Slide Titre : Deep Learning Volatility – Introduction, numerical results and POC

**Slide 1: Reference**

Référence : « Deep Learning Volatility, A deep neural network perspective on pricing and calibration in (rough) volatility models ». Blanka Horvath Department of Mathematics, King’s College London – Aitor Muguruza Department of Mathematics, Imperial College London & NATIXIS – Mehdi Tomas CMAP & Ladhyx, Ecole Polytechnique

Submitted online in January 29th and planned to be presented at QuantMinds 2019.

Link to the paper: <https://arxiv.org/pdf/1901.09647.pdf>

Link to a presentation: <https://www.youtube.com/watch?v=O03erV5nYXA>

**Slide 2: Tractability supplants modelling accuracy**

Some popular pricing models: BS (closed formula); SABR (asymptotic IV formula); Heston (Fourier pricing)

All these models have well known hiccups but are still used thanks to their tractability despite more accurate models are available in the quant literature 🡺 SV with jumps, Rough vol,…

Problem: calibration on market data

Choices made by financial institutions: **Fast calibration** VS accurate pricing

It would be simpler if one had a “formula” that directly outputs the market observable (IV surface) for a given choice of model parameters of the stochastic.

**Slide 3: Combining both advantages with Deep Learning**

* Pricing vanillas: no models needed (only BS formula as a transform tool)
* Hedging (exotic) derivatives: accuracy in modelling is crucial

Splines, SVI 🡺 parameters directly translated into a shape of an IV surface.

SABR 🡺 We have a formula (asymptotic expansion, with limitations) which links the model assumptions about the underlying with the shape of the IV surface. However, it tends to be only used as a “Data Model”.

A solution to have “Best of both worlds”: deep learning in a two-step approach.

**Slide 3: A two-step approach for the calibration**

1. LEARN A MODEL

* “Off-line” process: learn (approximate) the mapping of the stochastic parameters to the IV surface.
* Can take time but is done only 1 time!

1. CALIBRATE TO DATA

* “On-line” process: calibrate the now-deterministic learned price map.
* Speeds-up the on-line calibration by orders of magnitude.

Why not directly calibrate to data with an ANN?

* Meaning of calibrated network parameters unexplained and ambiguity about the number of network parameters and design 🡺 challenges towards today’s regulatory requirements
* Out of sample performance seems to differ from the in sample one (A. Hernandez. Model calibration with neural networks. Risk, 2017).

Why use ANN to learn a pricing functional (IV surface) of a model?

* Interpretability of model parameters, risk management of libraries of models remains valid. Network parameters do not need interpretation.
* Availability of training data: synthetically generated hence not an issue.
* Extends the scope of models that can be used in production

**Slide 4: Numerical results (Graphes Blanka)**

**Slide 5: Conclusion of the paper and extensions to “best-fit” models**

**Slide 6: POC with Heston (QuantLib) and Python (Scikit learn)**