CREST - GENES
Cours doctoraux 2019-2020

Short-Course Proposal :

Risk Estimation via Copulas and Curve Time Series

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SCHEDULE	Thursday	09th January 2020 16 th January 2020 23 th January 2020 30 th January 2020	De 14h0 à 17h00 De 14h0 à 17h00 De 14h0 à 16h00 De 14h00 à 16h00	Salle 2001

Abstract

In this mini course the problem of estimating and forecasting market risk (specifically Value at Risk and Expected Shortfall) is addressed via two different approaches: dynamic copulas and curve time series. These approaches have been independently developed in the literature and have a broader potential than dealing with risk forecasting. This course is developed around the results of a series of research papers, published during the last ten years, which are co-authored by the proponent.

1. **Copulas** (for continuous variables): general introduction, Sklar´s Theorem for the conditional case, decomposition of the joint probability density function, maximum likelihood estimation, etc.

2. **Dynamic Copulas**: does it make sense that dependence parameters vary over time?
    a. A. Patton`s (2006) Dynamics: a point to start. We discuss his proposal for the copula parameters dynamics, comparing it to static copulas.
    b. Markov Switching Dynamics: here we go further in terms of flexibility by allowing that certain parameters in the equation governing the dynamics of the copula dependence parameters change according to a hidden Markov chain.
        i. O. Silva Filho, F. Ziegelmann, M. Dueker (2012): copula parameters vary via Patton´s (2006) approach but are also dynamically described by an equation in which the constant can switch according to a hidden Markov chain.

ii. P. Tofoli, F. Ziegelmann, O. Silva-Filho (2017): here the copula function itself can vary according to a hidden Markov chain.
iii. D. Tabak and F. Ziegelmann (work in progress): we replace Patton´s (2006) parameter dynamics by GAS (generalised autoregressive scores) models introducing a Markov switching as in i).

c. Vine Copula (P. Tofoli, F. Ziegelmann, O. Silva Filho and P. Pereira 2019): we choose a D-vine structure applying time dynamics for a low-dimensional case.
d. Factor Copula with GAS (A. Patton and D. Oh, 2017; M. Bartels and F. Ziegelmann, 2016): we employ a one factor copula model for a high-dimensional vector of random variables. It is a computationally challenging problem, since all the computations and estimations are performed numerically. We restrict ourselves to the one factor copula case.

3. **Curve Time Series**
   a. Theory and Inference (N. Bathia, Q. Yao and F. Ziegelmann, 2010): functional analysis for curve time series is introduced. Finite dimensionality is a key assumption for the method. Then it reduces to a kind of functional principal component analysis.
   b. Forecasting (E. Horta and F. Ziegelmann, 2018): a forecasting approach for the work in a) is designed using several different strategies.

4. **Applications to Volatility and Risk Forecasting** (previous papers): a common objective. Despite having broader objectives than simply estimating and forecasting risk, we focus our applications of dynamic copulas and curve time series to risk forecasting.

5. **Conditional VaR and Portfolio Optimization** (F. Silva and F. Ziegelmann, work in progress): an interesting problem from an applied point of view. Here copulas are employed to optimize portfolios that have low Conditional Value at Risk.

References:

1. Market risk forecasting for high dimensional portfolios via factor copulas with GAS dynamics, Bartels, M., and Ziegelmann F. A., Insurance Mathematics & Economics, Volume 70, p.66-79, (2016)
2. Identifying the Finite Dimensionality of Curve Time Series, Bathia, N., Yao Q., and Ziegelmann F. A., Annals of Statistics, Volume 38, p.3352-3386, (2010)
3. Dynamics of financial returns densities: A functional approach applied to the Bovespa intraday index, Horta, E., and Ziegelmann F. A., International Journal of Forecasting, Volume 34, p.75-88, (2018)
4. Modelling Asymmetric Exchange Rate Dependence, A. Patton, International Economic Review, 47(2), 527-556, (2006).
5. *Modelling Dependence in High Dimensions with Factor Copulas*, D.H. Oh, Journal of Business & Economic Statistics, 35(1), 139-154, (2017).
6. F. Silva and F. Ziegelmann (work in progress)
7. Modeling dependence dynamics through copulas with regime switching, Filho, Silva O. C., Ziegelmann F. A., and Dueker M., Insurance Mathematics & Economics, Volume 50, p.346-356, (2012)
8. D. Tabak and F. Ziegelmann (work in progress)
9. A Comparison Study of Copula Models for European Financial Index Returns, Tofoli, P., Ziegelmann F. A., and Filho Silva O. C., International Journal of Economics and Finance, Volume 9, p.155-178, (2017)
10. Dynamic D-Vine Copula Model with Applications to Value-at-Risk (VaR), Tofoli, P., Ziegelmann F. A., Silva Filho O. C., and Pereira P. L. V., Journal of Time Series Econometrics, Volume 11, Issue 2, p.20170016, (2019