Emprical Exercises - 1
GMM Estimation of the US Monetary Policy Rules

Applied Statistics and Econometrics II
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Exercise 1. Monetary Policy Rules
This exercise illustrates how to perform a GMM estimation in practice using R.

We want to estimate a monetary policy rule of the form

$$r_t = \alpha_0 + \alpha_1 E[\pi_{t+12} - \pi^* | \, I_t] + \alpha_2 E[y_t | \, I_t],$$

and we focus on the period with Greenspan as a chairman for the Federal Reserve Board: 1987 - 2005.

Data: Download the dataset `monetary.csv` from the course webpage on NYU Home. The dataset contains the following monthly time series for the US economy between 1971:1 - 2005:8:

ff	Average effective Federal funds rate.
fftarget	Target for the Federal funds rate.
bond	Average 10 years bond yield.
inf	Inflation from year to year.
infexcl	Inflation from year to year excluding food and energy.
caputil	Capacity utilization.
capgap	Measure of output gap: Deviation of caputil from mean.
ip	Industrial production.
ipgap	Measure of output gap: Deviation of ip from a smooth HP trend.
unr	Unemployment rate.
unrgap	Measure of output gap: Deviation of unr from mean.

[1] Construct time series graphs of the data.

a) Compare the three measures of the output gap.

b) Can you see any apparent relation between inflation and the policy instrument?

c) Can you see any apparent relation between the output gap and the policy instrument?

Do the graphs for the full period and for the period under Greenspan, 1987:1 - 2005:8, seem to tell the same story?

[2] We measure inflation by the variable `inf` and the output gap by the variable `capgap`. As instruments we take lag one and two of the variables, i.e.

$$\mathbf{z}_t = \left(1,\, \text{ff}_{t-1},\, \text{ff}_{t-2},\, \text{inf}_{t-1},\, \text{inf}_{t-2},\, \text{capgap}_{t-1},\, \text{capgap}_{t-2}\right)'$$

Set up the model using the GMM functions in R and estimate the parameters using a heteroskedasticity and autocorrelation consistent (HAC) estimator of the weight matrix. Choose a Bartlett kernel HAC-estimator with a bandwidth B = 12.

[3] Construct the predicted policy rate. To do this copy the vector of residuals, say `ufunc` and construct the prediction as `predt = fft - ufunct`.

What is your impression of the model?

[4] Change the number of lags for the instruments and see whether the results are robust.

[5] Change the settings for the estimator of the weight matrix and see whether the results are robust.

Exercise 2. Monetary Policy and Asset Price Volatility (Bernanke-Gertler)
At the Federal Reserve Bank of Kansas City's symposium New Challenges for Monetary Policy in Jackson Hole, 1999, Ben Bernanke and Mark Gertler presented a paper[1] arguing that central banks should pursue flexible inflation targeting. Their main argument was that "in the context of short-term monetary policy management, central banks should view price stability and financial stability as highly complementary and mutually consistent objectives, to be pursued within a unified policy framework."

Within the framework of the classic Taylor rule, the central bank adjusts the interest rate in response to expected inflation to achieve the goal of price stability. By contrast, the central bank should not respond to changes in asset prices, except when they signal changes in expected inflation. However, Bernanke and Gertler argue that asset price volatility becomes an independent source of economic instability that policy makers should take into account if 1) asset markets are partly driven by non-fundamental factors, such as market psychology, and, 2) if booms and busts in asset markets have important effects on the real economy, for example through the balance sheet channel caused by frictions in credit markets. Consequently, Bernanke and Gertler suggested an extension of the classic Taylor rule where the central bank combines its long-run goal of price stability with a short-run goal of financial stability.

After presenting a simple theoretical model to illustrate their proposed policy frame- work, Bernanke and Gertler present an empirical analysis where they estimate a Taylor rule with interest rate smoothing extended with asset price volatility. Specifically, they consider the extended Taylor rule with interest rate smoothing:

$$r_t = (1-\rho) r_t^* + \rho r_{t-1}\,, \tag{1}$$

$$r_t^* = \overline{r}_t + \beta\left(E(\pi_{t+12}|\, I_t) - \overline{\pi}\right) + \gamma\left(E(\tilde{y}_t|\, I_t)\right) + \xi' \mathbf{z}_t \tag{2}$$

[1] Bernanke, B., and M. Gertler (1999), "Monetary Policy and Asset Price Volatility", Economic Review - Federal Reserve Bank of Kansas City, Fourth Quarter.

where r_t is the Federal Funds rate, r_t^* is Federal Funds target rate, $\overline{r}$ is an inflation target, π_t is the year-on-year inflation rate, $E(\pi_{t+12}|\, I_t)$ is the forecast of inflation at time $t+12$ based on the information set I_t, $\overline{\pi}$ is an inflation target, $\tilde{y}_t = y_t - y_t^*$ is the output gap, $E(\tilde{y}_t|\, I_t)$ is the forecast of the output gap at time t based on the information set I_t, and $\mathbf{z}_t$ is a vector of stock market returns at times t to $t-5$. Inflation stabilization requires that $\beta > 1$, output stabilization requires that $\gamma > 0$, while financial stabilization requires $\xi > 0$. Bernanke and Gertler estimate the model in (1) and (2) by GMM for the United States using a sample of monthly data from 1979:10 - 1997:12.[2] They get the estimates $\widehat{\beta} = 1.71$ and $\widehat{\gamma} = 0.20$, and both coefficients are significant. However, they get a negative and insignificant estimate of the average of the coefficients in ξ of -0.082. Based on these results, Bernanke and Gertler conclude that "the Fed has focused its attention on expected inflation and the output gap and has neither sought to stabilize stock prices nor reacted to information in stock returns other than that useful for forecasting the output gap and inflation."

Using monthly data for the US economy covering the period from 1983:01 to 2006:12, the aim of this assignment is to analyze if there is empirical evidence of the Federal Reserve setting its interest rate in accordance with the extended Taylor rule with interest rate smoothing in (1) and (2).

Data: Download the dataset `monetaryAsset.csv` from the course webpage on NYU Home. The dataset contains the following monthly time series for the US economy between 1983:01 - 2006:12. This dataset contains the variables in `monetary.csv` as well as the following additional ones:

spx	SP500 stock market index.
rspx	Log-returns on the SP500 stock market index.
cape	Cyclically adjusted price-earnings ratio for the SP500 stock market index.

The data source is the FRED Database maintained by the Federal Reserve Bank of St. Louis, except from the stock market data which is downloaded from Robert Shiller's website.

Conduct an empirical analysis based on GMM estimation to analyze if there is empirical evidence of an extended Taylor rule with interest smoothing in (1) and (2). Follow these **Hints**:

[1] You must explain how the generalized method of moments estimator can be derived from the equations (1) and (2). In particular, explain how the moment conditions can be derived and how you choose your instruments for GMM estimation.

[2] You must report some robustness analysis for your empirical results. Hints (3) to (7) below gives some suggestions for robustness analyses along different dimensions.

[3] You can try to estimate the model with different numbers of lags of the stock market returns. You can also try to include other measures of the stock market, for example you can use indicator functions to estimate if the Fed has reacted differently to positive

[2] In their paper, the estimation procedure and results are described in Section IV, while the main results are presented in Table 2.

and negative stock market returns, or you can include the cyclically adjusted price-earnings ratio as a measure of the deviation of the level of the stock market from its long-run fundamental level.

[4] The data set contains two inflation rates, one based on the personal consumption expenditures and one for the personal consumption expenditures excluding food and energy (including oil), and two proxies for the output gap, one based on the capacity utilization and one based on the unemployment rate. You can choose which variables to work with, and you can see if your results are robust to the choice of variables.

[5] You can try different choices of instruments. Are your results robust for your choice of instruments? Argue for your preferred choice of instruments and report the Hansen test for overidentification.

[6] You can estimate your model with different weight matrices. What seems like a reasonable assumption about the moments, and what does it imply for the choice of the weight matrix? Are your results robust for different weight matrices?

[7] You can try estimate the Taylor rule without interest rate smoothing by setting $\rho = 0$. Does your estimated extended Taylor rule depends on whether you allow for interest rate smoothing?

[8] Conduct a graphical analysis to detect if there is evidence for a Taylor rule. You can plot the actual Federal Funds rate together with the rate predicted by the estimated reaction function if it can be interpreted as a Taylor rule.

Formalities:

[1] You must hand in a report that (i) presents your graphical analysis, (ii) describes the econometric model, (iii) outlines the modeling progress (e.g., the approach you have taken, the alternative models you have tried, etc.), (iv) presents your preferred model including interpretation and statements on economic and statistical significance, and (v) discusses the potential weaknesses of the model.

[2] The report must be a maximum of 10 pages of pdf produced from an R markdown file. You must hand in your R markdown file and pdf files together. You can use the R markdown template that I have posted on course webpage. Please name your files as follows: `empEx1-surname(s).Rmd`

[3] If you prefer, you are allowed to work in groups of up to three persons (not necessarily in the same exercise class as yours). The requirements and assessment criteria are the same for assignments written by one, two, or three persons.