

## Project Update – Michael Tehranchi

Since the renewal of my fellowship, I have been working on several research projects. The project most related to my proposal is on the development of polynomial models. As described in my key findings to date, easy-to-check necessary and sufficient conditions on the model parameters have been found. This work was done jointly my former PhD student Si Cheng, who now works at a hedge fund in London. The paper has been reviewed, and a revision has been requested from *Mathematical Finance*.

I have also been working on implied volatility. Implied volatility is a useful quantity for financial practitioners, but is difficult to calculate directly from models. I have derived uniform bounds on implied volatility which improve upon the existing asymptotic expansions. The paper was accepted for publication by the *SIAM Journal on Financial Mathematics*, and indeed, has already appeared.

In another stream of research, I have discovered that the set of arbitrage-free call prices has the mathematical structure of a noncommutative semigroup. The analysis of this structure has given rise to new families of tractable equity derivative pricing models. The paper has been submitted and is now under review.

I am continuing my work with my PhD student, David Driver, connecting certain Merton-style optimal investment problems with classical reaction-diffusion equations. Our approach sheds new insight on the equations; moreover, physically interesting quantities such as the speed of travelling wave fronts can be calculated from our new representations.

In work that at first seems far removed from finance, I have collaborated with colleagues in Astrophysics studying black hole accretion disks. By modelling the complicated turbulent dynamics by Brownian motion, we were able to calculate the statistics of thermal instability. It turns out the computations are similar to the computations of the price of certain path-dependent options in the Black-Scholes model. This paper was accepted by the *Monthly Notices of the Royal Astronomical Society*, and has already appeared.

Since April 2016, the following papers have been accepted for publication:

MRI turbulence and thermal instability in accretion disks. *Monthly Notices of the Royal Astronomical Society*. <https://doi.org/10.1093/mnras/stx564>. (2017) (with J. Ross and H.N. Latter)

Uniform bounds for Black-Scholes implied volatility. *SIAM Journal on Financial Mathematics*. 7:893-916. (2016)

A revision has been requested for the following paper:

Polynomial term structure models. Available at <http://arxiv.org/abs/1504.03238> (with S. Cheng)

The following paper has been submitted and is under review:

A Black-Scholes inequality: applications and generalisation. Available at <http://arxiv.org/abs/1701.03897> (2017)

I have presented my research at the following seminars and conferences:

Meeting on Rough Volatility, Imperial College London, October 2016.

London Mathematical Finance Seminar Series, December 2016.

Workshop on Mathematics of Quantitative Finance, Oberwolfach Research Institute for Mathematics, February 2017.