## Computer Tutorial 4: State Space Models and TVP-VARs

Data and Matlab code for all questions are available on the course website.

**Exercise 1:** *Inflation Persistence in the US*
Use the unobserved components model of Stock and Watson (2007) "Why Has U.S. Inflation Become Harder to Forecast?," Journal of Money, Credit and Banking. The program, TVP_AR_SW.m, contains code for the model given in their equations (8) - (11) which we replicate here:

$$\begin{aligned}
\pi_t &= \tau_t + \eta_t, \;\; \eta_t \sim N\left(0, \sigma_t^{\eta}\right) \\
\tau_t &= \tau_{t-1} + \varepsilon_t, \;\; \varepsilon_t \sim N\left(0, \sigma_t^{\varepsilon}\right) \\
\log\left(\sigma_t^{\eta}\right) &= \log\left(\sigma_{t-1}^{\eta}\right) + v_t^{\eta}, \;\; v_t^{\eta} \sim N\left(0, \gamma_1\right) \\
\log\left(\sigma_t^{\varepsilon}\right) &= \log\left(\sigma_{t-1}^{\varepsilon}\right) + v_t^{\varepsilon}, \;\; v_t^{\varepsilon} \sim N\left(0, \gamma_2\right)
\end{aligned}$$

We provide data on three measures of inflation ($\pi_t$), CPI inflation, PPI inflation and GDP deflator inflation. Use the code to plot trend inflation ($\tau_t$) and the volatilities $\sigma_t^{\eta}$ and $\sigma_t^{\varepsilon}$. Is there evidence that $\sigma_t^{\eta}$ is varying over time? Is there evidence that $\sigma_t^{\varepsilon}$ is varying over time?

Optional: Stock and Watson (2007) also estimate a model (see their equations (5) and (6)) where state and measurement equation variances are constant ($\sigma_t^{\eta} = \sigma^{\eta}$ and $\sigma_t^{\varepsilon} = \sigma^{\varepsilon}$). You can also consider models where there is stochastic volatility in one equation but not the other (i.e. $\sigma_t^{\varepsilon} = \sigma^{\varepsilon}$ but $\sigma_t^{\eta}$ is time varying or $\sigma_t^{\eta} = \sigma^{\eta}$ but $\sigma_t^{\varepsilon}$ is time varying). Modify the code to estimate these models and compare results to the full model.

Optional: I have not included a question on the TVP-VAR since this is covered in the lecture after this computer lab. Nevertheless, I have included code for estimating it in this package of computer materials. You may wish to experiment with it in your own time after I have covered the topic in lectures.