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Time series patterns in credit ratings

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Abstract

This article offers a substitute setting to simulate credit rating migrations. The internal correlations model tracks time-series movements within credit rating entries, rather than cross-ratings correlations. The proposed nonhomogeneous process is authenticated through the likelihood ratio Dickey–Fuller test, and is found to be statistically and economically significant, by better fitting observed cumulative default rates. Several nonlinear regression models assist to better identify these time-related patterns. The economic structure underlying the time dependency often corresponds to changes in GDP, business cycles, and market risk. Furthermore, significant positive autocorrelation is detected mostly among downgrade probabilities.

JEL classification: G21; G24; G32; G33

Keywords: Credit ratings; Time-series patterns; Dickey–Fuller test; Homogeneous Markov chain; Serial correlation

1. Introduction

Developments in credit ratings commonly reveal an improvement or deterioration in the credit-worthiness of a firm. Although rating agencies primarily meant to utilize credit ratings to signify the current credit quality, several theories use the rating transitions phenomenon to forecast default events, or to price risky bonds.

Academicians and practitioners often use the homogeneous Markov chain, first proposed by Jarrow et al. (1997), to describe the dynamics of credit ratings. Yet, in reality, this process does not correspond to actual yield curves, as well as violates several observed dependencies.

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So far, few attempts have been made to step away from the homogeneity assumption of the Markov chain transition matrix. The CreditMetrics™ methodology offered of Gupton et al. (1997) examines cross-ratings correlations. The momentum scheme proposed by Bahar and Nagpal (2001) considers lagged rating transitions. The generator matrix investigated by Israel et al. (2001) offers procedures to simulate further transition matrices. Bangia et al. (2002) distinguish between transition matrices depending on the business cycle, and the density-dependent model of Parnes (2007) associates firm's survivability and transitivity to the market-density. These nonhomogeneous models consider the credit ratings migration not to be a memory-less process any more.

This article offers a different approach to track rating transitions while accounting for time-series movements within credit entries, rather than cross-rating dependencies. We substantiate this nonhomogeneous dynamic through a Dickey–Fuller statistical test, associate it with market variables, and demonstrate its economic importance.

The article proceeds as follows. Section 2 presents the alternative model. Section 3 discusses the data and methodologies. Section 4 explains the empirical findings and their economic meaning, and Section 5 concludes.

2. Time series patterns in credit ratings

An evidence for time series correlation in credit ratings migration can be found in Altman and Kao (1992a, 1992b). The authors divide the examined time frame into two sub-periods, from 1970 to 1979, and from 1980 to 1985, and reveal a tendency for a downgrade in rating to be followed by a second downgrade, indicating on a serial correlation when the initial rating changes was a downgrade. However, weak autocorrelation is found when the first change is an upgrade.

The following model makes an attempt to track trends in transition probabilities over time, and to generate future transition probabilities that follow the same affine trend. This scheme explicitly assumes that each transition probability is univariate autoregressive correlated with previous transition probabilities within the same entry in the credit ratings matrix.[1] By that, the model implicitly assumes that transition probabilities are cross-correlated with other transition probabilities within the same column. The cross correlation evolves from the fact that the sum of entries within each column always remains one. Thus, when a specific entry in the transition matrix tends to increase (decrease), other entries in the same column tend to decrease (increase). The model estimates AR(1) time-series regressions for each entry in the transition matrix as

$$s_{ij}(t+1) = \alpha_{ij} + \beta_{ij} s_{ij}(t) + \varepsilon_{ij}(t) \quad \forall i, j, \tag{1}$$

where entry $s_{ij}(t)$ denotes the transition probability from state j to state i at time t in the survival sub-matrix S. The β coefficient of the regression equation determines whether a transition probability is stationary. Transition probabilities must remain in their domain, thus, unless α is close to 1 and β is positive, or α is close to 0 and β is negative, the model requires no constrains.[2]

[1] Describing the life cycle of a company requires the distinguishing between different survival states and an absorbing state of default. Transition matrix T is a nonnegative square matrix of dimensions 22×22, where its entries represent probabilities of all credit ratings migration. Matrix T contains a survival sub-matrix S of dimensions 21×21, representing transitions among livelihood states, an absorbing row vector D of dimensions 1×21, representing transitions from livelihood states into the default state, and an arbitrary column vector of zeros and one.

[2] The empirical investigation has found no evidence for these extreme situations.