Project RM 4

(Credit Portfolio VaR with Regime Switching)

Financial Engineering AY 2023-24

Consider the MC simulation for Credit Portfolio Risk introduced for the discussion of RM case #2 with the aim of considering the role of migration risk across several rating classes together with the time-dependence of the rating transition process, as discussed in [1].

Students will:

i) Discuss whether the rating transition process follows a time-homogeneous Markov chain thanks to the analysis of eigenvalues and eigenvectors explained in [1], section 4.3.1. In detail, the analysis should be applied to the unconditional estimate of the transition matrices "Global Corporate" across the period 1981-2021 presented in [2], Table 21 across the time horizons: 1 year, 3 years, 5 years, 7 years. Results of the analysis should be compared to the results presented in [1], Figs. 9 and 10. Critically discuss whether the "strong evidence for the assumption of Markov properties" claimed by the authors of [1] is still valid for the global bond market two decades later[1].

ii) Assume that ratings volatility can be explained by the switch between expansion and contraction states, as discussed in [1], section 5, and assume that the matrices M_E and M_C (relative to the US market 1981-1998) shown in [1], Table 4 could be still valid today for the global corporate bond market, as well as the regime switching matrix shown in [1], Table 5 right (1981-1998). Based on these assumptions, students should simulate via MC method following the methodology outlined in [1], section 5.2.1, the unconditional 5-year rating transition matrix and discuss similarities and differences between the simulated matrix and the one presented in [2], Table 21.

iii) Extend the elementary single-factor MC model for the calculation of the Credit Portfolio VaR introduced in case RM #2, by introducing seven rating classes (i.e. AAA, AA, A, BBB, BB, B, CCC) prior to default according to the one-year rating transition matrix presented in [2], Table 21. The correlations used to derive the single-name AVR from the simulated single-factor return should be derived from the rating class of the issuer (i.e. from the one-year PD associated to each rating class - see the transition matrix above) thanks to the BCBS asset correlation function presented on page 13 of [3] with size adjustment calculated in the case of annual sales S = 50m. Evaluate the "Present Value in a years'time" according to the CreditMetrics approach of the five bonds listed at point iv) below, using the rating transition matrix to determine the forward value of each bond under each simulated rating (assuming spot Risk-free zero-coupon rate 1% constant across all maturities and recovery rate R = 25% for all issuers).

[1] Students should remove the "NR" status according to the "non-information" approach described in [1], section 3.3.

iv) Thanks to the extended MC simulation, students shall calculate the 99.9% VaR with one year time horizon for the five alternative portfolios (composed each by N = 100 coupon bonds with 5y maturity, that pay annual coupons and the Face Value FV = 1$ at maturity) issued by different corporates with same initial rating as follows:

1. All issuers with A initial rating, coupon rate 1.50%;
2. All issuers with BBB initial rating, coupon rate 1.75%;
3. All issuers with BB initial rating, coupon rate 2.50%;
4. All issuers with B initial rating, coupon rate 4.00%;
5. All issuers with CCC initial rating, coupon rate 6.00%.

Realize a library in matlab.

[1] Bangia A, Diebold FX, Kronimus A, Schagen C, Schuermann T. *Ratings migration and the business cycle, with application to credit portfolio stress testing*. Journal of banking & finance 26.2-3 (2002): 445-474.
[2] S&P Global Ratings *2021 Annual Global Corporate Default and Rating Transition Study*. April 2022
[3] Bank for International Settlements (2005), *An Explanatory Note on the Basel II IRB Risk Weight Functions* http://www.bis.org/bcbs/irbriskweight.htm July 2005.

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