References


Table 1

Maximum likelihood parameter estimates of the Markov regime switching model of short term riskless interest rate dynamics:

\[ r_{t+1} = \sigma_r^2 \epsilon_{t+1} \]  \hspace{1cm} (16)

\[ \ln(\sigma_r^2) = \theta + \beta I_t. \]  \hspace{1cm} (17)

Short term riskless rates are proxied by one-month Treasury yields obtained from the CRSP riskfree file. The sample period is June 1964 to December 1989*.

<table>
<thead>
<tr>
<th></th>
<th>( p )</th>
<th>( q )</th>
<th>( \theta )</th>
<th>( \beta )</th>
<th>( \gamma )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimate</td>
<td>0.9351</td>
<td>0.0393</td>
<td>-5.1987</td>
<td>-1.6900</td>
<td>0.6792</td>
</tr>
<tr>
<td>Std Error</td>
<td>(0.0421)</td>
<td>(0.0264)</td>
<td>(0.8907)</td>
<td>(0.2442)</td>
<td>(0.1679)</td>
</tr>
</tbody>
</table>

*The Markov regime switching model assumes that the 'base' instantaneous volatility \( \sigma_r \) follows a two stage Markov chain characterized by \( p \) (the probability of remaining in the high volatility state once in the high volatility state) and \( q \) (the probability of switching to the high volatility state from the low volatility state). The model is cast in state-space form and the resultant likelihood function is evaluated using a nonlinear filter. The first sixty observations of the sample period are used to initialize the filtering procedure.
Table 2

Maximum likelihood parameter estimates of the stochastic volatility model of short term riskless interest rate dynamics:

\[
\ln(\tau e_{t+1}^2) = x_t + 2\gamma \ln(\tau_t) + \ln(\epsilon_{t+1}^2) \\
x_{t+1} - \mu = \beta(x_t - \mu) + \xi \epsilon_{t+1}^2.
\]

(18)  (19)

Short term riskless rates are proxied by one-month Treasury yields obtained from the CRSP riskfree file. The sample period is June 1964 to December 1989*.

<table>
<thead>
<tr>
<th></th>
<th>$\mu$</th>
<th>$\beta$</th>
<th>$\xi$</th>
<th>$\gamma$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimate</td>
<td>-6.231</td>
<td>0.9152</td>
<td>0.3480</td>
<td>0.6871</td>
</tr>
<tr>
<td>Std Error</td>
<td>(1.4175)</td>
<td>(0.0538)</td>
<td>(0.1156)</td>
<td>(0.2576)</td>
</tr>
</tbody>
</table>

*The stochastic volatility model assumes that the logarithm of $\sigma^2(t) = x(t)$ follows a diffusion process. The model is cast in state-space form and the resultant likelihood function is evaluated using an integration-based nonlinear filter which assumes that the prior on the state is normally distributed. The first sixty observations of the sample period are used to initialize the filtering procedure.
Figure 1: Simulated Interest Rates Assuming $\gamma = 1.4999$
Figure 4
Estimated Volatility of Interest Rate Changes

Annualized Volatility

Year

64  68  72  76  80  84  88  92