CIMF-IESEG Conference
Cambridge 1st September 2011

Discussion of
A Term Structure Model for Defaultable European Sovereign Bonds
by
M Medeiros, L Vereda & P Burity

M A H Dempster

University of Cambridge & Cambridge Systems Associates

mahd2@cam.ac.uk www.cambridge-systems.com

Outline

- Summary of the Paper
- General Comments
- Technical Comments
- References

Overview

- This paper addresses the current reality of possible default of sovereign bonds by EMU nations by proposing an implementable framework to assess the response of their yield spreads over German bund yields to their own, German and macroeconomic variables
- For Italy, Greece and Spain – a prescient choice? – the main question addressed is “to what extent these yield spreads can be attributed to economic fundamentals” – in particular national budget deficits and debt to GDP levels – of each country in relation to those of Germany
- An affine model is developed to explain the short rate and market prices of risk for sovereign bonds of various maturities for the EMU nations together with Germany and adds factors in the yields – discount factors – for losses and illiquidity in the sovereign bonds of the former
- An SVAR model is developed to estimate the impact on one nation’s spreads and Germany’s corresponding yields for 9 maturities up to 10 years in terms of their 3 leading covariance eigenvalue factors and macroeconomic variables – industrial production, inflation, deficit/GDP, debt/GDP and a market risk indicator – for each nation

Findings

- Factor loadings on the yield curve for the macroeconomic variables and impulse responses over 1, 5 and 10 years of the spreads to macroeconomic variable shocks are analyzed
- These accord with intuition
- Market stress – Moody's Baa corporate bond yield – in all three countries affects the long end of the spread curves for maturities 6 to 8 years – bearing in mind that 10 years is the maximum studied – wise?
- For Italy the one standard deviation shocks which have the largest impulse responses on one year maturity spreads are **market stress**, **Germany's debt** and **national debt**
- For Spain these are **Germany's debt**, **market stress** and **national debt** have the largest impacts
- For Greece these are **national debt** and **deficit**
- For all three countries the largest impact of national debt is on one year spreads – reflecting annual budget cycles?

General Comments

- Some of the conclusions drawn in the paper strike the reader as quite obvious
- “A possible explanation (for the importance of German debt) is a perception of markets that Germany is the lender of last resort (for) the largest economies in the EMU”
- The yield curve factor loading of industrial activity is always negative “suggesting that economic growth is perceived as reducing sovereign risk”
- The paper contains a good literature survey and informative graphs
- While generally clear and well written it is confusing and unclear in some places
- Some terminology could be improved e.g. yields are not always“paid” but mostly only realized and affine functions are referred to as “linear”
- There is a derivation on p.6 which appears never to have been used and perhaps the others on p.6 are not needed in specifying the affine model used
- Some references are missing

Technical Comments

- It is the use of the exponential affine model that actually guarantees arbitrage free bond yields – both risk free (German) and defaultable
- The assumption (Hypothesis 3) that the impacts of the factors and macroeconomic variables on loss rates and illiquidity costs are uniform across yield maturities is a bit heroic
- The Cochrane & Piazzi (2008) practice of orthogonalizing yield factors with the macroeconomic variables implies that only yield variability uncorrelated with the other variables remains which is to my mind somewhat roundabout and needs some explanation and justification
- Each country / Germany SVAR model has 370 parameters with 1945 observations – approximately 5 observations per parameter! Enough?
- In Appendix 3 “identifying “ parameter (0) restrictions are made which imply that the structural form of the SVAR model could be directly estimated by OLS as it is in Wold recursive – or cascade – form

Some Queries and Suggestions

- How were the x-axes of the impulse response diagrams scaled?
- Are those several with virtually no impact understood?
- The text should always refer in full to "industrial activity"
- How was the bootstrap parameter error estimation actually achieved?
- Rather than using proxy monthly variables at quarterly frequency to interpolate quarterly macroeconomic variables at monthly frequency were other methods for this common problem considered?
- We have had success with deterministic scaling Dempster *et al.* (2003)
- Have alternative arbitrage –free factor evolution specifications such as the Christensen *et al.* (2007) enhancement of Nelson &Siegel (1987) been considered?
- Have the use of latent yield curve factors with some form of Kalman filtering with maximum likelihood parameter estimation in the EM algorithm been considered? Such methods are amenable to including observed macroeconomic variables in the state variable dynamics and filtering

Are Three Factors Sufficient?

Table 1: **PCA results for oil futures and interest rates**

	variance explained – interest rates (%)	variance explained – oil futures (%)
first factor	95.70	93.55
second factor	4.06	5.89
third factor	0.21	0.47
fourth factor	0.02	0.07
fifth factor	0.00	0.02

Litterman & Scheinkman (1991)

The Exponential Affine Model

$$F_t(\tau) = \mathbb{E}_t^Q[\exp(\boldsymbol{v}_T)]$$ Future price

$$P_t(\tau) = \mathbb{E}_t^Q[\exp(-\int_t^T \boldsymbol{r}_s ds)],$$ Bond price

$$\boldsymbol{x}_t = \phi_0 + \phi_Y{}'\boldsymbol{Y}_t,$$ Observation dynamics

$$d\boldsymbol{Y}_t = K(\Theta - Y_t)dt + \Sigma\sqrt{\Upsilon}d\boldsymbol{W}_t^Q,$$ Factor dynamics

$$Z_t(\tau) = \exp[A(\tau) + B'(\tau)Y_t],$$ Price dynamics

State Space Model Formulation

Transition Equation

$$\boldsymbol{Y}_t = d + \Phi Y_{t-1} + \boldsymbol{\eta}_t,$$

$$\begin{aligned} E[\boldsymbol{Y}_t | Y_{t-1}] &= d + \Phi Y_{t-1} \\ var(\boldsymbol{\eta}_t) &= var(\boldsymbol{Y}_t | Y_{t-1}) = \Omega(Y_{t-1}) := \Omega_t \end{aligned}$$

Measurement Equation

$$\mathcal{Z}_t = \mathcal{A} + \mathcal{B} Y_t + \varepsilon_t$$

Measurement Error Specification

We define the new state vector X in terms of Y and ε, i.e. $X_t = \begin{pmatrix} Y_t \\ \varepsilon_t \end{pmatrix}$

and assume that ε_t follows a first order vector auto-regressive process

$$\varepsilon_t = \Pi \varepsilon_{t-1} + u_t$$

Then the **augmented state space form** becomes

$$\begin{aligned} X_t &= f + GX_{t-1} + w_t \\ Z_t &= A + CX_t, \end{aligned}$$

Dempster & Tang (2011)

References

J Christensen, F Diebold & G Rudebusch (2003). The affine arbitrage-free class of Nelson-Siegel term structure models. Working Paper, Federal Reserve Bank of San Francisco

J H Cochrane & M Piazzi (2008). Decomposing the yield curve. Working Paper, Booth Business School, University of Chicago

M A H Dempster, M Germano, E A Medova & M Villaverde (2003). Global asset liability management. *British Actuarial Journal* **9** 137-216

M A H Dempster & K Tang (2011). Estimating exponential affine models with correlated measurement errors: Applications to fixed income and commodities. *Journal of Banking & Finance* **35** 639-652

J Durbin & S J Koopman (2001). *Time Series Analysis by State Space Methods*. Oxford University Press

R Litterman & J Scheinkman (1991). Common factors affecting bond returns. *Journal of Fixed Income* **1** 54-61

C Nelson & A Siegel (1987). Parsimonious modelling of yield curves. *Journal of Business* **60** 473-489