Modelling Oil and Copper Commodity Prices Through Term Structure Estimation: New R Package NFCP useful in future commodity pricing research

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Commodities are consumption goods. They differ in several key fundamental aspects to other asset classes.

Short-term and long-term oil futures prices (2015-2021)

Many commodity prices exhibit

- Short-term behaviour
- Long-term behaviour
- Mean-reversion
- Seasonal trends
- Volatility clustering
- Shocks and jumps
- The Samuelson Effect

N-factor modelling of commodity prices can capture these characteristics:

$$\ln\big(S(t)\big) = \sum_{i=1}^{N} x_i(t)$$

$$dx_1(t) = \mu^* dt + \sigma_1 dw_1 t$$

$$dx_i(t) = -\big(\lambda_i + \kappa_i x_i(t)\big)dt + \sigma_i dw_i t, \qquad i > 1$$

Many commodities have liquid futures markets. N-factor models can be estimated through term structure estimation using futures prices.

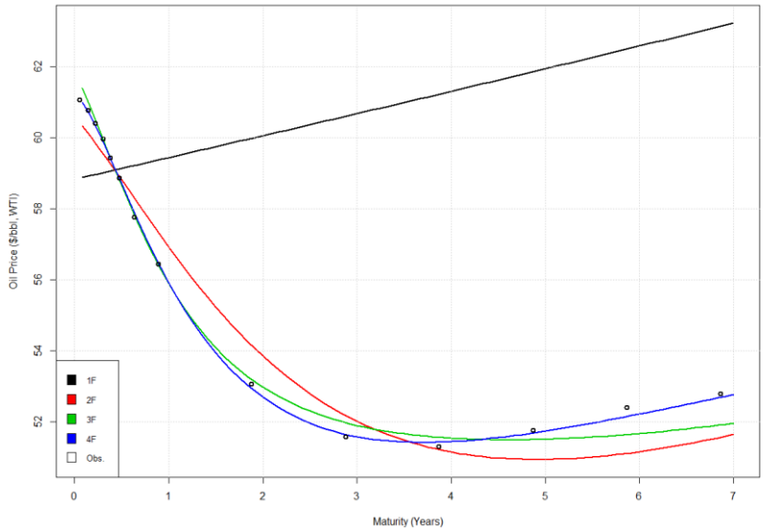
The new R package NFCP estimates and analyzes commodity pricing models:

- Parameter estimation through maximum likelihood estimation
- Analytic European options on futures contracts pricing
- Numeric American options on futures contracts pricing
- Probabilistic forecasting and Monte Carlo simulation of spot and futures prices

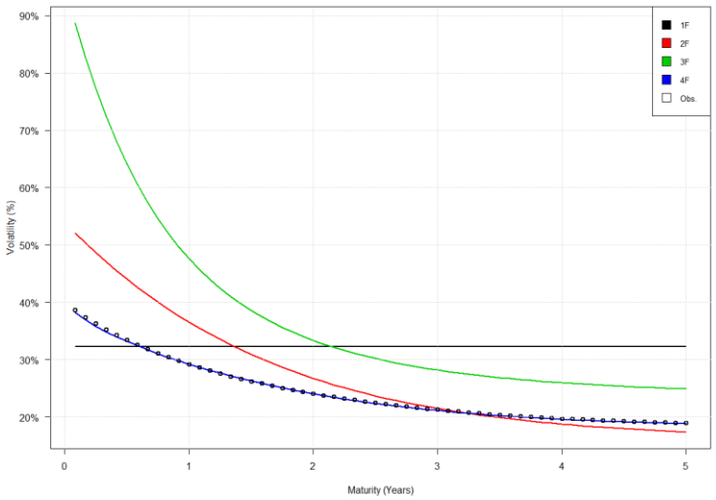
Case Study

Oil	Copper
Four-Factors	Three-Factors

- Significant mean-reversion observed for both commodities
- Oil is driven by more complex characteristics and requires a greater number of factors N
- High observed fit for both commodities



Oil futures price curve (2019-12-31)



Oil volatility term structure (2019-12-31)

- Increasing the number of factors will generally increase model fit to stability and performance metrics

	1F	2F	3F	4F
Oil	12.1%	2.7%	2.1%	1.1%
Copper	1.7%	0.8%	0.7%	-

Out-of-sample RMSE (%)

- High out-of-sample fit, implying stability in estimates and that they can be used for forecasting prices

Commodity Pricing Models are important for:

- Valuing and hedging commodity contingent claims
- Valuing natural resource investments through discounted cash flow and real options analysis
- Other commodity related investments