The Dynamics of Corporate Credit Risk: An Intensity-based Econometric Analysis

Monteiro, A.

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Abstract

Corporate Credit Risk refers to the risk borne by investors who enter into a *defaultable* financial contract with a privately owned *debt issuer*, usually a corporation. Using both public and privately available information, credit rating agencies classify corporate debt issuers according to a particular ordinal scale. Corporate credit ratings are aimed at providing a simple qualitative summary of the overall solidity, solvency and prospects of a firm. Credit ratings further provide a subjective assessment of the default probability incurred by an investor who enters into a long financial position with a (rated) corporate counterparty. Credit ratings play a prominent role in the credit industry. First, they directly influence the interest rate to be applied to a particular loan. Additionally, under the Basle II accord, credit ratings are used to determine the required capital buffer to be held by the lender. If ratings co-vary with the business cycle this has the potential to exacerbate a downturn of the economy, as capital becomes increasingly expensive when it is most needed. Therefore, credit ratings have an indirect impact over the stability of the whole financial system. This means that it is crucial to understand the aggregate dynamic behaviour of credit ratings.

This thesis presents a novel econometric framework for modelling and handling credit rating data. Building on the multi-state duration frameworks of Kavvathas (2001) and Lando and Skødeberg (2002), a parameter driven extension of the standard continuous-time Markov chain credit risk model of Jarrow et al. (1997) is introduced. This model enables the empirical measurement and estimation of both corporate default and rating transition probabilities using historical (agency) rating data. Because this new multi-state duration model allows observed transition rates to be conditioned upon external variables, measuring for example the state of the business cycle, it becomes possible answering questions like: what will be the increase in the default probability of an *investment grade* firm over the next year if GDP growth decreases by 500 basis points? Because the transition model introduced in this thesis is a *parameter driven* one, it is possible to gauge whether or not the empirical 'credit cycles' follow closely the business cycle. Chapter 4 investigates precisely this and other related questions.

In order to obtain a first impression of the historical behaviour of credit ratings, Chapter 2 of this thesis presents a nonparametric analysis of the CreditPro 7.0 database from Standard & Poor's. Historical clustering of credit events and duration-dependence effects are found to be statistically significant. This chapter makes several contributions to the statistical literature on semi-Markov processes. First, it presents for the first time a formal proof of the existence and uniqueness of the semi-Markov transition matrix as a function of the observed transition rates. Second, it presents a computational procedure for obtaining this transition matrix and establishes its numerical convergence. It is further shown that this procedure preserves the consistency of the hazard rate estimators over which it is based. Finally, a set of nonparametric estimators of the semi-Markov kernel is

presented. Chapter 2 also investigates, empirically, the impact of these non-homogeneous semi-Markov effects over the rating transition matrices. This was the first time, in the empirical finance literature, that the impact of this non-Markovian behaviour of credit ratings over the rating transition matrices was quantified.
In chapters 3 and 4 the new Multi-state Latent Factor Intensity (MLFI) model for credit rating transitions is introduced and applied to the above-mentioned database on credit ratings from Standard & Poor's. The empirical findings further confirm the results from the nonparametric analysis performed in the previous chapter. Additionally, it is found that both defaults and downward rating transitions exhibit a higher degree of clustering when compared to upward rating revisions. Chapter 3 also introduces a novel parametric bootstrap procedure for obtaining short-term forecasts of the credit rating transition matrices over arbitrary (short) horizons. In Chapter 4 a systematic investigation of the macro economic determinants of aggregate credit cycles is conducted. The empirically observed rating transition rates were regressed over three sets of variables. The first set was chosen in order to measure the state of the business cycle. The second and third sets of variables were selected in order to gauge the state of the credit (bank lending conditions) and financial (equity) markets, respectively. The main explanatory macro economic variable for the empirically observed clustering of rating events turns out to be GDP growth. The empirical analysis performed in this thesis shows that credit cycles are, to some extent, idiosyncratic.

The new modelling framework introduced in this thesis is computationally demanding. Computing the data Likelihood implied by the MLFI model requires evaluating a multivariate integral whose dimension increases with the sample size. In the final chapter of this thesis I compare the use of three different estimation algorithms for solving this problem. On the basis of a simulation study, it is found that the EIS algorithm of Richard and Zhang (2007) yields the most accurate finite-sample parameter estimates. This accuracy, however, seems to come at the cost of an extremely high computational load. The Durbin-Koopman Monte Carlo likelihood method seems to be very efficient in computational terms. The estimation accuracy obtained, as measured by the aggregate MSE, with this method is lower than the one attained by the EIS algorithm. The deterministic numerical Likelihood approximation of Davis and Rodriguez-Yam (2005) yielded mixed results. In one of the simulations it yielded the best overall accuracy. In general terms, however, it performed worse than the simulation-based methods.

Chapter 6 concludes this thesis, wrapping up its main ideas as well as the contributions made to the literature. Some ideas for future research are also briefly discussed.