

Project Update – Michael Tehranchi

Since my last report, I have continued my collaboration with David Driver. Our starting point is a certain Merton-style optimal investment problem. The investor tries to maximise the expected utility of a stream of consumption in a market where the volatility is a function of an economic factor whose dynamics are correlated with the price dynamics. The corresponding Hamilton-Jacobi-Bellman equation, after some transformations, reduces to a particular reaction-diffusion equation, called the FKPP equation. Coincidentally, the FKPP equation arises in several applications, for instance, in population genetics. There is interest in the new insight that our economic approach sheds on the equation. Two papers have been written, one already submitted and the other under preparation to be submitted soon. I should mention that I was the supervisor of David's PhD. He had his viva in February.

I have also been following up on work that I did with Chris Rogers several years ago on the dynamics of the implied volatility surface. In that work, we answered a question of Steve Ross of whether the implied volatility surface could move by parallel shifts. We found that, subject to some assumptions, the answer is no. In the follow-up work, I removed the assumptions and find that even the at-the-money implied volatility term structure cannot move by parallel shifts. This work was presented at the Cambridge-Lausanne conference.

The paper on polynomial models written jointly my former PhD student Si Cheng is still in the review process *Mathematical Finance*.

The paper on a certain Black-Scholes inequality and semigroup structure of the set of arbitrage-free call is still in the review process with *Finance & Stochastics*.

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

Inequalities for the Gaussian measure of convex sets. *Electronic Communications in Probability* 22(51): 1-7. (2017)

If B and $f(B)$ are Brownian motions, then f is affine. *Rocky Mountain Journal of Mathematics*. 47(3): 947-953. (2017)

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 by *Mathematical Finance* for the following paper:

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

A revision has been requested by *Finance & Stochastics* for the following paper:

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

The following paper has been submitted and is currently under review:

Optimisation-based representations for a class of reaction-diffusion equations. (with D. Driver)

The following papers are in preparation:

Parallel shifts of the at-the-money implied volatility.

Duality for a Merton problem with CRRA utility and a correlated factor. (with D. Driver)

Why does residual risk become relatively more important the more diversified the portfolio is? (with S. Satchell)

Spectral term structure models. (with S. Cheng)

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

Cambridge-Lausanne Workshop, Cambridge, March 2018.

Tokyo Metropolitan University Workshop on Finance, August 2017.

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

London Mathematical Finance Seminar Series, December 2016.

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