the value of the credit default swap in a classical structural model such as the one proposed here are the distance from the default boundary, the value of the assets of the company, the volatility of the value of the company, the level of the interest rate and the time to maturity of the credit default swap. In the earliest structural model, the Merton model, it was assumed, that the default boundary was just the face value of debt. In the later models the default boundary was given exogenously or determined endogenously as in Leland(1994), Leland and Toft (1996) and Anderson and Sundaresan (1996). Even if we don't observe the exact value of this boundary we can identify the influence of various factors on the distance from this boundary. A decrease in the stock price will lower the distance to this boundary, the same is true for an increase in leverage. An increase in volatility would also increase the probability of default as the likelihood increases that the firm value process crosses the default boundary.

3.3 A Reduced Form Approach and Implications

We turn now to a reduced form approach. In the reduced form approach the probability of default is governed by the hazard rate. This is common to all the models like Jarrow and Turnbull (1995), Duffie and Singleton (1997) and Lando (1994/97). The hazard rate denoted h(t) could be a function of a various other variables.

Lando (1994/97) derives some simple representations for the valuation of credit derivatives. The value of a contingent claim that pays some fixed amount if default has not occurred before that time is obtained as

$$I\!E_t^Q \left[\exp \left(- \int_t^T r\left(s\right) ds \right) X \cdot I\!\!I \left(\Gamma > T\right) \right] = \tag{7}$$

$$I\!\!I\left(\Gamma > t\right) I\!E_t^Q \left[\exp \left(- \int_t^T r\left(s\right) + \lambda\left(s\right) ds \right) X \right]$$

where Γ is the time of default and λ is the intensity of the Poisson process governing the default probability. This expression is exactly the value of one of the payments of the credit default swap rate times the notional conditional on no default up to that point. The other leg of the default swap would be valued with the expression for a credit derivative that pays off Z(Γ) if the underlying defaults at time Γ and zero otherwise. This expression is given by

$$I\!E_t^Q \left[\exp \left(- \int_t^\Gamma r\left(s\right) ds \right) Z\left(\Gamma\right) \right] = \tag{8}$$

$$I\!\!I\left(\Gamma > t\right) I\!E_t^Q \left[\int_t^T Z\left(s\right) \cdot \lambda\left(s\right) \exp \left(- \int_t^s r\left(u\right) + \lambda\left(u\right) du \right) ds \right]$$
$$where\ \Gamma = is\ the\ time\ of\ default$$

The payment Z(s) would in our case be defined as

$$Z\left(s\right) = FV - \mathrm{Re}\,covery\ value$$
$$where\ FV = face\ value$$

The recovery value can be defined in a variety of ways. Jarrow and Turnbull (1995) define it as an ex-ante known value. Another possibility is to treat it as being dependent on a number of state variables. Das and Tufano (1996) for instance assume, that the recovery rate is correlated with the

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default free spot rate. Duffie and Singleton (1998) specify the recovery value as a fraction of the pre-default value of the bond (Recovery of Market Value). This solution has some advantages on the modelling side while recovery of Face Value (where the creditor receives a fraction of the promised face value) or Recovery of Treasury (where the creditor receives a fraction of an identical but default free bond) are more common (see Jarrow and Turnbull (1995)).

A variety of authors have suggested that the default rate could depend on some state variables reflecting the economic environment and some firm specific information. Lando (1994/1997) assumes that the hazard rate depends on a number of state variables. Jarrow and Turnbull (2000) use the same kind of process and assume that the hazard rate is a function of the random elements in the evolution of a stock price index and the short term interest rate. Their hazard rate function is given by

$$\lambda(t) = a_0(t) + a_1 r(t) + \beta \sigma_1 W_1(t) \tag{9}$$

where a_0, a, and β are constants; r is the risk free rate and W_1 is a Brownian motion governing the unexpected part of the returns of a stock price index. Their model can be calibrated to fit some observed structure of default spreads. The constant in their model could depend as well on some parameters related to the firm value like the rating, the leverage or the stock price volatility. In the reduced form framework the valuation formula would be given by

$$Value\ of\ a\ credit\ default\ swap = \tag{10}$$

$$\mathbb{1}(\Gamma > t) \cdot \sum_{i=1}^{N} I\!\!E_t^Q \left[\exp\left(-\int_t^{Ti} r(s) + \lambda(s)\, ds \right) X \right]$$

$$+ \mathbb{1}(\Gamma > t) \cdot I\!\!E_t^Q \left[\int_t^T Z(s) \cdot \lambda(s) \exp\left(-\int_t^s r(u) + \lambda(u)\, du \right) ds \right]$$

The reduced and the structural form approaches differ significantly in the way they model the default probabilities. On the other hand the economical differences become much smaller if we use a structural model with a jump-diffusion process for the firm value, thus allowing for sudden drops in the value of the firms assets, or if we introduce a hazard rate that depends on economic and firm specific factors. Therefore the factors influencing the prices of default swaps are basically the same, but the weighting of their influence is different. The form of their influence on credit risk itself will

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obviously differ amongst the different modelizations. Based on these models we identify a number of factors that should affect the prices of credit default swaps and credit risk in general. These factors are primarily in the case of reduced form models the default process, the interest rate and the recovery rule as well as the maturity of the instrument.

4 The Credit Default Swap Data

The credit default swap data is obtained from a major London interdealer broker. The data consist of several thousand one way quotes and 393 realized trades. In this study we focus on the realized trades. A one way quote in an OTC market is just the request to sell or to buy a specific instrument for some specific price. It is not cleared market data with a well defined bid ask spread. The traded data on the other hand is market cleared data, hence it represents the market consensus on the fair value of the credit default swap at transaction time. Therefore we will restrict ourselves to the 393 observations of traded contracts. These trades took place during the period from January 1998 to February 2000, with observations of all qualities well-spread over the period (with a peak end of 1998 and beginning of 1999). In the sample we have 70 sovereign and 323 corporate underlyings. The underlyings come from a variety of countries. The domiciles of the underlyings are:

Country	Corporate	Sovereign
Argentina	0	1
Australia	14	0
Austria	2	0
Belgium	1	1
Canada	3	0
China	2	17
Czech Rep.	0	5
France	21	0
Germany	15	0
Greece	0	5
HongKong	2	0
Hungary	0	9
India	2	0
Israel	1	1
Italy	7	1
Japan	34	6
Rep. of Korea	17	0
Mexico	0	2
Netherlands	8	0
Philippines	0	3
Poland	0	9
South Africa	0	4
Spain	5	1
Sweden	2	0
Switzerland	2	0
Thailand	0	2
Tunisia	0	1
United Kingdom	19	0
United States	165	0

The majority of underlyings are from the United States followed by European countries. The corporations underlying the contracts tend to be large, with a minimum market capitalization for the US ones of $500 millions and an average of $40 billions. Most of the contracts are denoted in US dollars. The remaining ones are in Euro or Yen. The prices of the credit default

swaps are denoted in basis points per annum. The notional amounts of the contracts range from 1 to 20 million US . The payment at default is defined as the difference between the notional of the credit default swap and the recovery value of a bond on this underlying with the same notional. Deviations from the general structure outlined above are possible. For some of the contracts more detailed procedures in case of default are specified directly between the counterparties without the involvement of the broker. These could include for instance the payment of the value of the bond during some time before the default and other refinements. We have excluded the highest observation because we consider it to be an outlier. The observation is a quote from a credit default swap of Russia. We realize that the overall value is instructive, but we believe that as it is the only value of this magnitude it would bias more our results than add any quantitatively reliable information. The following table summarizes the basic statistics of the data.

	Whole Sample	Corporate	US Corporate	Non US Corporate	Sovereign
Observations	392	323	166	157	69
Mean	0.0088	0.0073	0.0054	0.0092	0.0157
Median	0.0047	0.0042	0.0034	0.0048	0.0081
Maximum	0.0780	0.0780	0.0335	0.0780	0.0700
Minimum	0.0005	0.0011	0.0011	0.0011	0.0005
Std. Dev.	0.0119	0.0103	0.0060	0.0132	0.0159
Skewness	2.988	3.853	2.993	3.162	1.422
Kurtosis	13.171	20.873	12.105	13.782	4.535
Ratings					
Average	6.83	6.58	6.47	6.72	7.90
Max	16	16	16	16	12
Min	1	1	1	2	1

Table 1: Descriptiv statistics of the credit default swap rates of the whole sample and all the sub-samples.

5 The determinants of credit risk: Variables we consider and our sources

In this section we outline the factors to be analyzed in the subsequent econometric analysis. As shown earlier, the choice of those factors is justified by the existing theoretical literature on the pricing of credit sensitive contracts. Overall, structural models stress the influence of the value of the assets of the company, its volatility, the distance from the default boundary (as influenced notably by the leverage), the level of interest rate and the maturity. Reduced form models use also the latter two but exogeneize the default process and the recovery rule.

1. Credit ratings

Credit ratings are the most widely observed measure of credit quality of a specific debt issue or the issuing entity in general and remain the most commonly used information for the default process and the hazard rate λ. All the reduced form models rely in one way or another on the estimation of a default probability. In practice default probabilities are estimated very often by rating classes. Some models like Jarrow et al. (1997) are directly based on the estimation of the rating migration matrix. Numerous studies on credit ratings have shown that often changes in ratings are anticipated by the market. Thus we expect that ratings have only a limited explanatory power for price changes. However other studies particularly on sovereign ratings (for example Cantor and Packer (1996)) have shown that ratings subsume efficiently all the fundamental information. Moreover they seem to provide some additional information beyond the fundamentals used in their study. Our research uses a cross-section of initial prices of credit default swaps. We are investigating the various factors that influence the level of credit default swap rates, not the changes. Therefore credit ratings should have a significant explanatory power in our regressions . The main critique concerning ratings is their infrequent revisions. A structural alternative to ratings based on an implementation of the Merton model is currently available in the market as discussed underneath.

The credit ratings we use are the ratings of the underlying company for its long term debt. They range from AAA to C in Standard and Poor 's rating system and from AAA to B3 in Moody's notation. We have used the

Standard and Poor's rating whenever possible. If only the Moody rating was available we used it instead of the Standard and Poors rating. The choice was made based on the facts that we had more ratings available from Standard and Poor's than from Moody's in our sample. The differences among the two ratings are however small. We use the ratings in two ways in our regressions. We introduce dummy variables that represent each rating and thus let us analyze the impact of each rating with no assumption on its relationship to the other ratings. We also have translated the alpha numeric rating classes into a numerical scale ranging from 1 for the highest to 17 for the lowest credit rating. This procedure, while being common in the literature, might introduce a bias because we implicitly assume that the influence of a rating change is the same between AA and A or BB and B. It is clear that the rating change can have a more dramatic influence for lower quality underlyings than for higher quality underlyings and we will indeed investigate this point. However working with a number of dummy variables can be not very well suited for some subsamples (as we observe only very few observations for some of the rating classes). We thus use both methodologies to confirm our results, using dummy variables in some regressions and the numeric-translation in some alternatives. We also use extensively an intermediate approach and allow for behavioral differences among high and low ratings by using either a single dummy variable or subsamples. The numerical values that we assigned to the different rating classes can be found in the following table:

Value	Moody's	S&P	# Observations
1	Aaa	AAA	9
2	Aa1	AA^+	7
3	Aa2	AA	32
4	Aa3	AA^-	33
5	A1	A^+	36
6	A2	A	52
7	A3	A^-	40
8	Baa1	BBB^+	43
9	Baa2	BBB	56
10	Baa3	BBB^-	36
11	Ba1	BB^+	10
12	Ba2	BB	4
13	Ba3	BB^-	2
14	B1	B^+	2
15	B2	B	4
16	B3	B^-	0
17	C	C	0

It is interesting to notice that our data offer a wide spread of ratings rare in empirical academic studies, from AAA to B with half of the underlyings being BBB-rated or less.

2. Interest rate

It is interesting to note that most of the current credit risk management models as used by practitioners, whether based on ratings or on structural variables (such as leverage and variance) do not include stochastic interest rates. On the other hand, the spot rate is a factor that appears in all of the current academic credit risk pricing models. In general the spot rate is negatively correlated with the credit spread. This impact is confirmed in empirical studies (see Duffee (1998) and others). We expect to find a negative relationship between the US spot rate and the observed credit default swap rates. We use the US spot rate as the risk free benchmark for all of the countries.

We use the 3 month treasury constant maturity rate series from the database of the federal bank of St.Louis (FRED) as the proxy for the short

term risk free rate. We are working with monthly observations and chose the latest observation before the trading date of the credit default swap. The choice of the US rate is certainly a viable choice for the US corporate underlyings as well as a usual choice for the sovereign underlyings as the US government is regarded normally as the highest grade counterparty in the world. In order to examine the influence of this choice we use additionally series of bench mark yields up to five years from datastream for the following countries: Australia, Germany, Japan and the UK.

3. Slope of the yield curve

The slope of the yield curve does not appear in most of the structural models directly, but we would still expect it to have a significant impact via its influence on the expected short rate in the future and due to the fact that it is related to future business conditions. Some interest rate models like Brennan and Schwartz (1979) model explicitly the short and the long rate , while others take it into account implicitly by assuming that the short rate is mean reverting around the long rate level. Das (1995) is a model which uses the whole risk-free term structure. We interpret the economic influence of the yield curve as conveying information on future spot rates and economic conditions. Generally a steeper slope of the term structure is considered to be an indicator of improving economic activity in the future. Harvey (1988) finds that the slope of the yield curve has a positive relationship with future consumption. Estrella and Hardouvelis (1991) confirm that a positively sloped yield curve is associated with an increase in real economic activity as measured by consumption, consumer durables and investment. Finally Estrella and Mishkin (1995) test the predictive power of various financial variables in probit models for the prediction of recessions. They find that among all the variables examined the slope of the yield curve has the highest power, with a decrease in the slope being associated with an increase in the probability of a recession.

Therefore we introduce slopes of the yield curves of some other countries as the economies in the US, Europe and Japan are not at the same stages in the business cycle.

In order to measure the slope of the yield curve we use the difference between the long term and the short term interest rate series from the federal

bank of St.Louis (FRED). We include again the series for Australia, Germany, Japan and the UK. In this case we measure the slope of the yield curve as the difference between the benchmark yield over 10 years and the benchmark yields below five years. The series are taken from Datastream.

4. Time-to-maturity

We expect that time to maturity should have an influence on observed Credit Default Swap rates. However there is no consensus in the literature as to the shape of the term structure of credit spreads. Most of the structural models predict an upward sloping term structure for investment grade and a downward sloping term structure for speculative grade debt. But the expected term structures can be more complicated than that as illustrated by Merton's (1974) hump-shaped or Das' (1995) "N-shaped" term structures. Collin-Dufresne (1999) points out that the second effect is mainly due to the fact that these models use implicitly declining leverage ratios. We use the time-to-maturity reported in the database.

The time to maturity is reported in the database either directly as time to maturity reported in weeks, months or years or as a specific ending data. We translate all the times to maturity in a notation of weeks. In some cases we round the resulting number of weeks as the contract might have been initiated any date of the week The error introduced by using weeks instead of days is very small as most of the observations are expressed in years anyway and the maturities are rather long ranging anywhere from some months up to 10 years.

5.Stock prices

Stock prices contain information on the underlying companies. Negative information on the firm is reflected faster in the stock price than in the rating. In all the structural form models like Merton (1974) or the various extensions like Shimko et al (1993), Longstaff and Schwartz (1995), Leland (1994), Leland and Toft (1997) default is triggered by the firm value process. Leland (1994) shows that it is possible to reformulate the Merton model in terms of the stock price instead of V (the value of the firms' assets). Based on the structural models Kealhofer, McQuown and Vasicek (KMV) have

developed and marketed a model for the pricing and management of risky debt. They use stock prices to back out expected default probabilities.

In the context of a reduced form model Jarrow and Turnbull (2000) use a default rate which is dependent on the random element of a stock price index. Following their approach we could make the default rate dependent on the evolution of a stock price.

The influence of stock price changes are twofold. The stock price might reflect business conditions ahead of time. On the other hand a drop in the stock price induces a higher leverage ratio if one assumes that the level and value of debt fluctuates less strongly than the value of equity. We will adjust the stock returns for returns in the associated index in order to control for systematic stock movements. Moreover we will construct a dynamic measure of leverage in order to isolate the leverage effect.

The stock price data is collected from Reuters with a weekly frequency. We use the data to estimate changes in the stock price 4 weeks, 12 weeks, 26 weeks and 1 year before the trading date of the credit default swap. We use the absolute as well as the real percentage changes in the stock price as an explanatory variable. Due to the fact that we use the changes from a month up to a year the choice of the weekly frequency instead of daily does not seem to matter much. The prices are Friday's closing prices as reported by Reuters. We use the data from the last Friday before the trade of the credit default swap.

6. Variance or volatility of the firms' assets

All the structural models contain as an input the volatility of the assets of the firm. The credit spread is expected to increase with a higher volatility. Ronn and Verma (1986) show how to link the volatility of the firm value with the volatility of \ the stock price. As a proxy for the variability in the firms assets we will use the historical annualized variance of the stock returns.

We measure variance as the historical variance estimated using the weekly quotes reported by Reuters. We use a running window of 52 weeks to estimate the variance for every trading week. The weekly variance is annualized by using the scaling implied by a geometric Brownian motion for the underlying stock price. We use the historical variance because there are no liquid options

for a lot of the underlyings in our sample which makes it impossible to use the implied volatility from traded option prices.

7. Leverage

All of the structural models agree that the level of leverage has a significant impact on credit risk. Either they are directly based on the ratio of firm value to debt value or they depend on the distance of the firm value process from some default triggering level (also called the distance from default). Collin-Dufresne and Goldstein (1999) note that most of the structural form models use implicitly declining expected leverage ratios. This fact explains why these models predict a declining term structure of yield spreads for speculative grade debt. Collin-Dufresne and Goldstein develop a model which yields stationary leverage ratios. In the context of reduced form models, the leverage ratio has only an indirect influence via the hazard rate. In all the models higher leverage is associated with an increase of credit risk. As a proxy for leverage we will use a variable defined as book value of long-term debt divided by market value of equity. As the market value of equity changes at the same speed as the stock price we use this variable to control for leverage effects when we include stock price changes as an explanatory variable.

In order to control for changes in leverage we construct a dynamic proxy for leverage using the debt reported in the Equities 3000 database from Reuters and the market values from Datastream. We use as a proxy for leverage the ratio of the total liabilities and the market value of the firms' equity. The use of leverage differs significantly between the various countries. Therefore we restrict the use of the leverage proxy to the US sub-sample.

8. Index returns

In order to control for factors affecting all the securities in some markets we verify the robustness of our results regarding the influence of stock prices by using market index adjusted returns as well as index returns in combination with stock price changes. The indices include the following:

Australia	*All Ordinaries*	*Italy*	*Mibtel*
Austria	*ATX*	*Korea*	*KS* 11
Be lg ium	*Bel* 20	*Netherlands*	*AEX*
Canada	*TSE* 30	*Spain*	*MSI*
France	*CAC* 40	*Switzerland*	*SMI*
Germany	*Xetra DAX*	*UK*	*FTSE* 100
Hong Kong	*Hang Seng*	*US*	*S&P* 500
India	*BSEN*		

9. Idiosyncratic factors

The default probability and thus the credit default swap rates might also depend on a number of idiosyncratic factors. Nickel et al. (2000) investigate the stability of rating transition matrices. They find that rating transitions vary significantly between US and non-US obligors, between industries and the stage of the business cycle. Following the same lines we want to test for differences among various sub-samples. Our sample is composed of sovereign and corporate debt. Moreover it encompasses underlyings from a variety of countries. In practice different hazard rates are used for different industries. We will differentiate between sovereign and corporate and US and non US corporate underlyings by using dummy variables and sub-samples. We will not differentiate among the various industries as we do not have enough observations of the same industry in the different subgroups.

We are also dealing with an exotic product where liquidity effects may matter (notably when traders rely on replication for pricing). We use market capitalization as a proxy for liquidity and investigate its impact as well.

6 Estimations and Results

6.1 The credit rating and time to maturity

In a first step we want to analyze the influence of the rating on the credit default swap rates. Despite all their deficiencies, ratings are still considered the most important single source of information on the credit quality of a borrower. Therefore we expect a strong connection between ratings and credit default swap prices. The influence of the rating does not need to have the same influence on lower grade and high grade underlyings. We will investigate this question with a set of dummy regressions. The second variable that we will look at is the time to maturity. Although time to maturity is a natural variable to consider in any derivative contract, the theoretical influence of the time to maturity on credit default swap rates and credit risk in general is ambiguous. Many structural form models predict for example that we could observe a hump shaped term structure of credit spreads for low rated underlyings and a decreasing one for very low rated underlyings. Some predict even more complex term structures while reduced form models can accommodate many shapes.

We estimate all the equations as simple linear regressions on the level of default swap rates and as a semilog model on the logarithm of credit default swap rates. This second set of regressions represents a crude attempt at checking for some non linearities and confirming or infirming results obtained from linear regressions. It should be clear that the relationships we are looking for are most probably non linear. This work should be thought of as looking for the impact of variables on credit default swap rates via a linear approximation and a semi log approximation (we have also tested for a full log specification with very similar results, confirming the strength of the results beyond the issue of specification). Obviously, a better attempt would be to test for a more precise shape for the relationships. This would have to rely on the direct testing of a model. Unfortunately, such a methodology would have the double task of testing the model and testing the results, as no model has faced a consensus in the literature yet. This double testing would limit the analysis of the results by itself.

We will refer to the regressions on the logarithm of the CDSR as the log-regressions.We introduce a dummy for ratings below BBB. The choice of the BBB rating was done out of statistical considerations in order to have

a balanced sample size for all the subgroups. This dummy allows for a different sensitivity of the credit default swap rate with respect to the rating for highly rated underlyings and lower rated underlyings. We consider the following regressions

$$
\begin{aligned}
CDSR \;=\; & cons\tan t + \alpha_0 \cdot dummy1 + \alpha_1 \cdot rating + \\
& \alpha_2 \cdot dummy_1 \cdot rating + \beta_2 \cdot time + \varepsilon
\end{aligned} \tag{11}
$$

$$
\begin{aligned}
Log\,(CDSR) \;=\; & cons\tan t + \alpha_0 \cdot dummy1 + \alpha_1 \cdot rating \\
& + \alpha_2 \cdot dummy_1 \cdot rating + \beta_2 \cdot time + \varepsilon
\end{aligned} \tag{12}
$$

where

$CDSR$	$Credit\ default\ Swap\ rate$
$Rating$	$Credit\ Rating$
$Time$	$Time\ to\ maturity\ in\ weeks$
$dummy_1$	$dummy\ variable\ for\ underlyings\ rated\ below\ A$
ε	$Error\ term$

Previous empirical studies have found evidence that the market distinguishes between sovereign and corporate underlyings as well as between underlyings from various geographical regions. In order to gain more evidence, we run the above regression on the following sub-samples:

$$Corporate\ underlyings$$
$$US\ Corporate\ underlyings$$
$$Non\ US\ Corporate\ underlyings$$
$$Sovereign\ underlyings$$

In order to test for the statistical signifcance we estimated a pooled regression with unrestricted intercepts and coefficients. The following tables show the result of the individual regressions and the coefficient tests from the pooled regression. We have corrected for heteroskedasticity when necessary (using the White test and procedure).

Dependent Variable

Explanatory Variables	Whole Sample		Corporate	
	CDSR	Log(CDSR)	CDSR	Log(CDSR)
Constant	**-0.0043**	**-7.1393**	0.0002	**-6.9657**
	(0.05)	**(0.00)**	(0.92)	**(0.00)**
Dummy 1	-0.0035	0.6556	-0.0043	0.4376
	(0.83)	(0.36)	(0.78)	(0.51)
Rating	**0.0016**	**0.2394**	**0.0012**	**0.2063**
	(0.00)	**(0.00)**	**(0.00)**	**(0.00)**
Rating*Dummy1	0.0013	-0.0381	0.0012	-0.0174
	(0.37)	(0.54)	(0.38)	(0.76)
Time	0.0000	**0.0042**	0.0000	0.0036
	(0.64)	**(0.01)**	(0.28)	(0.10)
Adjusted R^2	0.40	0.55	0.35	0.50
White correction	x	x	x	x
Number of Observations	346	346	279	279
F-Statistic	**57.8900**	**104.7700**	**38.2000**	**70.0100**
	(0.00)	**(0.00)**	**(0.00)**	**(0.00)**

Dependent Variable

Explanatory Variables	Corporate US		Corporate Non US		Sovereign	
	CDSR	Log(CDSR)	CDSR	Log(CDSR)	CDSR	Log(CDSR)
Constant	-0.0009	**-6.8191**	0.0009	**-7.1543**	-0.0083	**-7.1172**
	(0.51)	**(0.00)**	(0.82)	**(0.00)**	(0.12)	**(0.00)**
Dummy 1	**-0.0393**	**-1.7593**	0.0198	2.0609	**-0.1185**	-0.2098
	(0.00)	**(0.00)**	(0.58)	(0.11)	**(0.04)**	(0.96)
Rating	**0.0009**	**0.1784**	**0.0015**	**0.2346**	**0.0022**	**0.2722**
	(0.00)	**(0.00)**	**(0.00)**	**(0.00)**	**(0.00)**	**(0.00)**
Rating*Dummy1	**0.0037**	**0.1453**	-0.0007	-0.1487	**0.0126**	0.0759
	(0.00)	**(0.01)**	(0.83)	(0.21)	**(0.01)**	(0.82)
Time	0.0000	0.0035	-0.0001	0.0045	0.0001	0.0033
	(0.99)	(0.14)	(0.27)	(0.19)	(0.14)	(0.17)
Adjusted R^2	0.68	0.50	0.37	0.55	0.63	0.66
White correction			x	x		
Number of Observations	145	145	134	134	67	67
F-Statistic	**77.4400**	**37.7100**	**20.9400**	**42.3000**	**29.2300**	**32.8400**
	(0.00)	**(0.00)**	**(0.00)**	**(0.00)**	**(0.00)**	**(0.00)**

Table 2: Results of the estimation of the following equation on the whole sample and the subgroups (on the credit default Swap rate and the log of it):
$$CDSR = cons\tan t + \alpha_0 \cdot dummy1 + \alpha_1 \cdot Rating + \alpha_2 \cdot dummy_1 \cdot Rating + \beta_1 \cdot Time$$

The first obvious result lies in the striking significance of the different regressions, with Fisher tests never under 20. This significance is notably linked to the significance of the ratings variable that remains strongly significant whatever the specification (linear or semi-log) and the sample considered (sovereign, US or nonUS corporates). The strongest impact economically of ratings happens with Sovereign credit default swap rates (with the largest coefficient in both specifications). This confirms the result already in the literature that Sovereign and Corporate ratings are not interchangeable and that the Sovereign rating differences are larger (from a pricing point of view) than the Corporates ones.

The use of the dummy variable multiplied by the rating is a way of testing whether low rated underlyings, whether Sovereign or Corporates, have a different price-rating relationship than highly rated underlyings. The coefficient is only significant for the US Corporate sub-sample (and for the Sovereign sub-sample in the linear regression). The value of the coefficient of the rating variable multiplied by the dummy is quite larger than the value of the coefficient of the rating variable on its own in the linear specification, thus indicating a potentially very strong threshold impact of ratings. This indeed indicates that the influence of the rating on the level of the credit default swap rate varies significantly for low rated underlyings and high rated underlyings. This can be considered in line with some theoretical results from the structural form literature, which predict that low rated riskier debt behaves significantly differently from high rated debt. We find the same evidence in the sovereign sub-sample with the same magnitude of impact of a rating change for low rated debt in the linear specification. This variable is not significant for the rest of the sub-samples. It may be a first hint that US Corporates ratings may behave or be considered differently from the non US ones in the Credit Risk pricing market. This is due to the fact that non US Corporates include a wide range of underlyings for which credit risk pricing does not react in the same way to changes in their rating. Ratings do differ as far as their pricing impact on credit risk in the US versus non US Corporates. One should thus be wary of importing models fitted in one sample for use in the other sample.

The time to maturity is nearly never significant. It has a positive coefficient in the case where it is significant (whole sample in semi-log configuration), meaning that a longer time to maturity leads to a higher CDS rate (or

30

higher credit risk). The reason for the overall lack of significance might be coming from the fact that we are working on initial offering prices of CDS. The standard maturity of these contracts is 5 years. About half of our observations have a time to maturity of five years or a value very close to 5 years. We have also tested for the impact of a variable constituted of the dummy variable multiplied by the time variable. The idea is to test whether the maturity has a different impact for low rated underlyings and for high rated underlyings, as would be expected from structural form models. We did not obtain significant results, which may point once more to a sample problem as far as maturity is concerned. Finally we have tested the possibility that the influence of time is more complicated than assumed by a simple regression. We have introduced dummies for various time bands. However the more complicated structure did not yield any better results. Nearly all of the coefficients were insignificant. The reason for this could be the same as mentioned above.

Our next regressions investigate more precisely the presence of non linear effects in ratings. We first regress our CDS spreads on credit rating dummies representing rating classes (whenever we had enough observations we have done the same test at the one-notch difference instead of the one-class difference with similar results). We have each time omitted the worst rating class so that the constant in the regression represents the coefficient to that class. Table 3 gives the results. On the whole sample, each rating class appears significant except for one. High ratings have a negative coefficient as expected (lower spread than the worst class) but non linearities appear (the top 3 classes do not differ much from each other while the lower classes clearly differ from the higher ones). Nonetheless some incongruities (such as the fact that the BB class requires a higher spread than the B class) may be linked to the mix of truly different data such as sovereign, US and non US corporates. Regressions on each sample separately show strongly different behaviors for each subsample. In US corporates, there is a clear distinction (that we will use further) between high (AAA to A) and low (BBB and lower) ratings, with seemingly no strong difference between the high ratings (except for the AAA class that stands somewhat out) and no strong difference between the low ratings (although these non significant differences are ordered in means as expected). This further reveals the strong threshold effect that exists in US corporate ratings.

Ratings' impact on nonUS corporates spreads is somewhat more erratic

and bears less explanatory power, confirming results already found in the linear expression. Sovereign underlyings produce an almost picture perfect regression of what would expect from ratings' impact, with a significant impact of each class, close to linear differences from one class to the other (except for the closeness of the two top classes) and a strong overall explanatory power. Ratings do matter for sovereign underlyings, their impact is consistent with common expectations and threshold effects do not seem as important as for US corporates.

Explanatory Variables	Whole Sample		Corporate	
Dependent Variable				
	CDSR	Log(CDSR)	CDSR	Log(CDSR)
Constant	**0.0131**	**-4.8999**	**0.0131**	**-4.8999**
	(0.00)	**(0.00)**	**(0.00)**	**(0.00)**
AAA	**-0.0109**	**-4.8999**	**-0.0115**	**-1.5646**
	(0.00)	**(0.00)**	**(0.00)**	**(0.00)**
AA	**-0.0103**	**-1.1054**	**-0.0103**	**-1.0682**
	(0.00)	**(0.00)**	**(0.00)**	**(0.00)**
A	**-0.0092**	**-0.7982**	**-0.0093**	**-0.8219**
	(0.00)	**(0.00)**	**(0.00)**	**(0.00)**
BBB	0.0001	0.2158	-0.0009	0.1176
	(0.98)	(0.30)	(0.78)	(0.58)
BB	**0.0199**	**1.3484**	0.0075	**0.8927**
	(0.00)	**(0.00)**	(0.12)	**(0.00)**
Adjusted R^2	0.33	0.47	0.20	0.38
White correction	x	x	x	x
Number of Observations	392	392	323	323
F-Statistic	**39.2339**	**70.0181**	**17.3403**	**41.2900**
	(0.00)	**(0.00)**	**(0.00)**	**(0.00)**

Explanatory Variables	Corporate US		Corporate Non US		Sovereign	
Dependent Variable						
	CDSR	Log(CDSR)	CDSR	Log(CDSR)	CDSR	Log(CDSR)
Constant	**0.0156**	**-4.9194**	**0.0121**	**-4.8915**	**0.0405**	**-3.2781**
	(0.00)	**(0.00)**	**(0.00)**	**(0.00)**	**(0.00)**	**(0.00)**
AAA	**-0.0139**	**-1.5451**			**-0.0380**	**-2.7680**
	(0.00)	**(0.00)**			**(0.00)**	**(0.00)**
AA	**-0.0124**	-0.9374	**-0.0095**	**-1.1976**	**-0.0394**	**-3.6089**
	(0.01)	(0.05)	**(0.01)**	**(0.00)**	**(0.00)**	**(0.00)**
A	**-0.0122**	-0.8982	**-0.0077**	**-0.7081**	**-0.0351**	**-2.1909**
	(0.01)	(0.06)	**(0.03)**	**(0.00)**	**(0.00)**	**(0.00)**
BBB	-0.0077	-0.1287	0.0048	0.3920	**-0.0248**	**-1.1553**
	(0.12)	(0.79)	(0.28)	(0.10)	**(0.00)**	**(0.00)**
BB	-0.0018	0.4499	**0.0119**	**1.1156**		
	(0.81)	(0.49)	**(0.03)**	**(0.00)**		
Adjusted R^2	0.29	0.31	0.22	0.46	0.50	0.61
White correction	x	x	x	x	x	x
Number of Observations	166	166	157	157	69	69
F-Statistic	**14.5118**	**16.0229**	**12.0659**	**33.7427**	**18.1860**	**27.4515**
	(0.00)	**(0.00)**	**(0.00)**	**(0.00)**	**(0.00)**	**(0.00)**

Table 3: Results of the estimation of the following equation on the whole sample and the subgroups (on the credit default Swap rate and the log of it): $CDSR = cons\tan t + AAA \cdot dummy + AA \cdot dummy + A \cdot dummy + BBB\ dummy + BB\ dummy$

Overall, it is remarkable that with ratings only we are able to explain up to 67 percent of the variation in our sample (and a minimum of 27 percent). The highest values are observed for the sovereign sub-sample. It is also noticeable that our subsamples vary widely in behaviors, US corporates presenting a clear threshold effect in ratings, sovereign being influenced quasi linearly and non US corporates presenting the least clear relationship to ratings. And it becomes very clear that large variations in the sample, and notably in the corporate samples, are not explained by the rating. Investigating how successful other variables will be at approximating Credit Default Swap rates remains thus important.

6.2 The US interest rate, the slope of the yield curve and the credit spread

Most of the empirical papers predict an increase in the credit spread if the level of interest rate decreases. Other interest rate variables can be considered for which interpretation may be more complex. The influence of the slope of the yield curve can be seen as a proxy for the state of the economy. A steeper term structure of interest rates is associated with an improvement of the business climate while a flatter term structure would be associated with a decrease in the economic activity. We have also considered the spread between longterm AAA corporate bonds and longterm government bonds which is a direct measure for the riskiness of this rating class in the US (and thus a measure of minimal credit risk). In order to investigate the relationship we estimate the following equation:

$$
\begin{aligned}
CDSR = \ & cons\tan t + \alpha_0 \cdot dummy1 + \alpha_1 \cdot rating \\
& + \alpha_2 \cdot dummy_1 \cdot rating + \beta_1 \cdot short\_US \\
& + \beta_2 \cdot slope + \beta_3 \cdot Spread + \beta_4 \cdot time + \varepsilon
\end{aligned}
\tag{13}
$$

$$
\begin{aligned}
Log\,(CDSR) = \ & cons\tan t + \alpha_0 \cdot dummy1 + \alpha_1 \cdot rating \\
& + \alpha_2 \cdot dummy_1 \cdot rating + \beta_1 \cdot short\_US \\
& + \beta_2 \cdot slope + \beta_3 \cdot Spread + \beta_4 \cdot time + \varepsilon
\end{aligned}
\tag{14}
$$

where

$short\_US$	$level\ of\ the\ US\ short\ rate$
$slope$	$Slope\ of\ the\ yield\ curve\ defined\ as\ long\ rate - short\ rate$
$Spread$	$Spread\ of\ the\ average\ US\ AAA\ rated\ bond\ over\ the$ $long\ government\ rate$

The following table depicts the correlation of the three interest rate variables for all the groups.

Whole Sample

	Short rate	Slope	AAA Spread
Short rate	1.0000	-0.4238	-0.7241
Slope	-0.4238	1.0000	0.7736
AAA Spread	-0.7241	0.7736	1.0000

Corporate

	Short rate	Slope	AAA Spread
Short rate	1.0000	-0.4293	-0.7392
Slope	-0.4293	1.0000	0.7705
AAA Spread	-0.7392	0.7705	1.0000

Sovereign

	Short rate	Slope	AAA Spread
Short rate	1.0000	-0.4035	-0.6297
Slope	-0.4035	1.0000	0.8064
AAA Spread	-0.6297	0.8064	1.0000

US Corporate

	Short rate	Slope	AAA Spread
Short rate	1.0000	-0.5314	-0.7574
Slope	-0.5314	1.0000	0.7859
AAA Spread	-0.7574	0.7859	1.0000

Non US Corporate

	Short rate	Slope	AAA Spread
Short rate	1.0000	-0.3523	-0.7272
Slope	-0.3523	1.0000	0.7604
AAA Spread	-0.7272	0.7604	1.0000

Table 4: Correlations of the three interest rate variables for the whole sample and the subgroups.

Due to the fact that all these three variables are quite strongly correlated we might face the problem of multicolinearity. As is typical in such a case the three variables seem to be insignificant based on individual t-tests, but the whole group is highly significant. In order to obtain more reliable estimates of the influence of any of the three interest rate variables, we estimate an additional set of regressions with only one of them at a time. The following table shows the result for the US sub-sample.

Explanatory Variables	Dependent Variable							
	US Corporate CDSR	Log(CDSR)	US Corporate CDSR	Log(CDSR)	US Corporate CDSR	Log(CDSR)	US Corporate CDSR	Log(CDSR)
Constant	-0.0110	**-8.1623**	**0.0066**	**-5.4475**	-0.0032	**-7.1951**	**-0.0092**	**-8.2221**
	(0.15)	(0.00)	(0.02)	(0.00)	(0.07)	(0.00)	(0.00)	(0.00)
Dummy 1	**-0.0370**	**-1.5257**	**-0.0418**	**-2.2112**	**-0.0365**	**-1.3097**	**-0.0393**	**-1.7526**
	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.02)	(0.00)	(0.00)
Rating	**0.0010**	**0.1977**	**0.0010**	**0.1898**	**0.0010**	**0.1864**	**0.0011**	**0.2010**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Rating* Dummy 1	**0.0035**	**0.1254**	**0.0039**	**0.1822**	**0.0035**	**0.1108**	**0.0037**	**0.1424**
	(0.00)	(0.02)	(0.00)	(0.00)	(0.00)	(0.04)	(0.00)	(0.01)
US Short Rate	0.0454	2.3858	**-0.1407**	**-25.7281**				
	(0.57)	(0.82)	(0.00)	(0.00)				
Slope	0.7023	88.5725			**1.3391**	**213.3073**		
	(0.12)	(0.21)			(0.00)	(0.00)		
Spread AAA	0.4229	69.2721					**0.5452**	**91.6958**
	(0.11)	(0.06)					(0.00)	(0.00)
Time	0.0000	0.0035	0.0000	0.0012	0.0000	0.0036	0.0000	0.0031
	(0.85)	(0.14)	(0.46)	(0.60)	(0.96)	(0.10)	(0.93)	(0.15)
Adjusted R^2	0.72	0.58	0.70	0.55	0.72	0.57	0.72	0.58
White correction	x				x		x	
Number of Observations	145	145	145	145	145	145	145	145
F-Statistic	**53.3400**	**29.3500**	**67.0600**	**35.6700**	**73.4300**	**39.1500**	**73.9500**	**40.8800**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

Table 5: Results of the estimation of the following equation for the US sub-sample (on the credit default Swap rate and the log of it):

$$CDSR = cons \tan t + \alpha_0 \cdot dummy1 + \alpha_1 \cdot Rating + \alpha_2 \cdot dummy_1 \cdot Rating$$
$$+\beta_1 \cdot short\_US + \beta_2 \cdot Slope + \beta_3 \cdot Spread + \beta_4 \cdot Time$$

The table includes the results of restricted regressions where some of explanatory variables are excluded.

The whole group of interest rate variables is highly significant as shown by a Fisher test as well as a Wald test, but the individual variables appear to be insignificant when included at the same time. However all the interest rate variables are highly significant when used one by one in the regressions. This is probably linked to the high multicolinearity exposed in Table 4.

The short rate is negatively related to the CDS rate. Higher interest rates lead to lower CDS rates, or to lower credit risk. An interpretation for this could be that the interest rate is correlated to positive macroeconomic

prospects. Interestingly though, the impact of the short rate on the CDS rate of US corporates is much higher for highly rated corporates than for low rated corporates where it becomes insignificant. This may be linked to the fact that low rated corporates are very sensitive to their financing costs which increase significantly as rates increase. It shows that interest rates' impact on credit risk matters overall but is rather complex.

The AAA spread has a positive sign as expected. Therefore we confirm the findings of previous empirical research for the US sub-sample. The adjusted R^2 of the regressions increases significantly due to the inclusion of the interest rate variables. Therefore a pricing model of credit default swaps should include at least some information related to the rating and the interest rate environment. However all the three interest rate variables have similar explanatory power for the US sub-sample. Therefore we can not conclude that one is more important that the other two,as we could have expected from their high correlations. The results of the estimation for the whole sample are shown below.

Explanatory Variables	Dependent Variable							
	Whole Sample		Whole Sample		Whole Sample		Whole Sample	
	CDSR	Log(CDSR)	CDSR	Log(CDSR)	CDSR	Log(CDSR)	CDSR	Log(CDSR)
Constant	0.0193	-5.6583	0.0137	-5.2813	-0.0045	-7.3613	-0.0121	-8.3492
	(0.04)	(0.00)	(0.00)	(0.00)	(0.08)	(0.00)	(0.01)	(0.00)
Dummy 1	-0.0096	0.3088	-0.0072	0.2758	-0.0034	0.8212	-0.0034	0.6787
	(0.58)	(0.68)	(0.67)	(0.71)	(0.84)	(0.24)	(0.84)	(0.33)
Rating	0.0017	0.2552	0.0017	0.2544	0.0016	0.2449	0.0017	0.2530
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Rating* Dummy 1	0.0018	-0.0111	0.0016	-0.0087	0.0013	-0.0512	0.0013	-0.0395
	(0.25)	(0.86)	(0.28)	(0.89)	(0.38)	(0.39)	(0.37)	(0.51)
US Short Rate	-0.4204	-32.7086	-0.3499	-36.0653				
	(0.00)	(0.00)	(0.00)	(0.00)				
Slope	-1.2510	-4.7787			0.0896	124.7125		
	(0.09)	(0.93)			(0.88)	(0.00)		
Spread AAA	0.0143	14.4605					0.5278	82.3000
	(0.97)	(0.64)					(0.03)	(0.00)
Time	0.0000	0.0031	0.0000	0.0031	0.0000	0.0042	0.0000	0.0038
	(0.98)	(0.04)	(0.92)	(0.05)	(0.64)	(0.01)	(0.69)	(0.01)
Adjusted R^2	0.43	0.60	0.43	0.60	0.40	0.56	0.40	0.58
White correction	x	x	x	x	x	x	x	
Number of Observations	346	346	346	346	346	346	346	346
F-Statistic	38.2300	74.7200	52.5400	105.0600	46.1800	87.9600	47.8300	96.1900
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

Table 6: Results of the estimation of the following equation for the whole sample (on the credit default Swap rate and the log of it):

$$CDSR = cons \tan t + \alpha_0 \cdot dummy1 + \alpha_1 \cdot Rating + \alpha_2 \cdot dummy_1 \cdot Rating$$
$$+\beta_1 \cdot short\_US + \beta_2 \cdot Slope + \beta_3 \cdot Spread + \beta_4 \cdot Time$$

The table includes the results of restricted regressions where some of explanatory variables are excluded.

Only the US short rate is significant when we use all the three variables in the same regression. The whole group on the other hand has a significant influence in all the sub-samples. The individual regressions show a different picture. For the whole sample all of the interest rate variables are significant except the US slope in the linear regressions. For the non US corporate and the sovereign underlyings only the US short rate remains consistently significant. The US slope and the AAA spread lose their significance. This result is interesting as it indicates that for non US underlyings the US rate

matters in a sense as the world's risk free rate, but the slope and the spread , which we interpreted as proxies for the state of the US economy and the US credit risk, have no explanatory power. This keeps confirming the differences in behavior between US and non US Corporates. The following tables show the results for the non US corporate and the sovereign sub-samples.

	Dependent Variable							
Explanatory Variables	Non US Corporate		Non US Corporate		Non US Corporate		Non US Corporate	
	CDSR	Log(CDSR)	CDSR	Log(CDSR)	CDSR	Log(CDSR)	CDSR	Log(CDSR)
Constant	0.0418	-4.8317	0.0242	-5.1315	0.0038	-7.2570	-0.0033	-8.1416
	(0.01)	(0.00)	(0.00)	(0.00)	(0.47)	(0.00)	(0.65)	(0.00)
Dummy 1	0.0189	1.9928	0.0191	1.9954	0.0198	2.0610	0.0196	2.0177
	(0.61)	(0.13)	(0.59)	(0.12)	(0.59)	(0.11)	(0.59)	(0.11)
Rating	0.0015	0.2414	0.0016	0.2427	0.0014	0.2365	0.0015	0.2430
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Rating* Dummy 1	-0.0008	-0.1463	-0.0007	-0.1448	-0.0008	-0.1469	-0.0007	-0.1399
	(0.82)	(0.23)	(0.84)	(0.22)	(0.82)	(0.21)	(0.84)	(0.23)
US Short Rate	-0.5886	-39.0581	-0.4167	-36.1625				
	(0.00)	(0.00)	(0.00)	(0.00)				
Slope	-2.7390	-41.1720			-1.5481	55.9195		
	(0.09)	(0.65)			(0.17)	(0.37)		
Spread AAA	-0.2114	-4.4880					0.3081	71.2103
	(0.75)	(0.93)					(0.38)	(0.00)
Time	-0.0001	0.0018	-0.0001	0.0020	-0.0001	0.0046	-0.0001	0.0038
	(0.08)	(0.60)	(0.12)	(0.55)	(0.26)	(0.19)	(0.25)	(0.27)
Adjusted R^2	0.43	0.61	0.41	0.61	0.38	0.55	0.37	0.58
White correction	x	x	x	x	x	x	x	x
Number of Observations	134	134	134	134	134	134	134	134
F-Statistic	15.5800	30.3100	19.5700	42.8300	17.2600	33.8900	16.7800	37.0600
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

Table 7: Results of the estimation of the following equation for the non US corporate sample (on the credit default Swap rate and the log of it):
$$CDSR = cons \tan t + \alpha_0 \cdot dummy1 + \alpha_1 \cdot Rating + \alpha_2 \cdot dummy_1 \cdot Rating$$
$$+\beta_1 \cdot short\_US + \beta_2 \cdot Slope + \beta_3 \cdot Spread + \beta_4 \cdot Time$$
The table includes the results of restricted regressions where some of explanatory variables are excluded.

Explanatory Variables	Sovereign CDSR	Log(CDSR)	CDSR	Log(CDSR)	CDSR	Log(CDSR)	CDSR	Log(CDSR)
Constant	**0.0821**	-0.4657	**0.0317**	**-3.6534**	-0.0066	**-7.1548**	-0.0106	**-7.8869**
	(0.00)	(0.70)	**(0.00)**	**(0.00)**	(0.26)	**(0.00)**	(0.32)	**(0.00)**
Dummy 1	**-0.1572**	-2.6727	-0.1239	-0.6769	**-0.1231**	-0.1083	**-0.1164**	0.4946
	(0.00)	(0.31)	(0.17)	(0.84)	**(0.03)**	(0.98)	**(0.05)**	(0.90)
Rating	**0.0031**	**0.3503**	**0.0030**	**0.3454**	**0.0021**	**0.2734**	**0.0022**	**0.2817**
	(0.00)	**(0.00)**	**(0.00)**	**(0.00)**	**(0.00)**	**(0.00)**	**(0.00)**	**(0.00)**
Rating* Dummy 1	**0.0154**	0.2431	0.0125	0.0698	**0.0130**	0.0666	**0.0124**	0.0071
	(0.00)	(0.31)	(0.12)	(0.82)	**(0.01)**	(0.84)	**(0.02)**	(0.98)
US Short Rate	**-1.4214**	**-109.8740**	**-0.9105**	**-78.8030**				
	(0.00)	**(0.00)**	**(0.00)**	**(0.00)**				
Slope	-1.4794	-45.0359			-0.9462	20.9506		
	(0.41)	(0.67)			(0.48)	(0.81)		
Spread AAA	-1.6471	**-113.5704**					0.1515	50.2066
	(0.08)	**(0.04)**					(0.80)	(0.20)
Time	**0.0001**	**0.0066**	**0.0001**	**0.0057**	0.0001	0.0033	0.0001	0.0034
	(0.00)	**(0.00)**	**(0.00)**	**(0.00)**	(0.13)	(0.18)	(0.14)	(0.16)
Adjusted R²	0.77	0.84	0.72	0.80	0.63	0.65	0.63	0.66
White correction			x					
Number of Observations	67	67	67	67	67	67	67	67
F-Statistic	**32.0900**	**49.2500**	**35.0700**	**55.0800**	**23.3000**	**25.8800**	**23.0400**	**26.8800**
	(0.00)	**(0.00)**	**(0.00)**	**(0.00)**	**(0.00)**	**(0.00)**	**(0.00)**	**(0.00)**

Table 8: Results of the estimation of the following equation for the sovereign sample (on the credit default Swap rate and the log of it):

$$CDSR = cons\tan t + \alpha_0 \cdot dummy1 + \alpha_1 \cdot Rating + \alpha_2 \cdot dummy_1 \cdot Rating$$
$$+\beta_1 \cdot short\_US + \beta_2 \cdot Slope + \beta_3 \cdot Spread + \beta_4 \cdot Time$$

The table includes the results of restricted regressions where some of explanatory variables are excluded.

6.3 The influence of foreign interest rates

We have found evidence that the slope of the US yield curve is significant for the US sub-sample. However it is not significant for non US underlyings. We want to test for the influence of non US interest rates. We have tested for the influence of the levels and the slopes of the yield curves of the following countries: Australian rates for Australian companies, Japanese rates for Asian companies, German rates for countries of continental Europe and British Pound rates for underlyings in the UK. The rates and the slopes of the individual country rates are highly correlated and we encounter the same kind of multicolinearity problems as with the US interest rate. Therefore we restrict ourselves to use only the level of the US short rate and the slopes of the individual country yield curves. We estimate the following equations:

$$
\begin{aligned}
CDSR = {}& cons\tan t + \alpha_0 \cdot dummy1 + \alpha_1 \cdot rating + \alpha_2 \cdot dummy_1 \cdot rating \\
& + \beta_3 \cdot short\_US + \beta_4 \cdot Au \cdot AuSlope + \beta_5 \cdot Ge \cdot GeSlope \\
& + \beta_6 \cdot JP \cdot JpSlope + \beta_7 UK \cdot UKSlope + \beta Time + \varepsilon \qquad (15)
\end{aligned}
$$

$$
\begin{aligned}
Log\left(CDSR\right) = {}& cons\tan t + \alpha_0 \cdot dummy1 + \alpha_1 \cdot Rating + \alpha_2 \cdot dummy_1 \\
& \cdot Rating + \beta_3 \cdot short\_US + \beta_4 \cdot Au \cdot AuSlope \\
& + \beta_5 \cdot Ge \cdot GeSlope + \beta_6 \cdot JP \cdot JpSlope \\
& + \beta_7 \cdot UK \cdot UKSlope + \beta_8 \cdot Time + \varepsilon \qquad (16)
\end{aligned}
$$

where

$short\_US$	level of the US short rate
$Au,\ Ge,\ Jp,\ UK$	Country Dummies
$Au,\ Ge,\ Jp,\ UKSlope$	Country Slopes

The results of the regressions are shown in the following table.

Explanatory Variables	Dependent Variable							
	Whole Sample		Sovereign		Corporate		Non US Corporates	
	CDSR	Log(CDSR)	CDSR	Log(CDSR)	CDSR	Log(CDSR)	CDSR	Log(CDSR)
Constant	0.0111	-5.5091	0.0199	-4.8481	0.0113	-5.5887	0.0222	-5.1642
	(0.01)	(0.00)	(0.05)	(0.00)	(0.02)	(0.00)	(0.00)	(0.00)
Dummy 1	-0.0038	0.4674	-0.1291	-0.6333	-0.0038	0.2400	0.0209	1.8121
	(0.82)	(0.54)	(0.01)	(0.77)	(0.82)	(0.75)	(0.55)	(0.03)
Rating	0.0017	0.2524	0.0026	0.3584	0.0012	0.1957	0.0015	0.2029
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Rating*Dummy1	0.0013	-0.0285	0.0128	0.0398	0.0012	0.0072	-0.0010	-0.1385
	(0.39)	(0.66)	(0.00)	(0.84)	(0.40)	(0.91)	(0.75)	(0.08)
US Short Rate	-0.2937	-30.7614	-0.5240	-51.0116	-0.2000	-23.4939	-0.2956	-24.1472
	(0.00)	(0.00)	(0.01)	(0.00)	(0.01)	(0.00)	(0.02)	(0.00)
AU*Slope AU	-2.7650	-144.7317			-1.8419	-92.9712	-4.6663	-305.7934
	(0.01)	(0.03)			(0.03)	(0.13)	(0.00)	(0.00)
GE*Slope GE	-0.4423	-55.0117	-1.9272	-139.8780	-0.1062	-51.2254	-1.5239	-176.5203
	(0.00)	(0.00)	(0.00)	(0.00)	(0.43)	(0.00)	(0.00)	(0.00)
JP*Slope JP	0.1640	31.3538	-0.6099	48.7801	0.4862	56.1647	-0.6186	-29.2604
	(0.52)	(0.07)	(0.57)	(0.35)	(0.07)	(0.00)	(0.07)	(0.27)
UK*Slope UK	0.3485	37.9199			0.0764	21.6882	1.2258	125.4778
	(0.06)	(0.08)			(0.70)	(0.30)	(0.00)	(0.00)
Time	0.0000	0.0036	0.0001	0.0053	-0.0001	0.0025	-0.0001	0.0044
	(0.75)	(0.02)	(0.01)	(0.00)	(0.19)	(0.29)	(0.22)	(0.11)
Adjusted R^2	0.44				0.37	0.56	0.45	0.70
White correction	x	x			x	x	x	
Number of Observations	346	346	67	67	279	279	134	134
F-Statistic	30.8300	63.1900	33.0300	77.3600	19.2300	39.9600	13.3200	34.7000
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

Table 9: Results of the estimation of the following equation for the whole sample and all the subgroups (on the credit default Swap rate and the log of it):

$$CDSR = cons\tan t + \alpha_0 \cdot dummy1 + \alpha_1 \cdot Rating + \alpha_2 \cdot dummy_1 \cdot Rating + \beta_3 \cdot short\_US + \beta_4 \cdot Au \cdot AuSlope + \beta_5 \cdot Ge \cdot GeSlope + \beta_6 \cdot JP \cdot JpSlope + \beta_7 UK \cdot UKSlope + \beta_8 Time$$

In general we find that the level of the short term US rate remains significant through out all the sub-samples. All the additional yield curve slopes are significant except the Japanese slope. The Japanese slope is significant for the corporate sub-sample including or excluding US corporations. It is however not significant for the sovereign and the overall sample. The reason for the insignificance in the sovereign sub-sample might be due to the fact

that there are only five observations of credit default swaps on the Japanese government. The signs of the coefficient are as expected for the Australian and the German slopes. They are positive and thus support the view that a steeper yield curve is associated with improving business conditions, and thus associated with lower credit risk. The coefficient of the Japanese slope changes sign but is insignificant and thus we can not draw any additional conclusions. The sign of the UK slope is negative, while we observed an inverted term structure for the whole sample period in the UK.

We find evidence that the US interest rate has a strong influence on credit default swap rates even after controlling for the effects of the local term structure. The slope of the local term structure adds additional information. We have interpreted the slope of the yield curve as an indicator of future economic conditions. As the US and the rest of the world are not at the same stage in the business cycle, the economic outlook for the various economies is different. The finding that the slope of the local interest rates matter is consistent with this interpretation.

6.4 The variance

Although we do not test for any specific models in this paper, it is interesting to investigate further stylized facts expected from theoretical models. Most of the structural form models predict that an increase in the variability of the firm's asset value leads to higher credit risk. We use the historical variance as a proxy for the variability of the firm value. All the variables used so far were not firm specific. Even if the rating encompasses theoretically all the relevant information contained in the stock price, it is a very sluggish measure of credit quality. The information contained in the stock price gets updated almost instantly on the arrival of new information relevant to the underlying firm. Therefore we expect that the variance and the other stock price related variables add information because they are firm specific and up to date. Variance and other stock related variables are at the center of the structural form models of credit risk (and can be incorporated in reduced form models).

We estimate the following equation

$$
\begin{aligned}
CDSR \;=\; & cons\tan t + \alpha_0 \cdot dummy1 + \alpha_1 \cdot Rating \\
& + \alpha_2 \cdot dummy_1 \cdot Rating + \beta_1 \cdot short\_US \\
& + \beta_4 \cdot Var + \beta_5 \cdot Time + \varepsilon
\end{aligned}
\tag{17}
$$

$$
\begin{aligned}
Log\,(CDSR) \;=\; & cons\tan t + \alpha_0 \cdot dummy1 + \alpha_1 \cdot Rating \\
& + \alpha_2 \cdot dummy_1 \cdot Rating + \beta_1 \cdot short\_US \\
& + \beta_4 \cdot Var + \beta_5 \cdot Time + \varepsilon
\end{aligned}
\tag{18}
$$

where

$$Var \quad Annualized\ variance\ of\ the\ stock\ returns$$

The following table depicts the results of the regressions.

Explanatory Variables	Dependent Variable					
	Corporate		US Corporate		Non US Corporate	
	CDSR	Log(CDSR)	CDSR	Log(CDSR)	CDSR	Log(CDSR)
Constant	**0.0064**	**-5.8587**	0.0039	**-5.7593**	0.0082	**-5.9863**
	(0.03)	**(0.00)**	(0.13)	**(0.00)**	(0.15)	**(0.00)**
Dummy 1	-0.0116	-0.3367	**-0.0326**	-1.1074	0.0258	1.2656
	(0.45)	(0.61)	**(0.00)**	(0.08)	(0.61)	(0.53)
Rating	**0.0012**	**0.2192**	**0.0012**	**0.2106**	**0.0010**	**0.2312**
	(0.00)	**(0.00)**	**(0.00)**	**(0.00)**	**(0.00)**	**(0.00)**
Rating*Dummy1	0.0014	0.0152	**0.0029**	0.0653	-0.0015	-0.1102
	(0.24)	(0.78)	**(0.00)**	(0.26)	(0.72)	(0.52)
US Short Rate	**-0.2095**	**-26.5179**	**-0.1667**	**-28.7906**	-0.1671	**-24.3960**
	(0.00)	**(0.00)**	**(0.00)**	**(0.00)**	(0.14)	**(0.00)**
Variance	**0.0345**	**1.8661**	**0.0192**	**2.3548**	**0.0412**	**1.7225**
	(0.00)	**(0.00)**	**(0.01)**	**(0.00)**	**(0.00)**	**(0.00)**
Time	-0.0001	0.0016	0.0000	0.0020	-0.0001	0.0009
	(0.14)	(0.47)	(0.70)	(0.38)	(0.12)	(0.84)
Adjusted R^2	0.56	0.62	0.76	0.61	0.56	0.63
White correction	x	x	x		x	
Number of Observations	241	241	131	131	110	110
F-Statistic	**51.8393**	**66.2826**	**68.8475**	**35.1568**	**24.1007**	**32.5349**
	(0.00)	**(0.00)**	**(0.00)**	**(0.00)**	**(0.00)**	**(0.00)**

Table 10: Results of the estimation of the following equation for the corporate sub-samples (on the credit default Swap rate and the log of it):

$$CDSR = cons\tan t + \alpha_0 \cdot dummy1 + \alpha_1 \cdot Rating + \alpha_2 \cdot dummy_1 \cdot Rating + \beta_3 \cdot short\_US + \beta_4 \cdot Variance + \beta_5 Time$$

Explanatory Variables	Dependent Variable							
	US High		US Low		Non US High		Non US Low	
	CDSR	Log(CDSR)	CDSR	Log(CDSR)	CDSR	Log(CDSR)	CDSR	Log(CDSR)
Constant	**0.0071**	**-5.0643**	-0.0037	**-5.0721**	0.0013	**-6.4395**	0.0381	**-3.4724**
	(0.00)	**(0.00)**	(0.67)	**(0.00)**	(0.58)	**(0.00)**	(0.20)	**(0.01)**
Rating	0.0003	0.0891	**0.0022**	**0.1416**	**0.0006**	**0.1729**	0.0017	**0.1348**
	(0.08)	(0.05)	**(0.00)**	**(0.00)**	**(0.00)**	**(0.00)**	(0.18)	**(0.04)**
US Short Rate	**-0.1227**	**-29.5465**	-0.2148	**-29.5358**	-0.0543	-14.8300	-0.4678	**-38.8352**
	(0.00)	**(0.00)**	(0.15)	**(0.02)**	(0.13)	(0.09)	(0.05)	**(0.00)**
Variance	0.0043	0.8057	**0.0354**	**3.3696**	0.0017	0.4566	**0.0411**	**1.7132**
	(0.17)	(0.29)	**(0.00)**	**(0.00)**	(0.48)	(0.45)	**(0.00)**	**(0.03)**
Time	0.0000	0.0042	0.0000	-0.0025	**0.0000**	**0.0078**	-0.0004	-0.0129
	(0.64)	(0.11)	(0.36)	(0.56)	**(0.04)**	**(0.02)**	(0.14)	(0.29)
Adjusted R^2	0.16	0.20	0.69	0.54	0.27	0.32	0.59	0.51
White correction			x				x	x
Number of Observations	81	81	50	50	75	75	35	35
F-Statistic	**4.8220**	**5.9119**	**28.7181**	**15.2710**	**7.7096**	**9.5905**	**13.2807**	**9.7422**
	(0.00)	**(0.00)**	**(0.00)**	**(0.00)**	**(0.00)**	**(0.00)**	**(0.00)**	**(0.00)**

Table 11: Results of the estimation of the following equation for the US sub-sample and the US high and low rated sub-samples (on the credit default Swap rate and the log of it):

$$CDSR = cons\tan t + \alpha_0 \cdot Rating + \beta_3 \cdot short\_US + \beta_4 \cdot Variance + \beta_5 Time$$

The influence of the variance of the underlying stock price is positive and significant for all the sub-samples, whether US or non US Corporates, in the linear or semi log specification. The coefficient is higher for the non US corporates. The contribution to the overall explanatory power of the regression is quite high on an already remarkable level. The result is a clear indication that firm specific information matters and the prediction of the structural form models is verified in our sample. Firm volatility adds information beyond what is captured in ratings for the pricing of Credit Default Swaps. We have also tested for different shapes for the relationship. For example, we have tested the influence of the volatility with and without the variance. If the volatility is included instead of the variance it is significant and has a positive coefficient. In combination with the variance both are significant. However the volatility has a negative coefficient. We have tested for the influence of the variance raised to a higher power. However these terms are not significant beyond the variance.

6.5 Stock price changes

The variance measures the overall variability of the past stock prices. It contains no information if the future prospects of the firm have improved or worsened. A booming firm can have the same variance as a firm on the verge of bankruptcy. The influence of past stock prices can be seen from several perspectives. A decrease in the stock price will lead to a smaller equity and without a reduction in the amount of outstanding debt to an increase in leverage. On the other hand a decline in the stock price can indicate a worsening in the prospects of a firm. The third possible influence is from the demand side. A decline of the stock price might induce bondholders to seek protection from credit risk. A stronger decline might lead to more demand an thus raise the price, e.g. the credit default swap rate.

In order to test for the information contained in the returns on the stock prior to the trading date of the credit default swap, we include the market adjusted change in the stock price during the year before the trade. We adjust the change in the stock price for the change in the associated market index. We estimate the following regressions:

$$
\begin{aligned}
CDSR \;=\; & cons\tan t + \alpha_0 \cdot dummy1 + \alpha_1 \cdot Rating + \alpha_2 \cdot dummy_1 \cdot Rating \\
& + \beta_1 \cdot short\_US + \beta_4 \cdot Var + \beta_5 \cdot mch1year + \beta_7 \cdot Time \quad (19)
\end{aligned}
$$

$$
\begin{aligned}
Log\,(CDSR) \;=\; & cons\tan t + \alpha_0 \cdot dummy1 + \alpha_1 \cdot rating + \alpha_2 \cdot dummy_1 \cdot Rating \\
& + \beta_1 \cdot short\_US + \beta_4 \cdot Var + \beta_5 \cdot mch1year + \beta_7 \cdot Time \quad (20)
\end{aligned}
$$

where

$$mch1\ year \quad market\ adjusted\ 1\ year\ change$$

We have tested different time intervals to calculate the return on the stock. In general the longer the calculation period the more significant the influence. We adjust the returns on the stock for the return on the market in order to control for market wide changes in the economy. The results obtained with or without the market adjustment do not vary significantly. Moreover the changes in the stock price remain significant and of the same sign. Market

adjusted results are somewhat more significative though, showing that underperformance related to the market may drive credit risk somewhat more that absolute underperformance. The following table shows the results of the estimation using market adjusted changes.

| Explanatory Variables | Dependent Variable | | | |
| | US | | Non US | |
	CDSR	Log(CDSR)	CDSR	Log(CDSR)
Constant	0.0027	**-5.8580**	0.0031	**-6.3358**
	(0.31)	**(0.00)**	(0.54)	**(0.00)**
Dummy 1	**-0.0392**	**-1.6504**	0.0244	1.1690
	(0.00)	**(0.04)**	(0.62)	(0.56)
Rating	**0.0012**	**0.2095**	**0.0010**	**0.2287**
	(0.00)	**(0.00)**	**(0.01)**	**(0.00)**
Dummy 1 * Rating	**0.0036**	0.1186	-0.0011	-0.0821
	(0.00)	(0.11)	(0.78)	(0.63)
US Short Rate	**-0.1435**	**-26.8879**	-0.0641	**-17.3576**
	(0.01)	**(0.00)**	(0.56)	**(0.02)**
Variance	**0.0175**	**2.2153**	**0.0374**	**1.4678**
	(0.01)	**(0.00)**	**(0.00)**	**(0.01)**
1 year changes	**-0.0013**	-0.1103	**-0.0061**	**-0.4157**
	(0.01)	(0.26)	**(0.00)**	**(0.01)**
Time	0.0000	0.0022	-0.0001	0.0012
	(0.83)	(0.34)	(0.12)	(0.77)
Adjusted R^2	0.76	0.61	0.59	0.66
White correction	x		x	
Number of Observations	131	131	110	11
F-Statistic	**61.1148**	**30.3847**	**23.3277**	**30.9352**
	(0.00)	**(0.00)**	**(0.00)**	**(0.00)**

Table 12: Results of the estimation of the following equation for the US sub-samples (on the credit default Swap rate and the log of it):
$$CDSR = cons\tan t + \alpha_0 \cdot dummy1 + \alpha_1 \cdot Rating + \alpha_2 \cdot dummy_1 \cdot Rating + \beta_3 \cdot short\_US + \beta_4 \cdot Variance + \beta_5 \cdot 1\ year\ market\ adjusted\ changes + \beta_6 \cdot Time$$

The change in the stock price is significant for all the subgroups. The 1 year change has a negative sign pointing to the fact that an increase in the stock price is associated with a lower credit risk while a decrease leads to a

higher risk. (We also looked at absolute changes which have positive sign and are significant, even when used with relative changes, showing that both the direction and the size of the change matter. We do not reproduce these here as absolute changes capture essentially the same element as variance or volatility does).

6.6 Leverage

One of the interpretations of why past stock returns may have explanatory power for the credit default swap rate could be linked to their effect on leverage. Most of the structural form models use the ratio of market value of equity and debt value as an indicator of default probability (distance to default). We use the ratio of market value of equity and debt as a proxy for leverage. We restrict ourselves to the US sub-sample for the following estimation for two reasons. Leverage is strongly dependent on the country and the industry, for accounting, tax and agency reasons. A country with large conglomeratesincluding a house bank may view a higher leverage as more acceptable than an economy with independent banks for agency reasons. Secondly as the debt value is almost always produced as an accounting number it depends strongly on the accounting principles used in every country. In order to have a somewhat reliable number we restrict the following estimation to the US sub-sample hoping the US accounting principle (US GAAP) provides a reliable estimate of the true leverage. We estimate the following equation:

$$
\begin{aligned}
CDSR \quad = \quad & cons\tan t + \alpha_0 \cdot dummy1 + \alpha_1 \cdot rating + \alpha_2 \cdot dummy_1 \cdot rating \\
& + \beta_1 \cdot short\_US + \beta_4 \cdot Var \\
& + \beta_5 \cdot mch1year + \beta_6 \cdot Lev + \beta_8 \cdot time \quad\quad\quad (21)
\end{aligned}
$$

$$
\begin{aligned}
Log\,(CDSR) \quad = \quad & cons\tan t + \alpha_0 \cdot dummy1 + \alpha_1 \cdot Rating + \alpha_2 \cdot dummy_1 \cdot Rating \\
& + \beta_1 \cdot short\_US + \beta_4 \cdot Variance \\
& + \beta_5 \cdot mch1year + \beta_6 \cdot Lev + \beta_8 \cdot time \quad\quad\quad (22)
\end{aligned}
$$

where

$$ Lev \quad Total\ Liabilities/Market\ value\ of\ equity $$

Table 13 shows the results of the regressions.

	Dependent Variable	
Explanatory Variables	**US**	
	CDSR	**Log(CDSR)**
Constant	0.0015	-6.0825
	(0.56)	**(0.00)**
Dummy 1	**-0.0413**	**-1.7519**
	(0.00)	**(0.03)**
Rating	**0.0012**	**0.2129**
	(0.00)	**(0.00)**
Dummy 1 * Rating	**0.0037**	0.1179
	(0.00)	(0.11)
US Short Rate	**-0.1340**	**-23.8107**
	(0.01)	**(0.00)**
Variance	**0.0185**	**2.0712**
	(0.01)	**(0.00)**
1 year changes	**-0.0014**	-0.0736
	(0.01)	(0.46)
Leverage	**0.0001**	**0.0215**
	(0.05)	**(0.00)**
Time	0.0000	0.0023
	(0.83)	(0.30)
Adjusted R^2	0.78	0.64
White correction	x	
Number of Observations	121	121
F-Statistic	**53.8643**	**27.2423**
	(0.00)	**(0.00)**

Table 13: Results of the estimation of the following equation for the US sub-sample (on the credit default Swap rate and the log of it):

$$CDSR = cons\tan t + \alpha_0 \cdot dummy1 + \alpha_1 \cdot Rating + \alpha_2 \cdot dummy_1 \cdot Rating + \beta_3 \cdot short\_US + \beta_4 \cdot Variance + \beta_5 \cdot 1 \ year \ market \ adjusted \ changes + \beta_6 \cdot Leverage + \beta_7 \cdot Time$$

The results show that leverage has a significant influence on the credit default swap rates in our sample beyond the rating, interest rate and volatility information. More surprisingly we note that the influence of the stock price changes remains significant even after controlling for the leverage effects. Overall, including the different variables, interest rate variables as well as the firm specific variables such as variance of the value of the firm's assets,

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leverage and past stock price evolution improves the adjusted R^2 to a high level of 78% in the linear form. This result confirms that the variables that were provided by theoretical models do explain most of the variation in credit risk pricing.

6.7 The impact of liquidity as measured by market capitalization

As Credit Defaults Swaps constitute an exotic market where pricing is often attempted by replication and thus affected by the existence and the liquidity of the considered securities, we try to capture liquidity effects by a market capitalization proxy.

We estimate the following equations

$$
\begin{aligned}
CDSR &= cons\tan t + \alpha_1 \cdot Rating + \alpha_2 \cdot Market\ Capitalisation \\
Log\,(CDSR) &= cons\tan t + \alpha_1 \cdot Rating + \alpha_2 \cdot Market\ Capitalisation
\end{aligned}
$$

and

$$
\begin{aligned}
CDSR &= cons\tan t + \alpha_1 \cdot Rating + +\beta_1 \cdot short\_US \\
&\quad +\beta_2 \cdot Variance + \beta_3 \cdot Leverage \\
&\quad +\beta_4 \cdot Market\ Capitalisation + \beta_5 \cdot Time \\
Log\,(CDSR) &= cons\tan t + \alpha_1 \cdot Rating + +\beta_1 \cdot short\_US \\
&\quad +\beta_2 \cdot Variance + \beta_3 \cdot Leverage \\
&\quad +\beta_4 \cdot Market\ Capitalisation + \beta_5 \cdot Time
\end{aligned}
$$

The following tables show the results of the regressions.

	Dependent Variable					
Explanatory Variables	**US Corporate**		**US High Rated**		**US Low Rated**	
	CDSR	**Log(CDSR)**	**CDSR**	**Log(CDSR)**	**CDSR**	**Log(CDSR)**
Constant	**-0.0049**	**-6.4573**	**0.0029**	**-5.9730**	**-0.0200**	**-7.0157**
	(0.02)	**(0.00)**	**(0.00)**	**(0.00)**	**(0.00)**	**(0.00)**
Rating	**0.0016**	**0.1661**	0.0002	0.0713	**0.0031**	**0.2225**
	(0.00)	**(0.00)**	(0.15)	(0.08)	**(0.00)**	**(0.00)**
Market Capitalisation	-0.0019	**-3.4200**	**-0.0141**	**-3.6500**	-0.0034	-1.9400
	(0.85)	**(0.00)**	**(0.00)**	**(0.00)**	(0.94)	(0.68)
Adjusted R²	0.50	0.53	0.09	0.11	0.57	0.39
White correction	x	x				
Number of Observations	136	136	85	85	51	51
F-Statistic	**68.0376**	**75.6900**	**5.2564**	**6.2523**	**34.6708**	**16.6626**
	(0.00)	**(0.00)**	**(0.01)**	**(0.00)**	**(0.00)**	**(0.00)**

Table 14: Results of the estimation of the following equation for the US, the US high and low rated sub-samples (on the credit default Swap rate and the log of it): $CDSR = cons\tan t + \alpha_1 \cdot Rating + \alpha_2 \cdot market\ capitalisation$

Explanatory Variables	Dependent Variable US	
	CDSR	Log(CDSR)
Constant	-0.0038	**-5.0741**
	(0.73)	**(0.00)**
Rating	**0.0021**	**0.1251**
	(0.00)	**(0.00)**
US Short Rate	-0.1984	-28.4542
	(0.36)	(0.14)
Variance	**0.0388**	**3.8258**
	(0.00)	**(0.00)**
Leverage	-0.0001	-0.0009
	(0.81)	(0.97)
Market Capitalisation	0.0000	0.0000
	(0.74)	(0.89)
Time	0.0000	-0.0020
	(0.36)	(0.51)
Adjusted R^2	0.69	0.55
White correction	x	x
Number of Observations	49	49
F-Statistic	**18.9674**	**10.6315**
	(0.00)	**(0.00)**

Table 15: Results of the estimation of the following equation for the US sub-sample (on the credit default Swap rate and the log of it):
$$CDSR = cons\tan t + \alpha_1 \cdot Rating + \beta_1 \cdot short\_US + \beta_2 \cdot Variance + \beta_3 \cdot Leverage + \beta_4 \cdot Market\ Capitalisation + \beta_5 \cdot Time$$

The proxy is significant for high rated US corporates but not for the low rated ones. This could be a sign that liquidity effects are leading differences in high rated US corporates. Nonetheless, interpretation is not secure as significance drops in multivariate regressions, notably when they include leverage. Overall, liquidity effects as measured by this proxy do not seem to impact prices significantly in this market.

6.8 The overall impact of structural variables versus ratings

We further explore how structural variables (variance, leverage, time, and interest rate) fare in predicting CDS rates versus ratings (and time). Ratings are the most used source of information for credit risk and remain overall the single most useful source of explanatory power in our regressions indeed.

When considering the overall sample of US Corporates for example, ratings provide for a R^2 of 47% in the linear form while structural variables provide for 31%. These structural variables are not subsumed in ratings as combining them with ratings increases the explanatory power significantly to 65%.

Nonetheless, when considering subsamples, the picture changes and the importance of considering structural variables becomes even stronger. Looking at high rated US corporates, ratings have very low explanatory power (4%) and this explanatory power is subsumed in size differences as discussed above. On the other hand, structural variables (notably with the leverage variable) keep a high explanatory power of 48%. Regarding low rated corporates on the other hand, ratings do dominate while structural variables (notably the variance variable) help boost the explanatory power, thus further illustrating the strong threshold effect that affects US corporates.

We have still a different picture for non US corporates, illustrating once more the non homogeneity of credit risk and its complexity. Ratings in non US corporates matter and provide most of the explanatory power for the high rated corporates while most of the explanatory power is provided by structural variables (variance) for low rated corporates. Overall though, this confirms the importance of considering structural variables in determining credit risk spreads. Reduced form models, which have many advantages compared to structural models, notably as far as implementation is concerned, should thus incorporate structural variables in the way some of the most recent such models do (eg Jarrow and Turnbull (2000)). Structural models, on the other hand, can keep instructing us on the theoretical shape of the relationship between structural variables and credit risk.

Explanatory Variables	Dependent Variable					
	US Corporate		US Corporate		US Corporate	
	CDSR	Log(CDSR)	CDSR	Log(CDSR)	CDSR	Log(CDSR)
Constant	-0.0026	**-6.0050**	0.0020	**-5.3041**	**-0.0039**	**-6.8475**
	(0.46)	**(0.00)**	(0.70)	**(0.00)**	**(0.04)**	**(0.00)**
Rating	**0.0015**	**0.1851**			**0.0015**	**0.1833**
	(0.00)	**(0.00)**			**(0.00)**	**(0.00)**
Short Rate	-0.1119	**-22.1849**	-0.0178	-12.7241		
	(0.07)	**(0.00)**	(0.83)	(0.20)		
Variance	**0.0301**	**2.1428**	**0.0426**	**3.8898**		
	(0.00)	**(0.00)**	**(0.00)**	**(0.00)**		
Leverage	0.0001	**0.0215**	0.0000	0.0066		
	(0.06)	**(0.01)**	(0.80)	(0.56)		
Time	0.0000	0.0018	0.0000	-0.0019	0.0000	0.0032
	(0.80)	(0.43)	(0.19)	(0.58)	(0.83)	(0.19)
Adjusted R^2	0.65	0.61	0.31	0.18	0.47	0.48
White correction	x		x		x	
Number of Observations	121	121	124	124	145	145
F-Statistic	**45.6770**	**38.0248**	**14.7818**	**7.5544**	**63.9601**	**67.9813**
	(0.00)	**(0.00)**	**(0.00)**	**(0.00)**	**(0.00)**	**(0.00)**

Table 16: Results of the estimation of the following equation for the US corporate sub-sample (on the credit default Swap rate and the log of it):
$$CDSR = cons\tan t + \alpha_1 \cdot Rating + +\beta_1 \cdot short\_US + \beta_2 \cdot Variance + \beta_3 \cdot Leverage + \beta_5 \cdot Time$$

The estimations includes restricted versions of the above equation.

Explanatory Variables	Dependent Variable US High Rated		US High Rated		US High Rated	
	CDSR	Log(CDSR)	CDSR	Log(CDSR)	CDSR	Log(CDSR)
Constant	**0.0082**	**-4.9086**	**0.0088**	**-4.6740**	0.0009	**-6.6861**
	(0.00)	**(0.00)**	**(0.00)**	**(0.00)**	(0.45)	**(0.00)**
Rating	0.0001	0.0480			**0.0003**	**0.1008**
	(0.42)	(0.23)			**(0.05)**	**(0.01)**
Short Rate	**-0.1172**	**-26.9325**	**-0.1154**	**-26.2720**		
	(0.00)	**(0.00)**	**(0.00)**	**(0.00)**		
Variance	-0.0014	-0.4981	-0.0015	-0.5556		
	(0.62)	(0.47)	(0.58)	(0.42)		
Leverage	**0.0002**	**0.0350**	**0.0002**	**0.0364**		
	(0.00)	**(0.00)**	**(0.00)**	**(0.00)**		
Time	0.0000	0.0034	0.0000	0.0027	0.0000	**0.0075**
	(0.88)	(0.15)	(0.72)	(0.24)	(0.12)	**(0.01)**
Adjusted R^2	0.48	0.41	0.48	0.41	0.04	0.11
White correction						
Number of Observations	72	72	72	72	93	93
F-Statistic	**14.0574**	**10.8603**	**17.4979**	**13.1179**	2.7333	**6.4374**
	(0.00)	**(0.00)**	**(0.00)**	**(0.00)**	(0.07)	**(0.00)**

Table 17: Results of the estimation of the following equation for the US high rated sub-sample (on the credit default Swap rate and the log of it):
$CDSR = cons \tan t + \alpha_1 \cdot Rating + +\beta_1 \cdot short\_US + \beta_2 \cdot Variance + \beta_3 \cdot Leverage + \beta_5 \cdot Time$

The estimations includes restricted versions of the above equation.

Explanatory Variables	Dependent Variable					
	US Low Rated		US Low Rated		US Low Rated	
	CDSR	Log(CDSR)	CDSR	Log(CDSR)	CDSR	Log(CDSR)
Constant	-0.0028	**-5.0352**	0.0112	**-3.5627**	**-0.0168**	**-6.7855**
	(0.78)	**(0.00)**	(0.21)	**(0.00)**	**(0.00)**	**(0.00)**
Rating	**0.0021**	**0.1254**			**0.0030**	**0.2137**
	(0.00)	**(0.00)**			**(0.00)**	**(0.00)**
Short Rate	-0.2232	**-29.3923**	-0.2218	**-40.0958**		
	(0.21)	**(0.03)**	(0.17)	**(0.01)**		
Variance	**0.0388**	**3.8261**	**0.0657**	**5.8979**		
	(0.00)	**(0.00)**	**(0.00)**	**(0.00)**		
Leverage	-0.0001	-0.0006	0.0000	-0.0133		
	(0.83)	(0.98)	(0.91)	(0.65)		
Time	0.0000	-0.0020	0.0000	-0.0036	-0.0001	-0.0040
	(0.37)	(0.65)	(0.93)	(0.49)	(0.20)	(0.33)
Adjusted R^2	0.70	0.56	0.54	0.47	0.58	0.39
White correction	x		x			
Number of Observations	49	49	52	52	52	52
F-Statistic	**23.2495**	**13.0566**	**15.9900**	**12.1997**	**35.5099**	**17.5329**
	(0.00)	**(0.00)**	**(0.00)**	**(0.00)**	**(0.00)**	**(0.00)**

Table 18: Results of the estimation of the following equation for the US low rated sub-sample (on the credit default Swap rate and the log of it):
$$CDSR = cons \tan t + \alpha_1 \cdot Rating + + \beta_1 \cdot short\_US + \beta_2 \cdot Variance + \beta_3 \cdot Leverage + \beta_5 \cdot Time$$

The estimations includes restricted versions of the above equation.

7 Conclusions

We have investigated the influence of various factors on Credit Default Swap rates and therefore on credit risk as reflected in a recent credit derivative market. This paper reflects the complexity of credit risk, a risk that is not homogenous amongst underlyings (whether sovereigns or corporates, US and non US based).

Starting from theoretical models, we have identified some factors that should influence the CDS rates. We have compared econometrically the influence of those factors on various subgroups in our sample. We find that all of the theoretical factors have a significant influence and that taken together these factors drive much of the variation in the pricing of Credit Default Swaps (up to 82% despite our probably misspecified linear form).

The rating is the most important single source of information on credit risk, although all the other factors add significant information to ratings and matter more than ratings for some subgroups. This latter fact stresses the importance of alternative theories such as structural form credit risk theories (and the need to incorporate such variables in reduced form theories). Ratings themselves can have strong threshold effects as we find that the sensitivity of the level of credit default swap rates to ratings is different for high rated debt and for low rated debt. Hence a difference in rating for high quality US corporate underlyings can have close to no explanatory power while structural variables such as market value leverage do have explanatory power. In general such structural variables (variance notably for low rated underlyings) have explanatory power and are not subsumed in ratings. Sovereign and Corporates have different sensitivities to rating information and US and non US corporates show different behaviors in relationship to ratings (with threshold effects seemingly not as significant for non US corporates as for US corporates). US interest rates influence the credit default rates of all the subgroups, e.g. US rates do matter for credit default swap rates of underlyings from other countries. For US companies the level, the slope of the yield curve and the spread matter. For non US underlyings the level of the US rates is important, however the local slope of the yield curve matters more than the US slope. Considering the slope of the yield curve as an indicator of future economic activity this points to the fact that default is linked to the performance of the local economy, as would be expected. We

thus have further evidence that international credit risk markets are not homogenous and that national markets may differ both in behavioral structure (thresholds) as well as in the variables to consider (local term structures). As predicted by structural models the variance of the stock price is positively linked with the default swap rates. It adds specific information beyond what is contained in ratings and thus should be considered when estimating credit risk. Declines in the stock price are positively associated with the observed default swap rates. We find evidence that the size and the direction of the change in stock prices matter. Further in line with structural form models we find that leverage has a significant influence on the default swap rates. Even when we control for leverage and market index changes the influence of past stock price changes remains significant. Liquidity effects as measured by market capitalization do not seem to matter. Overall considering stochastic interest rates and what we call structural variables remains a necessity beyond the use of ratings for a good approximation of credit risk.

Further research will be needed to investigate the influence of maturity further, explore further the threshold and other non linearities present in the variables, and overall build a convincing and empirically practical model that will allow for more precise empirical testing of what drives credit risk.

7.1   References

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