



ABCDE



Scientific Report

First name / Family name

Luis Ortiz Gracia

Nationality

Spanish

Name of the *Host Organisation*

CWI

First Name / family name
of the *Scientific Coordinator*

Cornelis W. Oosterlee

Period of the fellowship

01/10/2012 to 30/09/2013



I – SCIENTIFIC ACTIVITY DURING YOUR FELLOWSHIP

My research activity was carried out in the Scientific Computing group at CWI, the national research institute for Mathematics and Computer Science in the Netherlands, under the supervision of Professor Cornelis W. Oosterlee.

During the fellowship period, I focused my research on option pricing and market risk measurement. The first topic concerns the robust and efficient valuation of financial products, like options, by numerical techniques. This is an interesting recent field in applied mathematics and scientific computing. My second work was devoted to the study of numerical methods to evaluate market risk on portfolios of options, that is, the potential loss over the whole portfolio which may arise due to movements in market prices.

I had the opportunity to attend interesting conferences and courses in my field of interest, participate in referee processes, supervise the research work of an MSc post-graduated, as well as expand my scientific contact network.

I stay in contact with Professor Oosterlee and we aim to cooperate and publish more papers in the near future.

II – PUBLICATION(S) DURING YOUR FELLOWSHIP

1. L. Ortiz-Gracia and C.W. Oosterlee (2013). Robust pricing of European options with wavelets and the characteristic function. Accepted in *SIAM Journal on Scientific Computing*, available at www.ssrn.com.

Abstract. We present a novel method for pricing European options based on the wavelet approximation (WA) method and the characteristic function. We focus on the discounted expected payoff pricing formula, and compute it by means of wavelets. We approximate the density function associated to the underlying asset price process by a finite combination of j -th order B-splines, and recover the coefficients of the approximation from the characteristic function. Two variants for wavelet approximation will be presented, where the second variant adaptively determines the range of integration. The compact support of a B-splines basis enables us to price options in a robust way, even in cases where Fourier-based pricing methods may show weaknesses. The method appears to be particularly robust for pricing long-maturity options, fat tailed distributions, as well as staircase-like density functions encountered in portfolio loss computations.

2. L. Ortiz-Gracia and C.W. Oosterlee (2013). Efficient VaR and Expected Shortfall computations for non-linear portfolios within the delta-gamma approach. Submitted for publication, available at www.ssrn.com.

Abstract. We present four numerical methods to compute the Value-at-Risk and Expected Shortfall risk measure values of portfolios with financial options. The numerical methods are based on either wavelets or Fourier cosine approximations and belong to the class of Fourier inversion methods. We show that the risk measures can be efficiently calculated in terms of accuracy and CPU time. Besides, we provide a



theoretical result about the shape of the resulting probability density. This \emph{a priori} knowledge, allows us to enhance the efficiency and effectiveness of the proposed methods. Finally, we assess the accuracy of the approach in the presence of convexity or concavity properties of the financial portfolios.

III – ATTENDED SEMINARS, WORKHOPS, CONFERENCES

1. **Attended** *ERCIM ABCDE Seminar* at INRIA, Sophia Antipolis, France, 24/10/2012-25/10/2012.

2. **Co-organizer** (with Prof. Joan del Catillo) of the *Jornada CRM-Empresa sobre Finances Quantitatives*. Industry-Academia workshop at Centre de Recerca Matemàtica, Barcelona, Spain, 22/02/2013.

3. **Talk** *Medición Eficiente del Riesgo de Concentración en Carteras de Crédito con las Onditas de Haar*. Workshop at Centre de Recerca Matemàtica, Barcelona, Spain, 22/02/2013.

4. **Talk** *Efficient Credit Risk Measurement at Portfolio Level with Haar Wavelets*. Seminar at Université Marne-la-Vallée, Paris, France, 8/03/2013.

5. **Talk** *Robust Pricing of European Options with Wavelets*. Seminar at CWI, Amsterdam, The Netherlands, 15/04/2013.

6. **Attended** *Werkgemeenschap Scientific Computing*. Annual spring meeting at CWI, Amsterdam, The Netherlands, 17/05/2013.

7. **Talk** *Robust Pricing of European Options with Wavelets*. Seminar at University of Antwerp, Antwerpen, Belgium, 28/05/2013.

8. **Attended** *Summer School on Computational Aspects of Uncertainty Quantification*. Advanced courses by M. Giles (Oxford University) at University of Leuven, Leuven, Belgium, 30/05/2013-31/05/2013.

9. **Attended** *Financial Engineering Summer School*. Advanced Courses by D. Brigo, J. Gatheral, R. Martin and A. McNeil at Bolsa de Barcelona, Barcelona, Spain, 18/06/2013-21/06/2013.

10. **Talk** *Robust Pricing of European Options with Wavelets*. Financial Engineering Summer School, Barcelona, Spain, 18/06/2013-21/06/2013.

11. **Talk** *Robust Pricing of European Options with Wavelets*. Congreso de Matemática Aplicada, Castellón, Spain, 9/09/2013-13/09/2013.

12. **Talk** *Robust Pricing of European Options with Wavelets*. International Conference on Scientific Computation and Differential Equations, Valladolid, Spain, 16/09/2013-20/09/2013.



IV – RESEARCH EXCHANGE PROGRAMME (REP)

1. My first stay took place at INRIA, Paris, France, 04/03/2013-08/03/2013. My stay there was supervised by Professor Antonino Zanette, the scientific leader of Premia. I had the opportunity to implement in the Premia software systems an algorithm developed by me. Further, I had fruitful discussions with Antonino regarding computational methods in Finance, my field of expertise. I also gave a talk at Université Marne-la-Vallée during my stay there.

2. The second stay was at University of Antwerp, Belgium, 27/05/2013-31/05/2013, and was supervised by Professor Karel in't Hout. I gave a talk at University of Antwerp to disseminate my research carried out during my ERCIM fellowship, and I attended an advanced course at University of Leuven about Monte Carlo methods given by Mike Giles from Oxford University. I also had the opportunity to discuss with Karel and his team about numerical methods in Finance.