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The performance of hybrid models in the assessment of default risk

Mondher Bellalah [a,*,1], Sami Zouari [b,2], Olivier Levyne [c,3]

[a] THEMA, UCP, 33 bvd du port, 95011 Cergy, France
[b] THEMA, UCP, France
[c] ISC Paris, France

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ABSTRACT

This paper combines fundamental analysis and contingent claim analysis into a hybrid model of credit risk measurement. Our database consists of French companies listed on the Paris Stock Exchange (Euronext Paris). Our objective is to assess how the combination of continuous assessments provided by the market and the values derived from financial statements improve our ability to forecast the default probability. During the first phase, the default probability is estimated using both methods separately, and subsequently, the default probability of the structural model is integrated at each point in time in the non-structural model as an additional explanatory variable. The appeal of the hybrid model allows the default probability to be continuously updated by integrating market information via the probabilities of default extracted from the structural model. Our results indicate that default probabilities extracted from the structural model contribute significantly in explaining default risk when included in a hybrid model with accounting variables.

1. Introduction

Credit risk refers to the risk due to unpredicted changes in the credit quality of a counter party or issuer and its quantification is one of the major frontiers in modern finance. The creditworthiness of a potential borrower affects the lending decision and the credit spread, since it is uncertain whether the firm will be able to perform its obligation. Credit risk measurement depends on the likelihood of default of a firm to meet its required or contractual obligation and on what will be lost if default occurs. When we consider the large number of corporations issuing fixed income securities and the relatively small number of actual defaults might regard default as rare event. However, all corporate issuers have some positive probability of default. Models of credit risk measurement have focused on the estimation of the default probability of firms, since it is the main source of uncertainty in the lending decision. We may distinguish two large classes of credit risk models. The first class of traditional models assumes the fundamental analysis, called the non-structural models. The goal of these models that goes back to Beaver (1966) and Altman (1968) is to find significant factors in assessing the credit risk. The second class, called structural models assumes the contingency claim analysis. The models refer to Black and Scholes (1973) and Merton (1974) and assume corporate liabilities as contingent claims on the assets of the firm.[4]

This paper investigates the hybrid contingent claim approach with French companies listed on the Paris Stock Exchange (Euronext Paris). The main objective is to assess how the combination of continuous assessments provided by the market and the values derived from financial statements improve our ability to forecast the probability of default.

The structural model of Merton has the advantage of being flexible, since the probability of default can continually be updated with changes in the value of corporate assets. Its main drawback is that it may over-or underestimate the probability of default, since asset values are unobservable and must be extrapolated from the share prices. On the other hand, the non-structural model of Altman is more accurate because it uses the accounting data of companies, but it is less flexible. Because the frequency of information is generally annual, the probabilities of default cannot be updated during the fiscal year. The quarterly financial statements can be found, but they are not always audited by an external accounting firm.

The Bank of England estimated the hybrid model with data from British companies and found some interesting results. During the first phase, the probability of defaults is estimated using both methods separately, and subsequently, the probability of default of the structural model is integrated at each point in time in the non-structural model as an additional explanatory variable. The appeal of the hybrid model

* Corresponding author. Fax: +33 134256233.
E-mail addresses: mondher.bellalah@gmail.com (M. Bellalah), mohsamizouari@yahoo.fr (S. Zouari).

[1] Professor of Finance and International Finance professional advisor, specialized in Risk Management. He has published several articles and books with top finance journals. We would like to thank Dr. Fredj Jaouedi and Professor Jean Luc Prigent for their helpful comments.

[2] PHD student, specialized in Credit Risk. Assistant professor, UMLT, Tunisia.

[3] Specialized in Risk Management, Assistant professor, ISC Paris.

[4] Another widely used category of credit risk models is the reduced form approach where the dynamics of default are given exogenously by an intensity or compensator process.

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allows the probability of default to be continuously updated by integrating market information via the probabilities of default extracted from the structural model. In this paper, we apply the hybrid model to French companies listed on Paris Stock Exchange (Euronext Paris).

This paper is organized as follows. Section 2 reviews the main models in the literature. Section 3 presents the estimated structural model and describes the data used. Section 4 presents the estimation of the hybrid model and summarizes the main results.

2. The main models for default risk assessment

2.1. Non-structural models

Traditional non-structural models adopt fundamental analysis and try to find which factors are important in explaining the credit risk of a company. They assess the significance of these factors, mapping a reduced set of financial ratios, accounting variables and other information into a quantitative score. The latter, can be interpreted as a probability of default and can be used as classification system.[5]

Beaver (1966) introduced the univariate approach of discriminant analysis in the default risk of firm's explanation. Altman (1968) has extended it to a multivariate context and developed the Z-Score model. It weights the independent variables (financial ratios and accounting variables) and generates a single composite discriminant score. Altman et al. (1977) have developed the ZETA model, which integrated some improvements to the original Z-Score approach. Then, the binary dependent variable models, known as the logit and probit models have been used in bankruptcy prediction.[6] Ohlson (1980) used logit methodology to derive a default risk model known as O-Score. Probit (logit) methodology weights the independent variables and allocates scores in a form of failure probability using the normal (logistic) cumulative function.

Binary credit risk models are used by banks for their non-listed firm lending procedure. Several banks use this method for privately and publicly traded companies, either by buying a model, such as RiskCalc Moody's, or by programming their own estimate. One problem they often face is to build an appropriate proper database. Very often, credit files are not computerized or do not contain historical data.

The main advantage of non-structural models is their accuracy in estimating probabilities of default. In addition, they are easy to use for financial institutions equipped with solid management systems of database and may produce very accurate default probabilities. Nonetheless, these models are not flexible, because they need information from financial statements. Thus, it is very difficult to update the probabilities of default over a year. Some financial institutions may require reporting on a quarterly basis, but they are rarely audited by accounting firms.

2.2. Structural models

The original Merton model is based on some simplifying assumptions about the structure of the typical firm's finances. The event of default is determined by the market value of the firm's assets in combination with the liability structure of the firm. When the value of the assets falls below a certain threshold, the firm is considered to be in default. The main criticism that leveled at Merton's model is that it does not account for the possibility that the firm may default before the debt matures. To improve this basic model, several extensions have been suggested in the literature.

Crosbie and Bohn (2003) summarize KMV's default probability model. KMV's default probability model is based on a modified version of the Black–Scholes–Merton framework in the sense that KMV allows default to occur at any point in time and not necessarily at the maturity of the debt. In this model multiple classes of liabilities are modeled. There are essentially three steps in the determination of the default probability. The first step is to estimate the market value and volatility of the firm's assets, the second step is to calculate the distance-to-default, the number of standard deviations the firm is away from default, and the third step is to transform the distance-to-default into an expected default frequency (EDF) using an empirical default distribution.

Brockman and Turtle (2002) propose using barrier options. Thus, rather than stockholders who wait for the debt to mature before exercising a standard European call option, we have a down-and-out option on the assets in which lenders hold a portfolio of risk-free debt and a short put option combined with a long down-and-out call option on the firm's assets. The last part gives them the right to place the company into bankruptcy when they anticipate that its financial health can only deteriorate. Wong and Choi (2006) demonstrate that estimating the parameters of the Brockman and Turtle (2002) model by maximum likelihood yields results that resemble those from the iterative estimation method used in this literature when the theoretical model is Merton's. The appeal of the maximum likelihood method is that it allows for statistical inference or, more specifically, calculating descriptive statistics for the estimated parameters, such as the value of the firm.

Tudela and Young (2005) present an application of the hybrid model. This application uses barrier options with a down-and-out call option. The authors estimate various models on data from non-financial English firms for the period 1990–2001. They use data on firms that did, and did not, default, for their estimates of probabilities of default in the structural model. First, they verify whether the two firm types represent different predicted probabilities of default. Second, they compare their hybrid model with other non-structural models to verify whether the additional probability of default (PD) variable is significant for explaining probabilities of default. Third, they measure the performance of their model with power curve and accuracy ratio type instruments.

3. Estimation of the probabilities of default with the structural model: application of the Tudela and Young Model (2005)

3.1. Model description

In this model, the authors use the theory of barrier options[7] and more precisely the call option down-and-out, which vanishes when the underlying asset reaches the barrier. We assume that the capital structure consists exclusively of debt and equity. The level of debt is denoted by B and (T-t) represents the time remaining to maturity of the debt, the value of the firm is At and the value, at time t, of the debt maturing at time T is V (A, T, t). The share value at time t is f (A, t). The total value of the firm at time t is:

$$A_t = V(A, T, t) + f(A, t). \quad (1)$$

To derive the probability of default using a barrier option we assume that the value of the firm's underlying assets follows the following stochastic process:

$$dA = \mu_A A dt + \sigma_A A \ dz \quad (2)$$

where $dz = \varepsilon\sqrt{dt}$ and $\varepsilon \sim N[0, 1]$.

[5] For a review of traditional models (Jones (1987); Caouette et al. (1998), Saunders (2002)).

[6] Jones (1987) concludes that binary dependent variable models do not lead to notable improvements in the predictive power of fundamental analysis when compared to the earlier LDA models.

[7] Other equity-based models of credit risk that use the concept of barrier options are Black and Cox (1976), Longstaff and Schwartz (1995) and Briys and de Varenne (1997).

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