Do the Recovery Rate and the Accounting Regime Matter for Pricing Corporate Bonds and Loans? Evidence from Models with Incomplete Accounting Information*

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Abstract

In this paper I examine the effect of different recovery rate assumptions and different accounting regimes on credit spreads in the context of credit risk models with incomplete accounting information. I derive a general pricing framework for corporate bonds/loans under different recovery rate assumptions and incomplete asset information. Furthermore, noise parameters for IAS, US GAAP, and German GAAP (HGB) are estimated under the assumption of a naive investor. I find that the recovery rate assumption matters for the pricing of corporate bonds/loans whereas the accounting regime matters only marginally. While the recovery rate assumption is important for long times to maturity, low reported asset values, and low previous year reported asset values, the effect of the accounting regime is particularly strong for short times to maturity. The effect of different accounting regimes is almost independent of the market in which the company is traded.

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Abstract

In this paper I examine the effect of different recovery rate assumptions and different accounting regimes on credit spreads in the context of credit risk models with incomplete accounting information. I derive a general pricing framework for corporate bonds/loans under different recovery rate assumptions and incomplete asset information. Furthermore, noise parameters for IAS, US GAAP, and German GAAP (HGB) are estimated under the assumption of a naive investor. I find that the recovery rate assumption matters for the pricing of corporate bonds/loans whereas the accounting regime matters only marginally. While the recovery rate assumption is important for long times to maturity, low reported asset values, and low previous year reported asset values, the effect of the accounting regime is particularly strong for short times to maturity. The effect of different accounting regimes is almost independent of the market in which the company is traded.

JEL: G12, G13, G33.

Keywords: Default risk, incomplete accounting information, recovery rates.

1 Introduction

In this paper, I examine the effect of different recovery rate assumptions and different accounting regimes on corporate bonds/loans in models with incomplete accounting information. Models with incomplete accounting information were first introduced by Duffie and Lando (2001). These models were the first to generate more realistic credit spreads in the framework of a structural model. In comparison to standard structural models, their main feature is that one can only observe noisy asset values instead of the true asset values. In this paper, I interpret the noisy asset value as accounting information.

One main goal of models with incomplete accounting information is to explain credit spreads observed in the corporate bond markets. Since they work reasonably well on this subject, models with incomplete accounting information could be used as an alternative to traditional rating systems to price loans for which no market values are observable. This can be done by reducing the information of the accounting report to estimates of the parameters in the model.

The problem with models with incomplete accounting information is that they depend on several parameters that are not easy to understand. I chose to focus on two of these parameters because very little is known about their effects: 1) the recovery rate and 2) the noise parameters. The recovery rate is one of the major pricing influences, and thus a natural object of interest. Often people do not even ask for the underlying recovery rate assumption. I want academics and practitioners to become sensitive to different pricing implications of the recovery rate assumption. The noise in the asset value process comes from the inability of any accounting regime to reflect the true value of a firm's assets. But how good and reliable is the accounting information? I thoroughly explore the question whether there are major differences in information between the accounting regimes. If there are, a natural question is how this influences the pricing of corporate bonds/loans.

To analyze the effect of the recovery rate assumption I derive a closed form valuation formula for corporate bonds under the assumption that the recovery payoff is a fraction of the face value of the bond (recovery of face value) and under the assumption that the recovery payoff is a fraction of the discounted face value of the bond (recovery of treasury). I therefore extend the work of Guha and Sbuelz (2003), who studied recovery rate assumptions in standard structural models, to cases where the asset value process cannot be observed. While a pricing formula for the recovery of treasury assumption is already given in Duffie and Lando (2001), the closed form pricing formula for the recovery of face value assumption is an innovation.

Besides the effect of different recovery rate assumptions I also analyze the effect of different accounting regimes in the context of models with incomplete information. Different accounting regimes can be represented by different noise parameters in the unobserved asset value process. Using data from the German stock market I estimate noise parameters for companies with different accounting regimes. Due to changes in regulation it is possible in Germany to use either German-GAAP (HGB), US-GAAP, or IAS. This particularity of the German accounting system makes it possible to compare the three accounting regimes in one market, without having to take into account different pricing across markets in different countries. This empirical study follows the accounting literature on value relevance (see e.g. Bartov, Goldberg and Kim (2005), and Alford, Jones, Leftwich and Zmijewski (1993)). The innovation in my approach is that I am guided by the question how informative the accounting regime is for asset values as compared to equity returns. I therefore use the assumption of a naive investor who takes the reported asset value as an estimate for the true asset value. This naive investor adjusts for the bias and the noise in the accounting report only through a rational parametrization of the noise process. He does not use further information that could be extracted from the accounting report like earnings, cash flow information etc.

For a naive investor, reported asset values for IAS are less downward biased than for German GAAP (HGB) and US GAAP. Additionally, IAS accounting reports are less noisy than German GAAP reports that again are less noisy than US GAAP reports. The estimated noise parameters are used as input parameters to generate hypothetical credit spreads. I further find that the accounting reports for companies that are traded on *Neuer Markt* are more noisy than for those trading on other markets.

With the parameters estimated for the different accounting regimes and the analytical bond pricing formulas, I compare the effect on hypothetical credit spreads for the different recovery rate assumptions and different accounting regimes. I find that the recovery of treasury assumption consistently generates higher credit spreads than the recovery of face value assumption. While the difference of the credit spreads increases with the time to maturity of the bond and decreases with reported asset value and the asset value in the pre-period, it is not clear how it reacts to variations in the accounting noise. This can be explained by the fact that the default probability is the critical variable for the credit spread difference. The reaction of the default probability to different levels of accounting noise depends on the concrete parametrization of the asset value process and the reported asset values. Comparing hypothetical credit spreads for different accounting regimes, I find that the accounting regime does matter only marginally and especially for a short time to maturity. The market in which the companies are traded influences the noise parameters but these differences are not big enough to see considerable credit spread differences between different markets.

The rest of the paper is organized as follows: Section 2 reviews different classes of credit risk models. Section 3 explains the main characteristics of the model of Duffie and Lando (2001) and states the main corporate bond pricing formulas for different recovery rate assumption in this framework. In Section 4, I explain the main characteristics of the analyzed accounting regimes, and estimate noise parameters for each accounting regime from German stock market data for a naive investor. Section 5 then analyzes the effect on hypothetical credit spreads for different recovery rate assumptions and accounting regimes while Section 6 concludes.

2 Credit Risk Models

Typically credit risk models are divided into structural models and reduced form models. Structural models have their roots in the models of Black and Scholes (1973) and Merton (1974). In these models, a default occurs if the value of the assets of a firm is lower than a given boundary. While in the original setting default is only possible at maturity, the model of Black and Cox (1976) allows for default before maturity. In their model, a default occurs when a stochastic asset value process hits a default boundary for the first time. Further extensions to these kinds of models are Leland (1994) and Leland and Toft (1996). In their papers, they allow the default event to be endogenous. Structural models have also shown to be successful in practice. The company KMV uses equity data information to estimate parameters for the underlying asset value processes. It is then possible to derive probabilities of default. A detailed description of the KMV methodology is given by Bohn and Crosby (2003). A common feature of structural models is that under the assumption that asset values follow a geometric Brownian motion, the default event is predictable. As a consequence, spreads of corporate bonds should tend to zero as maturities decline. But this is not observed in empirical studies.

This shortcoming of structural models is not present in reduced form models. In reduced form models, it is assumed that a default could happen throughout the lifetime of the bond, hence default is unpredictable. Default is modelled as the first jumptime of a point process. Default probabilities and recovery rates are assigned exogenously to the model. The derived pricing formulas can be calibrated to market data. Examples of reduced form models are Artzner and Delbaen (1995), Jarrow and Turnbull (1995), Jarrow, Lando and Turnbull (1997), Duffie and Singleton (1999), and Lando (1998). These models differ in the way the default time and the recovery rate are specified. Because reduced form models are calibrated to market data they can explain the observed credit spreads. A disadvantage of reduced form models is that they lag a deeper economic concept.

Besides these two model classes, hybrid models have evolved. Zhou (2001) incorporates a jump component to the asset value process. Other models try to explain the shortcomings of structural models by assuming that the true asset value is unobserved and that investors only receive a noisy signal about the asset value. The first who introduced these models with incomplete information were Duffie and Lando (2001). In their model, investors receive a noisy accounting signal about the asset value. Additionally, investors receive the information whether the company is in default or not. Duffie and Lando (2001) also show that in the case of incomplete information there exists a default intensity. This means that default is completely unpredictable. Giesecke (2005) extends this approach to cases where the default barrier is unobserved. In Collin-Dufresne, Goldstein and Helwege (2002) the asset values are observed with a lag. Further models with incomplete information include Giesecke and Goldberg (2004), and Cetin, Jarrow, Protter and Yildirim (2004). A study that empirically examines the prediction of models with incomplete information is Yu (2005).

3 The Recovery Rate in Models with Incomplete Accounting Information

3.1 Basics: The Model of Duffie and Lando (2001)

In their model, Duffie and Lando (2001) assume a fixed probability space $(\Omega, \mathcal{F}, P)$. Additionally, the assets V of a firm follow a geometric Brownian motion with drift μ and volatility σ under the physical probability measure. Under the risk neutral measure, the asset value process is given by

$$dV_t = mV_t dt + \sigma V_t d\widehat{W}, \tag{1}$$

where $m = \mu - \lambda\sigma$, λ is the market price of risk, and $\widehat{W}$ is a standard Wiener process under the risk neutral measure. Since the asset value process is not observed the market becomes incomplete. Therefore, the asset value process under the risk neutral measure depends on the the market price of risk. Default is modelled as the first time τ that the asset value process V hits a pre-specified default barrier V_b

$$\tau \equiv \inf(u > 0, V_u = V_b). \tag{2}$$

They assume further that investors cannot observe the asset value directly but instead receive a noisy accounting report $\widehat{V}$ at discrete points in time $t_1, \ldots, t_n$ where the largest n is set such that $t_n < t$. Furthermore, investors know if default has already occurred or not. Hence, their information set is not $\mathcal{F}$ but $\mathcal{H}$, where $\mathcal{F}$ is the information set containing the full information of the asset values and $\mathcal{H}$ is the information set containing only the incomplete asset information

$$\mathcal{H} = \sigma\left(\widehat{V}(t_1), \ldots, \widehat{V}(t_n), I_{\{\tau \leq s\}} : 0 \leq s \leq t\right). \tag{3}$$

The next goal is to calculate the conditional distribution of the assets given $\mathcal{H}$. Here, I present only the simple case of having received one single noisy information at time

$t = t_1$.[1] Following Duffie and Lando (2001) it is assumed that the noisy asset report $\widehat{V}$ can be decomposed in the way of

$$Y(t) = \ln \widehat{V}_t = Z(t) + U(t), \tag{4}$$

where $Z(t) = \ln(V_t)$, and $U(t)$ is normally distributed with mean $\overline{u}$ and standard deviation a and independent of $Z(t)$. Therefore, a measures the degree of accounting noise. The logarithm of the noisy asset value ($Y(t) = \ln \widehat{V}_t$) is normally distributed with mean $z_0 + mt + \bar{u}$ and variance $\sigma^2 t + a^2$. After some algebra and the multiple use of Bayes theorem one can derive the density $g(x|y, z_0, t)$ of Z_t conditional on the noisy information Y_t and on the fact that the company is not in default, i.e. $\tau > t$. z_0 stands for the logarithm of the true starting value of the process V_0, y stands for the logarithm of the observed value in the accounting report at time t, v_b stands for the logarithm of default barrier V_b, and Φ stands for the cumulative standard normal distribution. The density $g(x|y, z_0, t)$ is given in Lemma 1:

Lemma 1. *(Duffie and Lando 2001)*
The density $g(x|y, z_0, t)$ of Z_t conditional on the noisy information Y_t and on $\tau > t$ is given by

$$g(x|y, z_0, t) = \frac{\sqrt{\frac{\beta_0}{\pi}} e^{-J(\tilde{y}, \tilde{x}, \tilde{z}_0)} \left[1 - \exp(\frac{-2\tilde{z}_0\tilde{x}}{\sigma^2 t})\right]}{\exp\left(\frac{\beta_1^2}{4\beta_0} - \beta_3\right) \Phi\left(\frac{\beta_1}{\sqrt{2\beta_0}}\right) - \exp\left(\frac{\beta_2^2}{4\beta_0} - \beta_3\right) \Phi\left(-\frac{\beta_2}{\sqrt{2\beta_0}}\right)} \tag{5}$$

with

$$\begin{aligned}
J(\tilde{y}, \tilde{x}, \tilde{z}_0) &= \frac{(\tilde{y} - \tilde{x})^2}{2a^2} + \frac{(\tilde{z}_0 + (m - 0.5\sigma^2)t - \tilde{x})^2}{2\sigma^2 t} \\
\beta_0 &= \frac{a^2 + \sigma^2 t}{2a^2\sigma^2 t} \\
\beta_1 &= \frac{\tilde{y}}{a^2} + \frac{\tilde{z}_0 + (m - 0.5\sigma^2)t}{\sigma^2 t} \\
\beta_2 &= -\beta_1 + 2\frac{\tilde{z}_0}{\sigma^2 t} \\
\beta_3 &= \frac{1}{2}\left(\frac{\tilde{y}}{a^2} + \frac{\left(\tilde{z}_0 + (m - 0.5\sigma^2)t\right)^2}{\sigma^2 t}\right).
\end{aligned}$$

[1] Duffie and Lando (2001) give also an extension to multiple observation times.

The variables $\tilde{y}$, $\tilde{x}$, and $\tilde{z}_0$ stand for $y - v_b - \overline{u}$, $x - v_b$, and $z_0 - v_b$ respectively.

With the density $g(x|y, z_0, t)$ it is now possible to derive the conditional distribution of the assets given the noisy asset values and survival to time tt. This distribution will be used to generate bond/loan prices and credit spreads.

3.2 Valuation of Bonds with Different Recovery Rate Assumptions

An often neglected component in pricing bonds and loans is the recovery rate. In this subsection, I derive theoretical bond prices for different recovery rate assumptions. While the following analysis is made for zero coupon bonds, it could be made with minor changes for coupon bonds. In the related literature, three recovery rate assumptions are dominant:

- Recovery of market value model (RMV)
  In the RMV-model, recovery rates are modelled as a fraction of the market value of the bond immediately prior to default. This recovery rate assumption was first introduced by Duffie and Singleton (1999). The main advantage of this recovery rate assumption is that for reduced form models a default-adjusted short rate can be derived with simple manipulations of the risk-free rate.

- Recovery of face value model (RFV)
  In the RFV-model, recovery rates are modelled as a fraction of the face value of the bond. The recovery of face value assumption implies an absolute priority rule when it comes to reorganising the debt of the company. Early models that incorporate this recovery rate assumption are Brennan and Schwartz (1980), Duffie (1998), and Lando (1998).

- Recovery of treasury model (RT)
  In the RT-model, the recovery rate is modelled as a fraction of the discounted face value of a bond. It was first introduced in the context of reduced form models by Jarrow and Turnbull (1995).

In structural models, the RMV-model does not make much sense, because there are no jumps in the model, and therefore, the market value of the bond prior to default would always be the default barrier. Hence, I concentrate my analysis to the latter two assumptions.

For my analysis, I assume a corporate zero coupon bond P with face value F. To better analyze the effects of the recovery rate assumption, the bond price is partitioned into a part that depends on the recovery rate and a part that is independent of the recovery rate. The partitioned price of the bond at time t is

$$P_{t,T} = P_{t,T}^{ZRR} + P_{t,T}^{RR}. \tag{6}$$

The first part of equation (6) stands for the bond price, if we assume zero recovery rate (ZRR). For a zero coupon bond the price of the first part of equation (6) is given by

$$P_{t,T}^{ZRR} = B_t(T)F[1 - Q(\tau < T|\mathcal{H}_t)], \tag{7}$$

where $B_t(T)$ stands for the price of a riskless zero bond at time t with maturity T. Using the results from equation (5), we can write the conditional risk neutral probability $Q(\tau < T|\mathcal{H}_t)$ as

$$Q(\tau < T|\mathcal{H}_t) = 1 - \int_{v_b}^{\infty} [1 - \varphi(T - t, x - v_b)]g(x|Y_t, z_0, t)dx,, \tag{8}$$

where $\varphi(T - t, x - v_b)$ denotes the first passage probability from a initial condition x to v_b in the time interval $T - t$. The first passage probability can be written as[2]

$$\begin{aligned} \varphi(T - t, x - v_b) &= Q(\tau < T|\mathcal{F}_t) \\ &= 1 - \Phi(d_1) + \exp\left(\frac{-2(x - v_b)(m - 0.5\sigma^2)}{\sigma^2}\right)\Phi(d_2) \end{aligned} \tag{9}$$

[2]See for example Bielecki and Rutkowski (2002) or Harrison (1990) for details.

with

$$d_1 = \frac{x - v_b + (m - 0.5\sigma^2)(T-t)}{\sigma\sqrt{T-t}}$$

and

$$d_2 = \frac{-(x - v_b) + (m - 0.5\sigma^2)(T-t)}{\sigma\sqrt{T-t}}.$$

The second part of (6) depends on the concrete recovery rate assumption. For the RFV-Model, $P^{RR}_{t,T}$ is given by

$$P^{RR,RFV}_{t,T} = E^Q[I_{\{\tau<T\}} \exp(-r(\tau - t))\omega F|\mathcal{H}_t]. \tag{10}$$

Because of the assumption of a constant face value F and a constant recovery rate ω the face value and the recovery rate can be taken out of the expectation. This leaves us with the valuation problem of $E^Q[I_{\{\tau<T\}} \exp(-r(\tau - t))|\mathcal{H}_t]$ which is essentially the price of *down-and-in cash-at-the-hit option*[3] for a non-observed asset value process. A closed form solution for (10) is given in Proposition 1.

Proposition 1. *(RFV-model)*
For the RFV-model, the second part of (6) is given by:

$$\begin{aligned} P^{RR,RFV}_{t,T} &= E^Q[I_{\{\tau<T\}} \exp(-r(\tau - t))\omega F|\mathcal{H}_t] \\ &= \omega F \int_{v_b}^{\infty} E^Q[e^{-r(\tau-t)} I_{\{\tau<T\}}|\mathcal{F}_t] g(x|Y_t, z_0, t)dx, \end{aligned}$$

where $g(x|Y_t, z_0, t)$ is given by (5) and $E^Q[e^{-r(\tau-t)} I_{\{\tau<T\}}|\mathcal{F}_t]$ is given by

$$E^Q[e^{-r(\tau-t)} I_{\{\tau<T\}}|\mathcal{F}_t] = \left[e^{\frac{-\tilde{x}(\mu_* + \zeta)}{\sigma^2}} \Phi\left(\frac{-\tilde{x} + \zeta(T-t)}{\sigma\sqrt{T-t}}\right) + e^{\frac{-\tilde{x}(\mu_* - \zeta)}{\sigma^2}} \Phi\left(\frac{-\tilde{x} - \zeta(T-t)}{\sigma\sqrt{T-t}}\right)\right],$$

with $\tilde{x} = x - v_b$, $\zeta = \sqrt{\mu_*^2 + 2\sigma r}$, and $\mu_* = m - 0.5\sigma^2$.

[3] A *down-and-in cash-at-the-hit option* is a special type of barrier option. The option becomes active when the price of the underlying is below a pre-specified barrier. When the option becomes active it directly generates the payoff.

Proof. The proof of Proposition 1 is given in Appendix A.1. □

For the RT-model, the valuation of the second part of (6) becomes easier. Proposition 2 gives a closed form valuation formula.

Proposition 2. *(RT-model)*
The price of the second part of (6) $P_{t,T}^{RR}$ for the RT-model is given by

$$\begin{aligned} P_{t,T}^{RR,RT} &= E^Q[I_{\{\tau<T\}} \exp(-r(T-t))\omega F|\mathcal{H}_t] \\ &= \omega B_t(T) F Q(\tau < T|\mathcal{H}_t), \end{aligned}$$

where $Q(\tau < T|\mathcal{H}_t)$ is given explicitly by (8).

Proof. The proof of Proposition 2 is straight forward. Just note that the risk free rate r, the recovery rate ω, and the face value F are constants and can therefore be taken out of the expectation. □

4 Choosing Parameters

4.1 Base Case Parameters

The model derived in the previous section depends on several parameters. In the following analysis, I vary some of the parameters to show their influence on credit spreads. The base case parameters are summarized in Table 1.

For simplicity, the face value F is set to 100. For the recovery rate ω my base case is 0.5 which is often used by practitioners when there is no further information about the recovery rate. The values for the default barrier V_b, for previous year asset value V_0, and the noisy reported asset value $\hat{V}_t$ are set to 60, 86.3, and 86.3 respectively. For the time-to-maturity $T-t$ I assume a period of ten years. The constant risk free rate is set to 4%.

For the other parameters, I distinguish between value companies (Panel A) and growth companies (Panel B). The difference between the two are the choices for the asset volatility

σ and for the risk neutral drift rate m. I estimate the equity volatility for value companies and growth companies from a time series of the DAX30-Index and the NEMAX-Allshare-Index for the period 1998–2003 respectively. The equity volatility is then transferred into an asset volatility by assuming a leverage of 48.93%.[4] As a result I got an asset volatility of 14.4% for value companies and of 20.0% for growth companies. Furthermore, for value companies, I assume a risk neutral drift of 0.07 while the risk neutral drift for growth companies is set to 0.1. Hence, growth companies have a higher drift rate and a higher volatility rate than value companies.

For the analysis of the recovery rate assumptions, I use the noise parameters for IAS as a base case while I use the RFV assumption as a base case for the analysis of the accounting regimes.

4.2 Choosing the Noise Parameters for Different Accounting Regimes

4.2.1 Accounting Regimes

The true asset value process is very often not observable. Instead of the true asset value process, investors only have access to a noisy periodic accounting report. This accounting report has to fulfil accounting standards set either by the government or by private standard setters. The quality of information available to an investor depends on the accounting regime. In models with incomplete accounting information, the noise process $U(t)$ is completely specified by the parameters $\bar{u}$ and a. Usually these parameters depend on the concrete firm. But as firms have to fulfil the same accounting rules, it is possible to determine if there is a systematic difference in information for different accounting regimes. In an empirical study, I compare parameter estimates for the noise process for German GAAP, US GAAP, and International Accounting Standards (IAS).

Within the accounting literature, accounting regimes are classified into two models: (1) the shareholder model and (2) the stakeholder model. In the shareholder model, accounting rules are set in an accounting environment, and the main goal is to provide the public with all relevant information to invest in the particular stock of the company. In

[4] This is the average leverage of our sample companies.

comparison, under the stakeholder model, the accounting rules are set by the government and are usually also the basis for tax claims. While there is no pure model in practice, the German GAAP can be classified into the stakeholder model and US GAAP and IAS can be classified into the shareholder model.

Although we will refrain from exploring the details of the three accounting regimes, some general principles merit attention. Generally, the German GAAP follows the principle of prudence, which means that gains are accounted for when they are realized and losses are accounted for when it is possible that they might occur in the future. Because the German GAAP are also the basis for tax liability and German tax rates are progressive, firms have incentives to smooth their earnings. US GAAP and IAS are rather similar to each other. They are not the basis for tax liabilities and their goal is to provide investors with relevant information. Nevertheless, US GAAP and IAS are not equal. FASB (1999) found 250 key differences between the two.

4.2.2 Data

It is a challenge to get reasonable values for the noise parameters $\bar{u}$ and a. If we try to estimate noise parameters directly from market prices of bonds, we are left with the problem that we cannot assume the notion that the true asset value is unknown for public companies. This is so because investors are able to use the information of the stock market to infer the true asset value. Hence, all public companies would be excluded. On the other hand, there are not many companies left that issue bonds but that do not issue stocks. Additionally, it is not easy to get the necessary accounting information for privately held companies.

Because of these problems, I employed another methodology. Instead of using the bond market information directly, I try to obtain values for the noise parameters from equity markets. A big advantage of this approach is that accounting information for companies issuing equity is available. The idea behind this approach is that we expect that the accounting noise is similar for private and public companies. If this is true, I can calculate the *true* market values of the assets and compare them with the noisy signal from the accounting report. By doing this, one has to keep in mind that the only goal of this procedure is to derive reasonable noise parameters. Of course, models with incomplete information will not work for companies where we know the true asset value.

I use data from the Compustat (Global) Database for German companies for the years 1998–2003. I chose this time period because since 1998, German companies have been allowed to prepare their annual financial statements in accordance with either German GAAP, IAS, or US GAAP. A major advantage for using this particular sample is that we do not have to take into account different pricing across markets in different countries. Restricting my analysis to German companies leaves me with 3,035 company years of observation. Out of the 3,035 company years 1,639 companies report their financial statements in accordance to German GAAP, 866 companies report their financial statements in accordance to IAS, and 530 companies report their financial statements in accordance to US GAAP. 503 out of 866 IAS companies and 387 out of 530 US GAAP companies were traded on the *Neuer Markt*, a trading segment on the Frankfurt stock exchange for growth-oriented and innovative companies.

4.2.3 Parameter Estimation

We know from equation (4) that the observed asset value process can be decomposed into

$$Y(t) = \ln \widehat{V}_t = Z(t) + U(t), \tag{11}$$

where $Z(t) = \ln(V_t)$, and $U(t)$ is normally distributed with mean $\overline{u}$ and standard deviation a. If we interpret $\widehat{V}_t$ as the value given by the accounting report and V_t as the true value given by the market, we can calculate $U(t)$ for each company in our data set. Therefore I derive a sample of error terms U for each of the three accounting regimes. Using the information that U is normally distributed with mean $\bar{u}$ and standard deviation a, it is possible to get estimates for the two parameters. By the weak law of large numbers, the empirical mean of a random variable converges to its true mean if we have a large enough sample. The mean parameter $\bar{u}$ can then be easily and consistently estimated by

$$E[U] = \bar{u} = \frac{1}{N}\sum_{i=1}^{N} U_i. \tag{12}$$

Equivalently, the variance of the error term can be calculated as

$$Var[U] = a^2 = \frac{1}{N-1}\sum_{i=1}^{N}(U_i - \bar{u})^2. \tag{13}$$

While I found a general way to calculate the noise parameters, the concrete parametrization of the noise process should be firm dependent. Hence, a deeper knowledge and analysis of the company's financial statements would be necessary.

A naive investor might use the asset value reported in the accounting report as an estimate for the true asset value. The error term U_i can then be calculated as the difference between the logarithms of the book values of the assets (BV_i) and the market values of the assets (MV_i).

$$U_i = \ln(BV_i) - \ln(MV_i) \tag{14}$$

I calculate error terms for all companies in our sample. With the formulas in (12) and (13), we can then calculate the noise parameters $\bar{u}$ and a. The book values for every asset were directly reported in the Compustat (Global) Database. For market values, I used equity values 2.5 months[5] ahead of the report date plus the value of the total liabilities in the accounting report. Table 2 summarizes the noise parameter estimates for IAS, US GAAP, and German GAAP. We see that in the case of a naive investor the expectation of the noise process is negative for all three accounting regimes. This does not necessarily mean that the accounting information is biased. Note that we can rewrite equation (4) as

$$\begin{aligned} e^{(Y(t))} = e^{\ln \widehat{V}_t} &= e^{\ln V(t) + U(t)} \\ &= V(t)e^{U(t)}. \end{aligned} \tag{15}$$

[5]KPMG (2002) presents the results of a survey of European companies about the time the company needs from the end of the accounting year until publishing the report. According to this survey German companies needed 74 days on average in 2002 and 76 days in 1999 to publish their financial reports. For ease we assume for all years a constant time until publication of 2.5 months.

Taking expectations and assuming independence between $\ln(V(t))$ and $U(t)$ yields

$$
\begin{aligned}
E[\widehat{V}_t] &= E[V(t)]E[e^{U(t)}] \\
&= E[V(t)]e^{\bar{u}+0.5a^2}. \qquad (16)
\end{aligned}
$$

Hence the accounting information would be unbiased if $\bar{u} = -0.5a^2$. To get a measure for how biased the accounting information is, we added $e^{\bar{u}+0.5a^2}$ into the third line of Table 2.

We see that the accounting information is most biased for companies using US GAAP, followed by companies using German GAAP (HGB) and companies using IAS. The estimated values for $e^{\bar{u}+0.5a^2}$ for all three regimes is smaller than 1 which means that the value given in the accounting report is on average smaller than the true asset value.

Furthermore, Table 2 gives an estimate for the standard deviation a of the noise term. The standard deviation (noise) is smallest for IAS with 0.660 followed by HGB with 0.733 and US GAAP with 0.839.

To interpret the results, we have to keep in mind that a large fraction of the companies which use IAS and US GAAP are listed on the *Neuer Markt*.[6] Because the companies in the *Neuer Markt* are usually young and technology-oriented, it might be more difficult for an accounting report to reflect the true asset values. Therefore, I divide the sample in companies which are traded on the *Neuer Markt* and companies which are traded on other markets. Table 3 reports the results for the two sub-samples. We see that the accounting noise for *Neuer Markt* companies is indeed larger than for other companies. It further seems that the estimates for US GAAP are more biased than for IAS. For companies traded on other markets the estimated noise parameters for IAS and US GAAP are almost identical.

The estimates were found under the assumption of a naive investor, i.e. the investor uses the asset value reported in the accounting report as an estimate for the true asset

[6]There are no companies listed on the *Neuer Markt* which use German GAAP, because the Frankfurt stock exchange required all companies of the *Neuer Markt* to report their financial statements in accordance to US GAAP or IAS.

value. On first view, this assumption might look very strong and misleading. But this is not the case. The idea behind the derivation of the noise parameters is that the accounting information about the asset value is rationally set in comparison to the corresponding market value. I call the investor naive because he only uses the book value of the assets as the accounting signal. Alternatively, the investor could derive his own estimated accounting signal for every company. This could for example include cash flow statement and soft information from the accounting report. Nevertheless, he would then again rationally derive the noise parameters.

While the estimated parameters for the noise process are interesting, the major aim is to make a statement concerning the credit spreads for corporate bonds. I therefore use the estimated parameters to compare credit spreads for different accounting regimes.

5 Hypothetical Credit Spreads

5.1 Calculation of Credit Spreads

With the chosen parameters, it is now possible to generate credit spreads for different recovery rate assumptions and different accounting regimes. The Credit Spread is measured by the difference between the yield of treasury bonds and the yield of corporate bonds that are identical in all aspects except the credit quality. I calculate the credit spread CS as

$$CS = -\frac{1}{T-t} \ln\left(\frac{P_{t,T}}{F}\right) - r, \tag{17}$$

where $T - t$ stands for the time to maturity, $P_{t,T}$ stands for the price of a corporate bond, F stands for the face value of the corporate bond, and r stands for the risk free rate or the yield of a treasury bond.

5.2 Comparison between Different Recovery Rate Assumptions

As a first step, I compare credit spreads generated by our model for different maturities. When the RFV-assumption is used, the credit spreads are always smaller than when the

RT-model is used for both growth and value companies. This result is not surprising, and comes from the definition of the recovery rate in the two models.[7]

The first line of Figure 1 shows the credit spreads (CS) generated for different times to maturity (TTM). Even for short times to maturity the credit spreads are strictly greater than 0, so that this problem of structural models can be overcome by models with incomplete information. The credit spreads are higher for growth companies (91.8 basis points in comparison to 49.2 basis points for value companies for a time to maturity of 10 years under the RT-model). Furthermore, I am interested in the credit spread difference (CSD) between the credit spreads generated by the RT-model and the RFV-model. The second line of Figure 1 shows how the CSD evolves for different maturities. For longer maturities the CSD increases for value companies and for growth companies. The CSD is higher for growth companies (32.1 basis points in comparison to 15.3 basis points for value companies for a time to maturity of 10 years), which comes from the fact that the corresponding default probabilities for growth companies are higher than those for value companies.

I further analyze the effect of the reported asset value. We see that the credit spreads decrease for value companies and growth companies with a higher reported noisy asset value. The first line of Figure 2 plots these results for the RT- and the RFV-model. We can further see that the credit spreads are again higher for growth than for value companies. Besides the credit spreads, the CSD is also decreasing with increasing reported asset values for value and growth companies. The CSD is plotted in the second line of Figure 2. Again, the decreasing CSD results from the fact that the default probability is smaller for higher reported asset values.

Another question is how the recovery rate assumption relates to the previous year asset values. The higher previous years asset values are the smaller are the credit spreads, for both the RFV- and the RT-model and for value companies and growth companies. Again this is what we would expect: when previous year assets are high, then it becomes less likely that the firm will default. On first view, it seems that the credit spreads are

[7] Keep in mind that a fixed rate from the face value (RFV-model) is always higher than a fixed rate from the discounted face value (RT-model). Hence, the credit spread of the RFV-model will be smaller than that of the RT-model.

similar for value and growth companies. But this is only the case for very low previous year asset values. The first line of Figure 3 summarizes the results. Furthermore, the CSD is highest when previous year assets are low. Again this is explained by the fact that the recovery rate assumption has its largest impact when the probability of default is high. The second line of Figure 3 shows how the Credit Spread Difference changes for different previous year asset values.

In conclusion, the recovery rate assumption does matter. The recovery rate assumptions are of significance especially for long maturities, for low reported asset values, and low previous year asset values. Furthermore, the recovery rate assumption is of higher importance for growth companies in comparison to value companies. These situations have in common that the implied probability of default is high. Thus, one can say that the recovery rate assumption is of significance in states with a high default probability.

5.3 Comparison between Different Levels of Accounting Information

In the previous subsection, I compared the RFV- and the RT-assumption for structural models with incomplete accounting information. In this subsection, I will take a deeper look at the assumed level of incomplete information. Therefore, I first compare credit spreads for different levels of accounting noise.

Choosing the drift parameter for IAS, I find that the credit spreads increase with a higher accounting noise for value companies and growth companies. The first line of Figure 4 shows this situation. However, this increase with respect to credit spreads does not have to be necessary. To demonstrate this, I assume that the reported asset value is not 86.3 like in the base case, but 65.0. We see in the first line of Figure 5 that in this case the credit spreads decrease with higher accounting noise.

It is not possible to give a general prediction of the influence of the accounting noise a. This comes from the fact that the investor knows the asset level of the previous year and the asset value process. If the noisy accounting report gives an unlikely low asset value like 65.0, then the probability that the noisy accounting report overestimates the true asset value is smaller than the probability of an underestimation of the true asset value. In such a case, credit spreads will decline with higher levels of accounting noise. A contrary argument holds for the case that the noisy accounting report gives an unlikely high asset value.

Looking at the CSD again, it is not possible to get a common tendency for the CSD for changing levels of accounting noise. The reason for this is that the CSD-curve depends directly on the credit spread curves. As a consequence of the unclear spread curves, the CSD-curve becomes even less clear. The second lines of Figures 4 and 5 show the CSD evolution for changing levels of accounting noise for value companies and growth companies. While in Figure 4 the CSD increases with higher accounting noise, it decreases in Figure 5.

5.4 Comparison between Different Accounting Regimes

While I analyzed the general effect of accounting noise in the previous subsection, in this subsection I want to find a solution to the question whether the differences in the noise processes for different accounting regimes matter. I therefore use the noise parameters that were estimated under the assumption of a naive investor. For further analysis, I concentrate on the RFV-assumption. While it is generally possible to do the analysis additionally for the RT-assumption, the insight would be restricted.

For both value companies and growth companies, Figure 6 plots the generated credit spreads for the three accounting regimes IAS, US GAAP, and German GAAP (HGB). Initially, it seems that the difference between IAS, US GAAP, and German GAAP is not notable. A further and detailed analysis is given in Figure 7. In general, we observe that for long times to maturity the accounting regime is of minor interest as the credit spread difference is almost zero.

For shorter time to maturities, an interesting pattern evolves. Comparing IAS and US GAAP the difference is most pronounced for very short maturities. For these very short maturities, the credit spreads are higher for value and growth companies using US GAAP. The difference is quite notable at around 1.7 basis points for value companies and 4.2 basis points for growth companies. The reason for this difference in spreads is the higher accounting noise in US GAAP that becomes most important for very short maturities. For greater maturities, the credit spreads are higher for companies using IAS whereas the credit spread difference is greater for growth companies than for value companies.

When we compare the hypothetical spreads between German GAAP and US GAAP we see almost no difference for medium and long maturities. The main difference is that the credit spreads of German GAAP are lower than the credit spreads of US GAAP for short maturities. This difference is around 1.4 basis points for value companies and around 4.7 basis points for growth companies for very short maturities. The main reason for this is that US GAAP is more downward biased than German GAAP and IAS, which means the asset value given in the accounting report is, on average, smaller than the true value of the assets. If the time to maturity is very short, this bias causes the default probability to be smaller than it would be the case if the reported asset value was equal to the true asset value.

When we compare the hypothetical credit spreads of German GAAP and IAS we see that the difference is small for short and long times to maturity. The difference is largest for medium times to maturity.

We therefore see that the accounting regime does matter only marginally for pricing corporate bonds. It is only important for a short and eventually for a medium time to maturity. But the resulting pricing effects are rather small.

As a robustness check, I look if the generated credit spreads are similar for our sub-sample of *Neuer Markt* companies. I restrict the analysis to IAS and US GAAP because the *Neuer Markt* requires companies to use one of these accounting regimes. The first line in Figure 8 shows the credit spreads for the sub-sample of *Neuer Markt* companies. We see that the pattern is very similar to that in Figure 6. Even though the estimated noise parameters are different for *Neuer Markt* companies, the credit spreads and the credit spread difference between IAS and US GAAP are almost identical. The credit spread difference is shown in the second line of Figure 8.

This robustness check shows that the credit spread patterns of different accounting regimes are relatively independent of the market in which the companies are traded.

6 Conclusions

In this paper, I analyzed the effects of the recovery rate assumption and the accounting regime on spreads of corporate bonds and loans in models with incomplete accounting information. I developed a closed form pricing equation for corporate bonds under the recovery of face value and under the recovery of treasury assumption.

The pricing equation that was constructed depends on several parameters that were chosen for a value company and a growth company. The parameters for the noise process were estimated from reported asset values and market prices of German companies in dependence of the accounting regime used by the company under the assumption of a naive investor. I found that the reported asset values are less downward biased for IAS than for German GAAP (HGB) and US GAAP. Additionally, I found that IAS reports are less noisy than German GAAP (HGB) reports, which in turn are less noisy than US GAAP reports. I further showed that for *Neuer Markt* companies the accounting noise is higher and that IAS reports are less biased than US GAAP reports in comparison to companies trading in other markets.

I then calculated hypothetical credit spreads and found that the recovery rate assumption does matter for corporate bond credit spreads. The recovery rate assumption is particularly of significance for long times to maturity, low reported asset values, and low previous year asset values. In all these cases, the probability of default is high. Furthermore, the accounting regime does matter marginally for corporate bond credit spreads and is most important for short times to maturity. The found results are independent of the market in which the companies are traded.

In this paper, it was shown that the recovery rate assumption does matter, while the accounting regime does matter only marginally. Practitioners who use models with incomplete information to price loans have to take account of what recovery rate assumption they specify and what accounting regime the company uses. However, even this may not be enough. In order to get truly reliable loan prices, it is necessary to analyze the whole information given in the accounting standards. This paper is of assistance because it allows practitioners to be more sensitive to two central problems.

References

Alford, Andrew, Jennifer Jones, Richard Leftwich and Mark Zmijewski, 1993, The Relative Informativeness of Accounting Disclosure in Different Countries, *Journal of Accounting Research (Studies on International Accounting)* pp. 183–223.

Artzner, Philippe and Freddy Delbaen, 1995, Default Risk Insurance and Incomplete Markets, *Mathematical Finance* pp. 187–195.

Bartov, Eli, Stephen R. Goldberg and Myungsun Kim, 2005, Comparative Value Relevance Among German, U.S. and International Accounting Standards: A German Stock Market Perspective, *Journal of Accounting, Auditing, and Finance* pp. 95–120.

Bielecki, Tomasz R. and Marek Rutkowski, 2002, *Credit Risk: Modeling, Valuation and Hedging.* (Springer Verlag Berlin).

Black, Fischer and John C. Cox, 1976, Valuing Corporate Securities: Some Effects on Bond Indenture Provisions, *Journal of Finance* pp. 351–367.

Black, Fischer and Myron Scholes, 1973, The Pricing of Options and Corporate Liabilities, *Journal of Political Economy* pp. 637–654.

Bohn, Jeff and Peter Crosby, 2003, Modeling Default Risk: Modeling Methodology, Working paper, Moodys KMV.

Brennan, Michael and Eduardo Schwartz, 1980, Analyzing Convertible Bonds, *Journal of Financial and Quantitative Analysis* 15, 907–929.

Cetin, Umut, Robert Jarrow, Philip Protter and Yildiray Yildirim, 2004, Modeling Credit Risk with Partial Information, *Annals of Applied Probability* pp. 1167–1178.

Collin-Dufresne, Pierre, Robert S. Goldstein and Jean Helwege, 2002, Are Jumps in Corporate Bond Yields Priced? Modeling Contagion via the Updating of Beliefs, Working paper Carnegie Mellon University.

Duffie, Darrel, 1998, Defaultable Term Structure Models with Fractional Recovery of Par, Working paper, Stanford University.

Duffie, Darrel and David Lando, 2001, Term Structures of Credit Spreads with Incomplete Accounting Information, *Econometrica* pp. 633–664.

Duffie, Darrell and Kenneth J. Singleton, 1999, Modeling Term Structures of Defaultable Bonds, *Review of Financial Studies* 12, 687–720.

FASB, 1999, *The IASC-US Comparison Report: A Report on the Similarities and Differences Between IASC Standards and US GAAP.* (FASB Norfolk) 2nd edn.

Giesecke, Kay, 2005, Default and Information, *Journal of Economic Dynamics and Control (forthcoming).*

Giesecke, Kay and Lisa R. Goldberg, 2004, Forecasting Default in the Face of Uncertainty, *Journal of Derivatives* pp. 14–25.

Guha, Rajiv and Alessandro Sbuelz, 2003, Structural RFV: Recovery Form and Defaultable Debt Analysis, Working paper, London Business School and Tilburg University.

Harrison, J. Michael, 1990, *Brownian Motion and Stochastic Flow Systems.* (Krieger Publishing Company Malabar, Florida, USA.).

Jarrow, Robert A., David Lando and Stuart M. Turnbull, 1997, A Markov Model for the Term Structure of Credit Spreads, *Review of Financial Studies* pp. 481–523.

Jarrow, Robert A. and Stuart M. Turnbull, 1995, Pricing Derivatives on Financial Securities Subject to Credit Risk, *Journal of Finance* pp. 53–85.

KPMG, 2002, Fast Close Survey 2002, Working paper, KPMG Consulting AG.

Lando, David, 1998, On Cox Processes and Credit Risky Securities, *Review of Derivatives Research* pp. 99–120.

Leland, Hayne E., 1994, Corporate Debt Value, Bond Covenants, and Optimal Capital Structure, *Journal of Finance* pp. 1213–1252.

Leland, Hayne E. and Klaus B. Toft, 1996, Optimal Capital Structure, Endogenous Bancruptcy and the Term Structure of Credit Spreads, *Journal of Finance* pp. 987–1019.

Merton, Robert C., 1974, On the Pricing of Corporate Debt: The Risk Structure of Interest Rates, *Journal of Finance* pp. 449–470.

Nelken, Israel, 1996, *Handbook of Exotic Options.* (Irwin Chicago, London, Singapore).

Yu, Fan, 2005, Accounting Transparency and the Term Structure of Credit Spreads, *Journal of Financial Economics* pp. 53–84.

Zhou, Chunsheng, 2001, The Term Structure of Credit Spreads with Jump Risk, *Journal of Banking and Finance* pp. 2015–2040.

A Proof of Proposition 1

The expectation $E^Q[I_{\{\tau<T\}}\exp(-r(\tau-t))\omega F|\mathcal{H}_t]$ can be rewritten as

$$E^Q[I_{\{\tau<T\}}\exp(-r(\tau-t))\omega F|\mathcal{H}_t] = \int_t^T e^{-r(s-t)}h(s|\mathcal{H}_t)\omega F ds,$$

where $h(\tau|\mathcal{H}_t)$ is the conditional density function of the stopping time τ given the information set $\mathcal{H}_t$. Since ω and F are constants, they can be taken out of the expectation. Additionally, we know that the conditional density function $h(\tau|\mathcal{H}_t)$ is given by

$$\begin{aligned} h(\tau|\mathcal{H}_t) &= \frac{\partial}{\partial T}\int_{v_b}^{\infty}\varphi(T-t,x-v_b)g(x|Y_t,z_0,t)dx \\ &= \int_{v_b}^{\infty}\frac{\partial\varphi(T-t,x-v_b)}{\partial T}g(x|Y_t,z_0,t)dx. \end{aligned}$$

Inserting the expression above into the pricing equation yields

$$E^Q[I_{\{\tau<T\}}\exp(-r(\tau-t))\omega F|\mathcal{H}_t] = \omega F\int_t^T e^{-r(s-t)}\int_{v_b}^{\infty}\frac{\partial\varphi(T-t,x-v_b)}{\partial T}g(x|Y_t,z_0,t)dxds.$$

Using Fubini's theorem, this leads to

$$\begin{aligned} E^Q[I_{\{\tau<T\}}\exp(-r(\tau-t))\omega F|\mathcal{H}_t] &= \omega F\int_{v_b}^{\infty}\int_t^T e^{-r(s-t)}\frac{\partial\varphi(T-t,x-v_b)}{\partial T}g(x|Y_t,z_0,t)dsdx \\ &= \omega F\int_{v_b}^{\infty}E^Q[e^{-r(\tau-t)}I_{\{\tau<T\}}|\mathcal{F}_t]g(x|Y_t,z_0,t)dx, \end{aligned}$$

where $E^Q[e^{-r(\tau-t)}I_{\{\tau<T\}}|\mathcal{F}_t]$ is the price of a *down-and-in cash-at-hit option.* This price is well known and documented. A derivation and a proof can be found for example in Nelken (1996).

B Tables and Figures

Table 1: The base case parameters were chosen for value companies and for growth companies. The difference between the two are risk neutral drift m and the asset volatility σ. All other parameters are identical for value and growth companies.

Parameter	$T-t$	m	σ	r	V_b	V_0	$\hat{V}_t$	F	ω
Panel A (value companies)	10	0.07	0.144	0.04	60.0	86.3	86.3	100	0.5
Panel B (growth companies)	10	0.1	0.200	0.04	60.0	86.3	86.3	100	0.5

Table 2: The first row shows the mean of the noise term $\bar{u}$ for IAS, US GAAP, and German GAAP (HGB) reports. The second row shows the standard deviation for the noise term. The third row shows a measure of how biased the accounting reports are.

	complete sample		
	IAS	US GAAP	HGB
$\bar{u}$	-0.272	-0.443	-0.351
(se)	(0.0224)	(0.0364)	(0.0181)
a	0.660	0.839	0.733
(se)	(0.0159)	(0.0258)	(0.0128)
$e^{\bar{u}+0.5a^2}$	0.947	0.913	0.923

Table 3: In this table I split the sample (only companies applying US GAAP or IAS) in sub-samples for Neuer Markt companies and other companies. The first row shows the mean of the noise term $\bar{u}$, the second row shows the standard deviation for the noise term, and the third row shows a measure of how biased the accounting reports are.

	Neuer Markt			other markets		
	IAS	US GAAP	HGB	IAS	US GAAP	HGB
$\bar{u}$	-0.325	-0.532	n/a	-0.200	-0.202	n/a
(se)	(0.0345)	(0.0472)		(0.0235)	(0.0371)	
a	0.773	0.928	n/a	0.448	0.444	n/a
(se)	(0.0244)	(0.0334)		(0.0166)	(0.0263)	
$e^{\bar{u}+0.5a^2}$	0.975	0.903	n/a	0.905	0.902	n/a

Figure 1: The first row shows credit spreads for different maturities (in years) for Panel A and Panel B parametrization. In the second row the credit spread difference between the RT-model and the RFV-model is drawn.

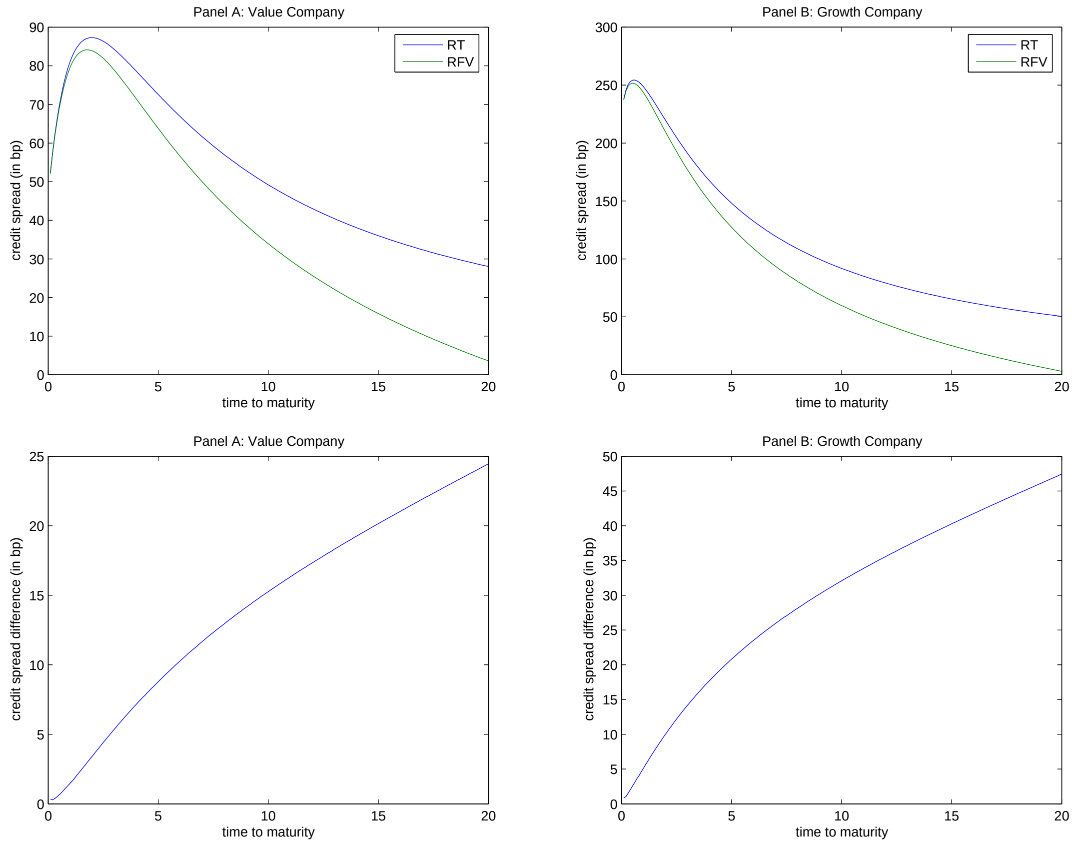

Figure 2: The first row shows credit spreads for different reported asset values for Panel A and Panel B parametrization. In the second row the credit spread difference between the RT-model and the RFV-model is drawn.

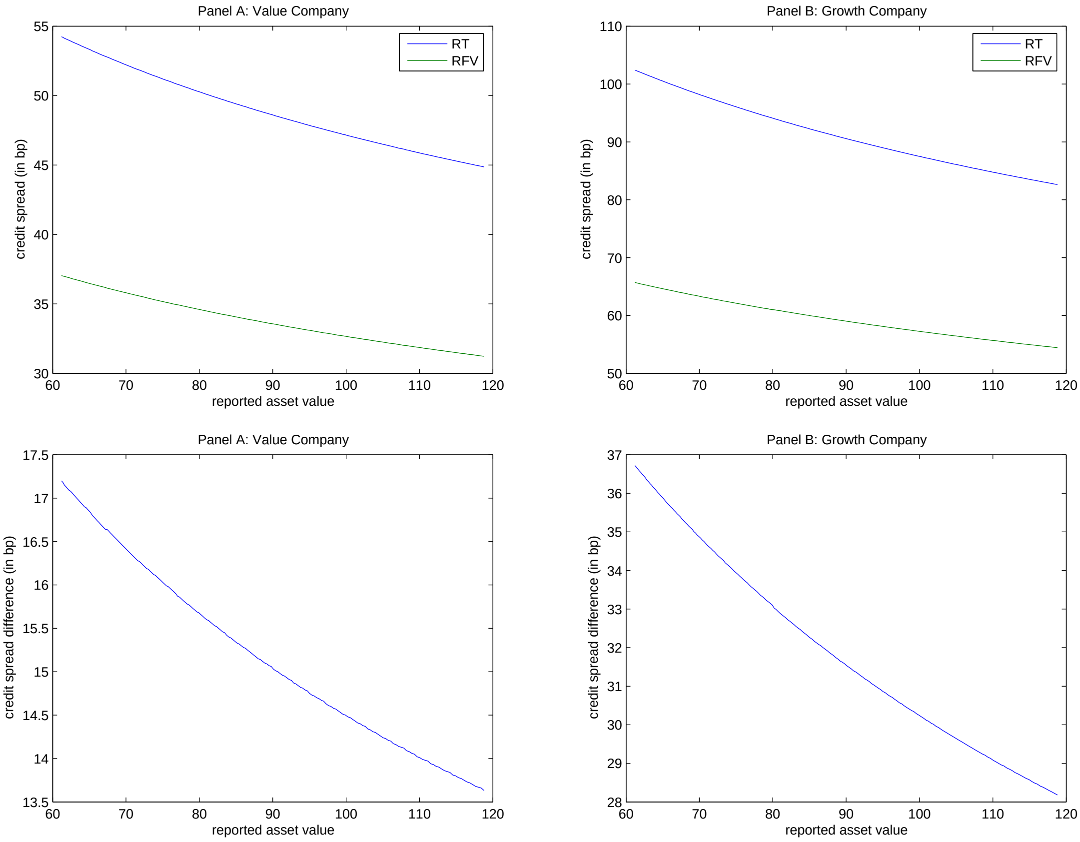

Figure 3: The first row shows credit spreads for different previous year asset values for Panel A and Panel B parametrization. In the second row the credit spread difference between the RT-model and the RFV-model is drawn.

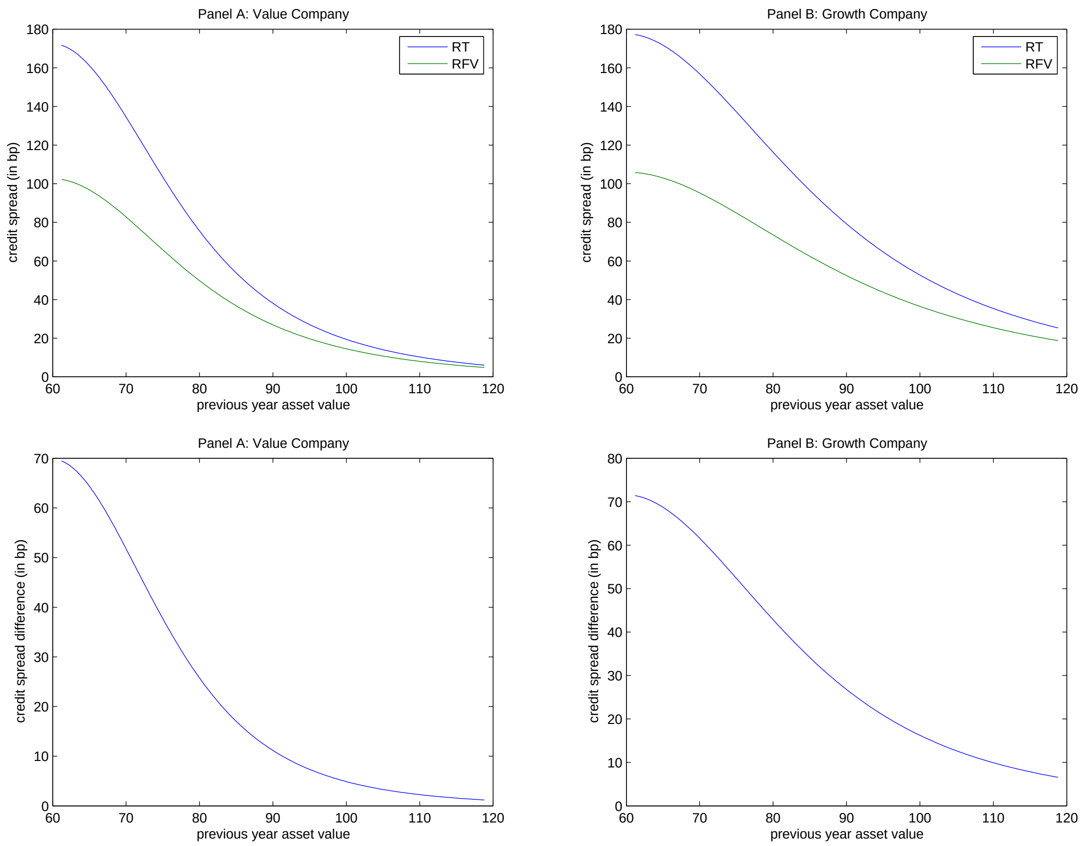

Figure 4: The first row shows credit spreads for different levels of accounting noise (a) for Panel A and Panel B parametrization. In the second row the credit spread difference between the RT-model and the RFV-model is drawn.

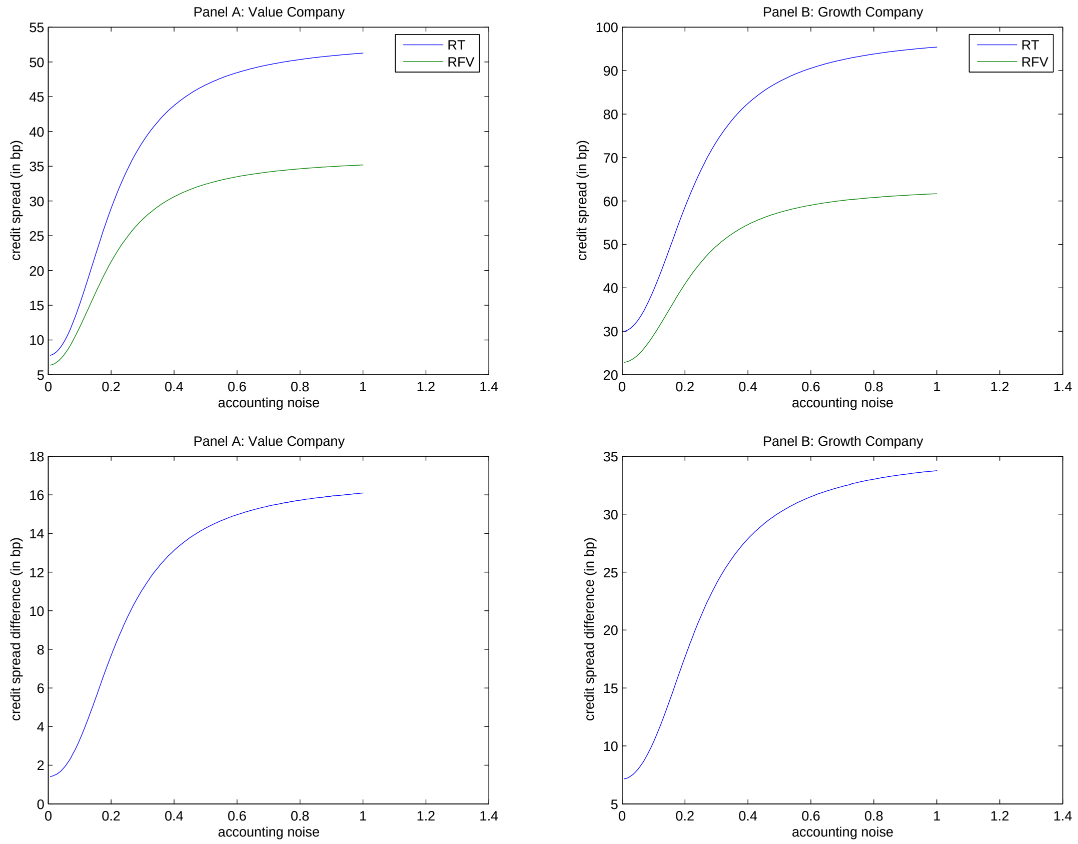

Figure 5: The first row shows credit spreads for different levels of accounting noise (a) for Panel A and Panel B parametrization. In comparison to figure 4 the reported asset value is set to 65.0 instead of 86.3. In the second row the credit spread difference between the RT-model and the RFV-model is drawn.

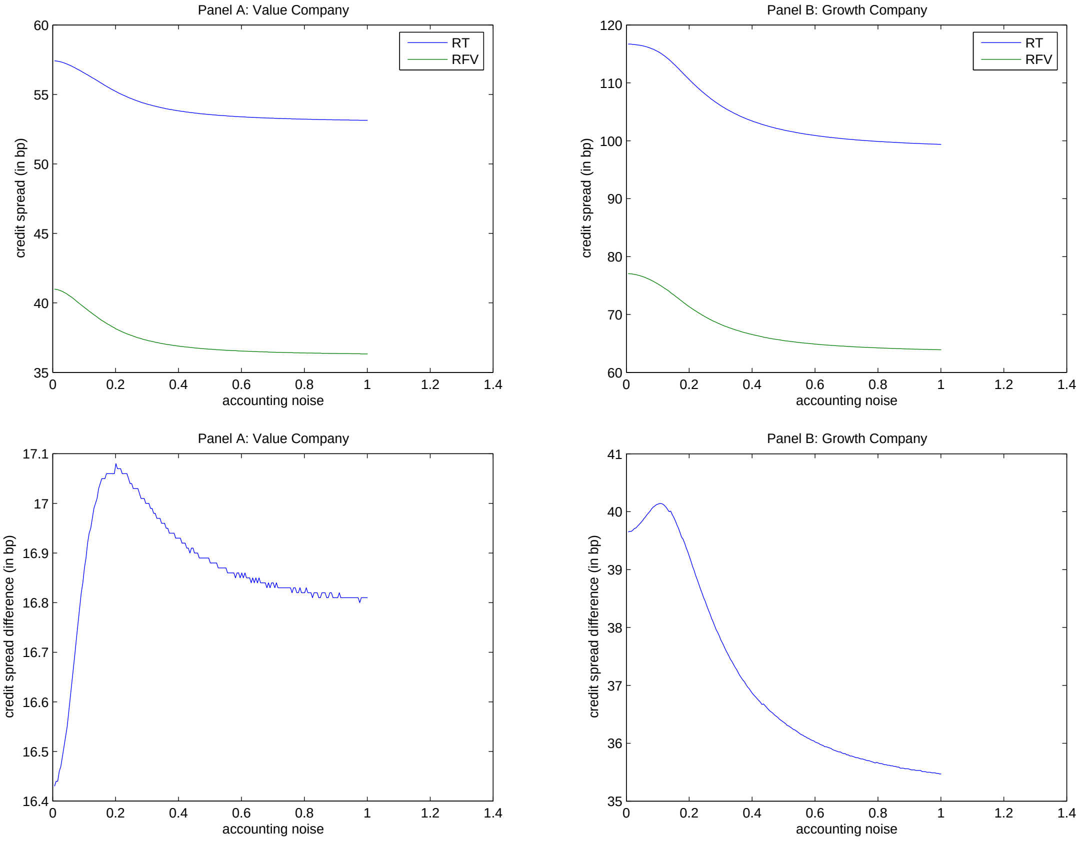

Figure 6: This figure shows credit spreads for the accounting regimes IAS, US GAAP, and German GAAP (HGB) for Panel A and Panel B parametrization.

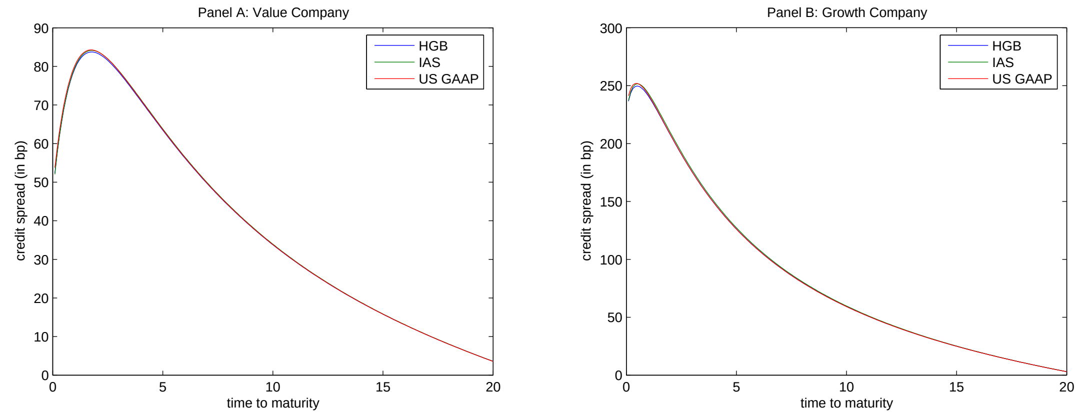

Figure 7: The first row shows the credit spread differences resulting from US GAAP and German GAAP (HGB) in comparison to IAS. The second row shows the credit spread differences resulting from IAS and German GAAP (HGB) in comparison to US GAAP. The third row shows the credit spread differences resulting from US GAAP and IAS in comparison to German GAAP (HGB).

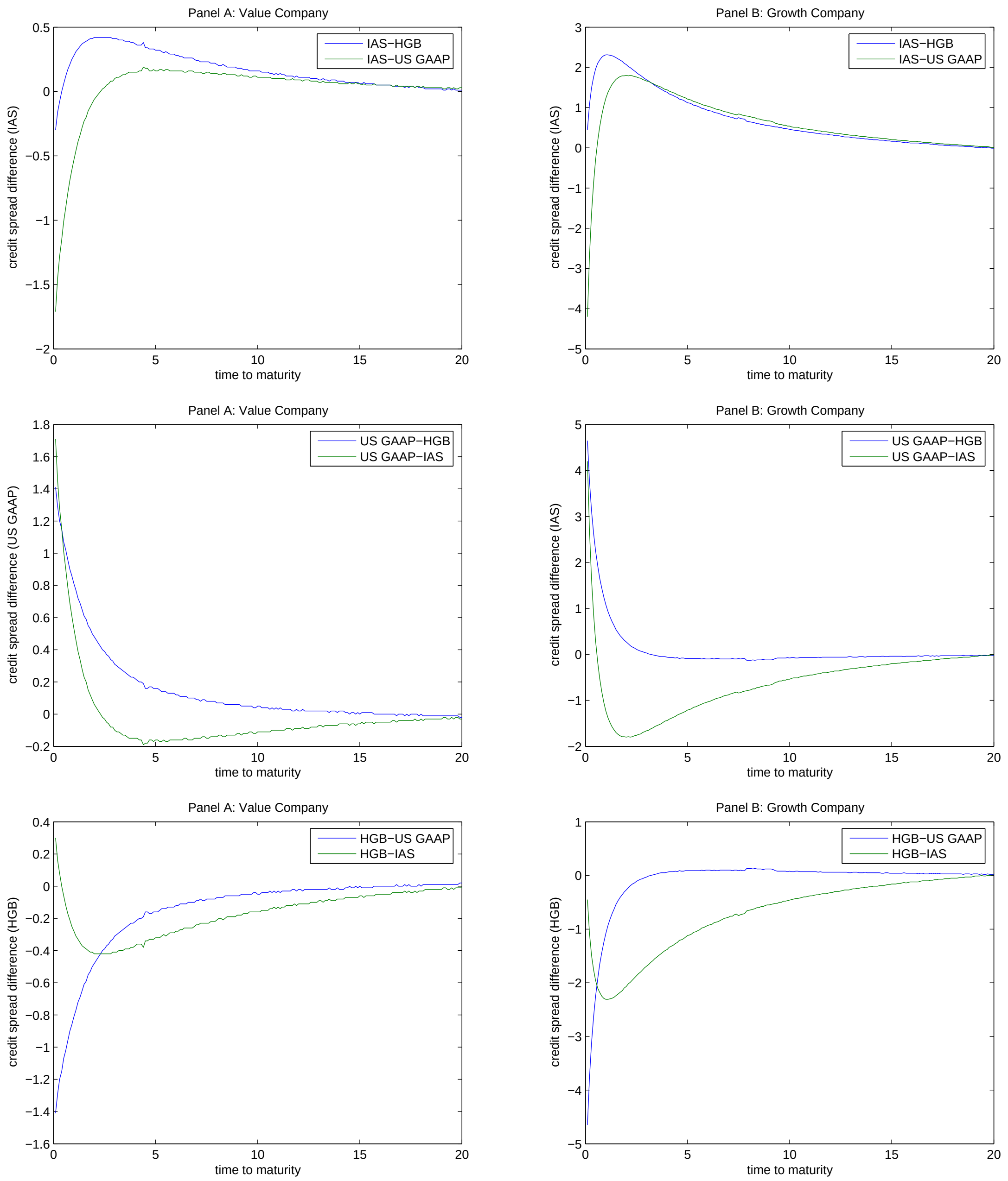

Figure 8: The first row shows the hypothetical credit spreads for the sub sample of companies that are traded on *Neuer Markt*. The second row shows credit spread difference between IAS and US GAAP.