Empirical yield-curve dynamics, scenario simulation and risk-measures - DTU Orbit
(19/08/2019)

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This paper has two objectives. First we will construct a general model for the variation in the term structure of interest rates, or to put it another way, we will define a general model for the shift function. Secondly, we will specify a Risk model which uses the shift function derived in the first part of the paper as its main building block. Using Principal Component Analysis (PCA) we show that it takes a 4 factor model to explain the variation in the term structure of interest rates over the period from the beginning of 2002 to early-2012. These 4 factors can be called a Slope factor, a Short-Curvature Factor, a Short Factor and a Curvature Factor.

Using the methodology of Heath, Jarrow and Morton (1990) we now specify a 4-factor model for the dynamic in the term structure of interest-rates.

This 4-factor model is afterwards being extended to have a stochastic volatility part, which we assume is to be modelled with a GARCH(1,1) process. The resulting 4-factor yield-curve model belongs to the class of USV (unspanned stochastic volatility) models, as the volatility part is un-correlated with the PCA model for the variation in the yield-curve. Our Risk-Model relies on the scenario simulation procedure of Jamshidian and Zhu (1997). The general idea behind the scenario simulation procedure is to limit the number of portfolio evaluations by using the factor loadings derived in the first part of paper and then specify particular intervals for the Monte Carlo simulated random numbers and assign appropriate probabilities to these intervals (states). Our overall conclusion is the following:

• The Jamshidian and Zhu scenario simulation methodology is best suited for the calculation of the Risk-Measure ETL - less for VaR
• We find that the scenario simulation procedure is computational efficient, because we with a limited number of states is capable of deriving robust approximations of the probability distribution
• We also find that it is very useful for non-linear securities (Danish Mortgage-Backed-Bonds MBBs), and argue that the method is feasible for large portfolios of highly complex non-linear securities - for example Danish MBBs
• Backtesting the Risk-Model setup during 2008 showed some very promising results as we were able to capture the extreme price-movements that were observed in the market

General information
Publication status: Published
Organisations: Department of Management Engineering, Management Science
Contributors: Madsen, C.
Number of pages: 61
Publication date: 2012

Publication information
Publisher: Department of Management Engineering, Technical University of Denmark
Original language: English
Keywords: Multi-factor models, PCA, Empirical yield-curve dynamics, APT, VaR, ETL, Risk-Model, Stochastic Volatility, Monte Carlo simulation, Scenario simulation, Non-linear securities - Danish MBBs
Electronic versions:
APTKUK_ADV_PHD.pdf
Research output: Book/Report › Report – Annual report year: 2012 › Research