Dimensionality Reduction for Large Portfolios

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The paper presents a two-step procedure for dimensionality reduction of large commodity portfolios. Such portfolios typically contain futures contracts for several commodities and for different expiry months. Dimensionality reduction across expiries for a single commodity is achieved by means of a 2-factor forward curve model, which extracts two fundamental factors: a level and slope of each forward curve. Dimensionality reduction across commodities is obtained by performing principal component analysis (PCA) of commodity-specific fundamental factors (levels and slopes).
The procedure enables to model the portfolio variance using only the first few principal components, significantly reducing the dimensionality of the problem. A range of GARCH specifications is considered for modelling the principal components' series, including GARCH with macroeconomic variables or GJR-GARCH with leverage effects. Finally, a framework for PCA-based Value-at-Risk estimation is proposed and backtested on an energy portfolio example.

Keywords: commodity futures; factor models, principal components; GARCH; Value-at-Risk.