Excess Volatility of British Pound: Jumps or Regime Switches?

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Introduction

- Explaining the excess volatility of the nominal exchange rate has been a challenge in international finance.
- This paper uses the continuous-time model with the jump-diffusion process and the regime-switching feature to decompose the driving force of the excess volatility of the nominal exchange rate.
- This study can shed light on the unknown structure of the excess volatility of the nominal exchange rate.

Variance Skewness Kurtosis
1770.49 1.21 3.44
Table 1. Summary Statistics.

Model Estimation

<table>
<thead>
<tr>
<th>Diffusion Process</th>
<th>$\kappa_i$</th>
<th>$\theta_i$</th>
<th>$\sigma_i$</th>
<th>$\Pi_i^1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regime 1</td>
<td>0.001109</td>
<td>230.486546</td>
<td>0.901875</td>
<td>0.91848</td>
</tr>
<tr>
<td>Regime 2</td>
<td>0.032429</td>
<td>110.618922</td>
<td>8.704419</td>
<td>0.87552</td>
</tr>
<tr>
<td>NIG Distribution</td>
<td>$\alpha_i$</td>
<td>$\beta_i$</td>
<td>$\delta_i$</td>
<td>$\mu_i$</td>
</tr>
<tr>
<td>Regime 1</td>
<td>0.536864</td>
<td>-0.371010</td>
<td>0.180108</td>
<td>0.172204</td>
</tr>
<tr>
<td>Regime 2</td>
<td>2.371331</td>
<td>-0.250890</td>
<td>1.021525</td>
<td>0.108689</td>
</tr>
</tbody>
</table>

Table 2. Estimated Parameters.

- $\alpha_i$: the tail heaviness and the intensity of jumps in state $i$. Smaller $\alpha_i$ reflects higher intensity of jumps.
- $\sigma_i$: the volatility in state $i$.
- $\Pi_i^1$: the probability of staying in the same regime $i$.

Method

Model: $dX_t = \kappa(Z_t)\left[\theta(Z_t) - X_t\right]dt + \sigma(Z_t)dW_t$
- $L_t$: a Lévy process which follows a normal inverse Gaussian (NIG) distribution.
- $(Z_t)_{t \geq 0}$: a continuous time Markov chain with transition probability $\Pi_i^1$.
- $f_{\text{NIG}}(x; \alpha, \beta, \delta, \mu) = \frac{\alpha \beta^\alpha}{\Gamma(\alpha)} \frac{\delta^\alpha}{\sqrt{2\pi \delta^2}} \exp\left(-\frac{(x-\mu)^2}{2\delta^2}\right)$: the density function of the NIG distribution.

Two-step estimation:
- Step 1: estimate the regime-switching Gaussian model.
- Step 2: fit the NIG distribution to each regime separately.

Model comparison:
- Regime-switching Gaussian model: $dX_t = \kappa(Z_t)\left[\theta(Z_t) - X_t\right]dt + \sigma(Z_t)dW_t$.
- Gaussian model: $dX_t = \kappa(\theta - X_t)dt + \sigma dW_t$.

- Regime 1 has smaller volatility and is more persistent. However, it faces larger extreme variations when unpredictable jump events happen.
- Switching between regimes adds further change of the volatilities and the jumps.

Model Fitting

- Filtered Probability
- Smoothed Probability
- Fit Model to Data

Contact

Comments are welcome and appreciated.
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Conclusion

- Jumps and regime switches play different roles in the exchange rate volatility.
- Understanding the dynamics opens future research to analyze the endogenous and the exogenous factors in the economic system that generate the excess volatility of the nominal exchange rate.