

# Time Series Analysis

## Homework assignment #5

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### Problems

1. Show that the innovations  $v_t = Y_t - E(X_t|Y_{1:t-1})$  in the local level model are mutually independent for different values of  $t$ .
2. Download 5 years worth of most recent daily levels of AAPL and S&P 500. Use Bloomberg as the data source: adjusted daily closes (Bloomberg symbols AAPL Equity and SPX Index, respectively). Let  $r_t$  and  $m_t$  denote the daily returns on AAPL and SPX, respectively. Consider the following CAPM model:

$$r_t = \alpha_t + \beta_t m_t + u_t, \quad (1)$$

where  $u_t$  are the residuals. The parameters  $\alpha_t$  and  $\beta_t$  are estimated daily by means of a linear regression based on a 3 month (63 days) rolling window. You are interested in observing  $\alpha_t$  as a trading signal.

- (i) We will formulate this model as the following local level model. Set  $X_t = \alpha_t$ ,  $Y_t = r_t - \beta_t m_t$ ; then

$$X_{t+1} = X_t + \varepsilon_{t+1},$$

$$Y_t = X_t + u_t.$$

Assume that the variances of  $\varepsilon_t$  and  $u_t$  are constant, and treat the values of  $\beta_t$  as known.

- (ii) Construct and run the Kalman filter for this model. Plot the graph of the observed vs filtered values of  $\alpha_t$ . Plot the graph of the smoothed values of  $\alpha_t$ . Evaluate the predictive power of this model.

**This assignment is due on March 16**