



Common Problems Faced by Institutional Traders

- Optimal order placement (limit order): Guo, De Larrard, and Ruan [2013], Guilbaud and Pham [2013], Fodra and Pham [2013a]
- Optimal order execution (market order): Obizhaeva and Wang [2013], Alfonsi, Fruth, and Schied [2010], Almgren and Chriss [2001], Tsoukalas, Wang, and Giesecke [2012], Horst and Naujokat [2013]
- We try to solve the following problem: If an institutional trader wants to buy given amount of shares from the limit order book within a given period, how should he strategically split the shares over time to minimize the execution cost, considering the market response.





EXIT

Introduction

Markowitz: The

Markowitz (1952)
in theory.

His formulas use

- (i) the vector of
 - (ii) the covarian
- of the returns on

In practice, these
estimated some

This problem has

- a source of
- a source of

OUTLINE

- 1 Model-Driven Approach
- 2 Adaptive Hedging Strategies
- 3 Simulation and Empirical
- 4 Conclusion

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Combining Return

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Joint work with Steven S.G.



The CBOE

- Introduced in 1993 and revised in 2004
- Estimates the expected volatility of the S&P 500 (SPX)
- Averages the weighted price of SPX puts and calls for a wide range of strike prices

Bayesian Inference

- Let $X_1 = (X_{11}, \dots, X_{1n})$, $Y_1 = (Y_{11}, \dots, Y_{1n})$ be some given \mathcal{D} and let $\pi(\theta)$ be the prior density of θ .
- Bayesian inference:
 - Marginal posterior

$$p(\theta | \mathcal{D}) \propto \pi(\theta) \prod_{i=1}^n p(X_i | \theta, Y_i)$$



Functional Principal Components for Derivatives of High-Dimension

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Even the most conservative and highly regulated investors
are using leverage





Markowitz's Portfolio Problem

- *Mean-Variance Consideration:*

For a single investment period, an agent seeks to minimize the risk of his/her investment, measured by the variance of his/her portfolio return (R_p), subject to a given mean return (target).

- Varying the target level leads to the so-called *efficient frontier* (with/without risk-free asset).

- Optimal portfolio depends on *individual's* preference towards risk (utility function).

- This talk considers $E(R_p) - (\gamma/2) \text{Cov}(R_p)$.
- $\gamma (> 0)$ measures the investor's degree of risk-aversion.





The conditional mean and error of a particle filter = MCMC with specified model parameters can be decomposed as a sum of $E[(X_T - \hat{x}_T)^2 | \mathcal{Y}_t]$ and Monte Carlo variance, and both can be consistently estimated.

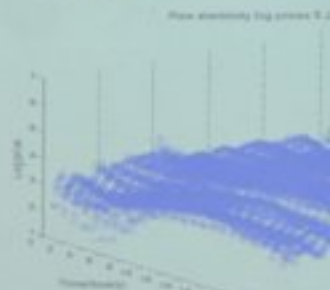
- The situation when there are unknown parameters can be handled by different methods. When there are finite-dimensional sufficient statistics α_t , [Schorf \(2002\)](#) has proposed an adaptive particle filter that samples β from $q(\beta | \alpha_t)$ and updates the sufficient statistics by propagating $\alpha_t \rightarrow \beta(\alpha_{t+1}, \beta, \alpha_t)$.
- In the past few years, much attention has been given to MCMC that offers new promise for complex models. (Della Pietra) has led to an alternative approach that uses MCMC for the substitution of atoms to approximate the posterior.
- Another approach is to use recursive maximum likelihood. In this case, we can decompose the conditional error as a sum of variance of MLE, Monte Carlo variance of particle filter, and $E[(X_T - \hat{x}_T)^2 | \mathcal{Y}_t]$.
- The missing component (estimation of beta) is actually closely related to recursive MCMC.



Autoregression

Many economic and financial time series exhibit a strong degree of autoregression over long horizons. This is reflected in the high cross correlation between variables.

CA electricity (log) prices: 5 Jul 1998



AFAP

1.38

1.09

0.88

$\{X_t\}$ be a Markov chain and let Y_1, Y_2, \dots be independent given X , such that

$$X_t \sim p_0(\cdot | X_{t-1}), \quad Y_t \sim g_0(\cdot | X_t).$$

homogeneous HMM here for notational simplicity, but Y_t is observed whereas the X_t 's are hidden states, e.g.

(X_t = location, Y_t = sensor information),
volatility models (X_t = volatility, Y_t = returns).



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