International Review of Economics and Finance 21 (2012) 87–105

Contents lists available at ScienceDirect

International Review of Economics and Finance

journal homepage: www.elsevier.com/locate/iref

Modeling the effect of macroeconomic factors on corporate default and credit rating transitions ☆

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ARTICLE INFO

Article history:
Received 12 February 2009
Received in revised form 5 January 2011
Accepted 6 April 2011
Available online 17 May 2011

JEL classification:
G32
E44
G24

Keywords:
Credit risk
Cox model
Default risk
Intensity model
Bond ratings

ABSTRACT

We explore how general economic conditions impact defaults and major credit rating changes by fitting reduced-form Cox intensity models with a broad range of macroeconomic and firm-specific ratings-related variables. For all corporate issuers in the period 1981–2002 we find both types of factors strongly influenced the risk of a credit event. However, while the effects of ratings-related factors were consistent with expectations and very robust under different specifications, significance levels and even signs for the macro variable coefficients depended heavily on which other variables were included. This sheds light on the disparate results reported in earlier studies.

1. Introduction

Models of corporate default fall into two broad categories, structural models and reduced form models. Structural models consider the evolution of the value of the firm, with default assumed to occur if firm value should fall below some insolvency threshold. They have the practical advantage of using the firm's current stock price, a sensitive barometer of its financial condition that is updated daily, unlike accounting statements that are only available quarterly.[2] But structural models pose difficult problems, including the need to value all of the components of a real world firm's complex capital structure, to model their dynamics and estimate those models empirically, and to specify exactly where the default boundary lies. This is a challenging task in itself, as the literature shows, and it becomes extremely difficult to introduce very many additional variables related to conditions in the macroeconomy. Moreover, important non-default credit events, such as a ratings downgrade, do not fit conveniently into the structural framework.

☆ We thank Moody's Credit Market Research Fund and Moody's Investor Services for providing funding, data, and expert advice. Stephen Figlewski is also grateful to NASDAQ OMX for research support. We thank Sanjiv Das, Stephen Brown, the Editor, Carl Chen, and seminar participants at NYU, Moody's, Columbia, Florida State, and Laval University for valuable comments and suggestions. The research was conducted while Weijian Liang was a Ph.D student at NYU.

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[2] How quickly the ratings agencies update their ratings as a firm's creditworthiness deteriorates becomes an important issue in comparing the relative performance of the two approaches. Güttler and Wahrenburg (2007) present evidence that Moody's does so in a more timely manner than S&P.

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doi:10.1016/j.iref.2011.05.004

This paper focuses on the reduced form approach, which treats default as a random event that can strike any firm at any time. The paradigm might be thought of as formalization and extension of the familiar ratings transition matrices published by Moody's and other ratings agencies.[3] In the basic reduced form model, a credit event corresponds to the first jump time of a Poisson process with a constant hazard rate. An "event" can be defined flexibly to be default, downgrade or upgrade from one bond rating category to another, or any other well-defined change of state. The reduced form approach has been widely used for credit risk analysis in both academic and real world research, e.g., Jarrow, Lando, and Turnbull (1995) and Jarrow, Lando, and Turnbull (1997), Lando and Skødeberg (2002), Duffie, Saita, and Wang (2007), Koopman et al. (2008) and Koopman et al. (2009).

The constant hazard rate formulation treats all issuers in a given credit class as homogeneous. But empirical evidence of non-Markovian behavior includes positive serial correlation in ratings changes, known as "ratings drift," time variation in default probabilities, and cross-sectional differences in credit risk across issuers within a given rating. For example, Altman and Kao (1992) found ratings drift among firms that recently had a change in rating, and Hamilton and Cantor (2004) showed that the transition probability out of a rating class depends on whether the bond entered its current rating by an upgrade or a downgrade.[4] Other kinds of non-Markovian behavior were described by Lando and Skødeberg (2002), who found that the probability of a rating change diminishes the longer the bond stays in the same rating; and by MacDonald and Van de Gucht (1999), whose results suggested a nonmonotonic aging effect. Results reported by Mann, Hamilton, Varma, and Cantor (2003), Hamilton and Cantor (2004) and Fledelius, Lando, and Nielsen (2004) indicate that within-class hazard rates for default and for ratings transitions vary considerably over time.

These results support the belief that credit risk exposure is affected by conditions in the macroeconomy. In particular, Bangia, Diebold, Kronimus, Schagen, and Schuermann (2002) and Nickell et al. (2000) found that upgrade, downgrade and default intensities differ across different economic regimes. Xie, Shi, and Wu (2008) used the reduced form approach to extract (risk neutral) default intensities from investment grade corporate bond yields and found strong evidence of common factors, the strongest of which was the performance of the stock market. Numerous other studies showing that default probability is sensitive to macroeconomic factors include Kavvathas (2001), Carling, Jacobson, Linde, and Roszbach (2007), Couderc and Renault (2004) and Duffie et al. (2007).

In this paper, we formulate and estimate extended reduced-form models for the occurrence of credit events, using the semi-parametric Cox regression model. This well-known approach adapted from survival analysis allows the hazard rate for a given issuer to be a function of both firm-specific factors and macroeconomic conditions.[5] In place of a formal structural model, we assume that the important factors tied to a firm's capital structure are adequately reflected in its current bond rating and its credit rating history. Our concentration is on assessing the relative importance of a much broader selection of macro variables, both individually and in combination, than has been carried out previously with the Cox hazard model.

Duffie et al. (2007) combined variables from both frameworks in developing a model for the term structure of credit risk as a function of a small number of structural and macro factors. But their focus on forecasting required building models for the time-series properties of their factors, which strictly limited the number of variables that could be considered.[6] By contrast, we wish to establish "stylized facts" about which macro covariates are most important and the nature of their impact on credit risk, including allowance for lagged effects. We do not attempt to predict the future values or the dynamics of those factors.

Default is the most important change in credit quality, but hardly the only one that matters to investors. Tables of historical transition frequencies among the ratings categories, and previous research on credit risk, have attempted to estimate the full transition matrix for ratings changes. We prefer to concentrate on the most important transitions rather than modeling the fine structure of the credit market.[7] We therefore focus on three especially important credit events: transition from solvency into default, transition from investment grade (Moody's Baa and above) down to speculative grade (Ba or below), and the reverse transition (upgrade from speculative to investment grade).[8]

It seems intuitively obvious that macroeconomic conditions should affect credit risk. This is true both in absolute terms and also relative to the degree of credit risk implied by a bond rating. The latter expectation is due to the rating agencies' practice of "rating through the cycle," i.e., assigning credit ratings based on each firm's creditworthiness *relative* to others in its cohort, and not adjusting the ratings as overall credit risk varies over the business cycle. But different researchers have obtained quite different results, depending on which macro variables were explored, how those variables entered the specifications (as contemporaneous values, with lags, or averaged over time), what other variables were included in the specification, and what time period was examined. Our comprehensive analysis sheds considerable light on these diverse results.

[3] See Hamilton, Varma, Ou, and Cantor (2006), for an example of a historical ratings transition matrix. Nickell, Perraudin, and Varotto (2000) explore the impact of overall "business cycle" conditions, along with the issuer's industry and country of domicile, on transition probabilities among ratings classes.

[4] Christensen, Hansen, and Lando (2004) modeled downward drift by introducing a hidden Markov chain. Subsequently, Frydman and Schuermann (2008) showed that a mixture of Markov chains statistically dominates a single Markov chain model.

[5] Shumway (2001) demonstrates the statistical superiority of hazard models over static models that do not take into account the fact that a firm is exposed to the risk of a credit event over multiple periods.

[6] Their final specification included only four variables: the trailing one-year return on the S&P 500 index and the 3-month Treasury bill rate, along with distance to default and the firm's own stock return. They report that they explored a number of other macro covariates, but did not incorporate them in their final model.

[7] Jarrow, Lando, and Turnbull (1997) modeled the ratings transition matrix, but faced the problem that many of the cells that involved transitions from a high rating to default or, in general, to a much different rating had no entries in their data. Yet one does not want to model such transitions as being impossible. Jarrow, Lando and Turnbull proposed a kind of "tweak" to deal with this problem; Kijima and Komoribayashi (1998) offered a more elegant solution. We minimize the problem by using broad ratings categories and eliminating from consideration transitions with too few occurrences.

[8] In an earlier version of this paper, we also broke down the speculative B and C grades and looked at their transitions separately. However, this did not provide much additional insight, beyond the observation that transitions for firms in the C categories tend to be more idiosyncratic and less obviously affected by macroeconomic factors than transitions for higher rated firms.