CALIBRATING AND ESTIMATING EXPONENTIAL–AFFINE MODELS IN R

Pedro Duarte Silva, Faculdade de Economia e Gestão, UCP – Porto
psilva@porto.ucp.pt

Lia Vaz Cruz, IGFCSS
lia.v.cruz@seg-social.pt

EXPONENTIAL – AFFINE MODELS

Popular Class of Continuous-Time Dynamic Models used in Financial Applications

Highly Flexible Models
+
Reasonable Tractability

Main Applications

- Modelling Term Structure of Interest Rates
- Modelling Term Structure of Defaultable Claims
- Asset Pricing of Derivatives

CALIBRATION & ESTIMATION

Fits model parameters to a cross section of market prices		Fits model parameters to a panel of market prices over a period:
Continuous update with evolving market conditions possible	↔	Assumes model remains valid for the whole estimation period
Not statistically based + Limited amount of market information	↔	Statistically based + Use of a larger set of information

Hard Problem: High Dimensionality + Identification Issues + Likelihoods (usually) of unknown form
Requires Integration of Different Mathematical Tools: Optimization routines + ODE solvers + Linear algebra systems
Computationally Very Intensive & Rapidly Evolving Literature

Estimation Problems

Current Practice Program a "reasonable" procedure in a formal (ex: C, Fortran) or high-level (ex: MathLab) language and "*hope for the best*"

OUR PROPOSAL

Build an integrated set of *R* functions and utilities for Exp-Affine Models: *Calibration + Estimation + Analysis*

Several choices incorporating recent advances in literature

Currently includes Multi-Factor Models for Term Structure of Interest Rates with the possibility to choose:

Estimation Method (quasi) maximum likelihood considering
- All Yields measured with errors (Kalman Filter)
- N Yields measured without errors
- First N Principal Components measured without errors

Different Market Price of Risk Assumptions

Non or cross correlated errors

Planned Asset Pricing models including: **Jumps** & **Stochastic Volatility**

EXAMPLE

Estimate a 3-Factor Completely Affine Gaussian Model from a panel of German Yields (RtT):
Open in R **`EstimTermSInt.R`**

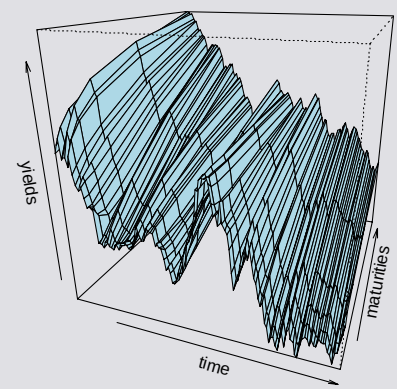
Run the **`EstIntRMod`** function with chosen Model and Inputs (initial parameters necessary):

```
ResA03 <- EstIntRMod ( m = 0,  N = 3,  ntrials = 10,
freepar = c(freeLDKappaDDg,delta0g,deltayg,lambda1g, sqrSigeg),
freeparsd = c(freeLDKappaDDsd,delta0sd,deltaysd,lambda1sd,sqrSigesd),
Yielddata = RtT,   tau = c(0.25,0.5,1,2,5,10),   h = 1/52,
estmethod = "fxyld",  fyi = c(1,4,6),   MktPRpar = "Completely" )
```

Estimated Parameters + Value Log-(quasi)Likelihood + State Variables(X)
+ other possibilities

ESTIMATE OTHER SPECIFICATIONS AND COMPARE !!

Completely Affine Results



Code Available
- please contact -
psilva@porto.ucp.pt

References

DAI, Q. and SINGLETON, K. (2000), Specification Analysis of Affine Term Structure Models. Journal of Finance, 55, p. 1943-1978.
DUFFIE, D. PAN, J. and SINGLETON, K. (2000). Transform Analysis and Asset Pricing for Affine Jump-Diffusions, Econometrica, 68 (6), p. 1343-1376.
R DEVELOPMENT CORE TEAM (2008). R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing , Vienna, Austria. ISBN 3-900051- 07-0, URL http://www.R-project.org