Financial Econometrics Workshop 6

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1 Introduction

In this workshop we will introduce GARCH models in STATA. We will estimate different kinds of GARCH model and observe leverage effect.

Consider a simple model of the U.S. Wholesale Price Index (WPI) **?**. The data are quarterly over the period 1960q1 through 1990q4.

2 Input Data and Date Transformation

The first step in STATA is input data, make sure your .dta file is in the right working directory. In this workshop we will use the dataset: quarterly over the period 1960q1 through 1990q4

Menu:

File → Change Working Directory → STATA Workshop

Command:

```
use http://www.stata-press.com/data/r15/wpi1,clear #macro data for
    GARCH study
tsset t
```

Note:

`tsset` declares data to be time-series data.

3 Graphic Analysis and Data Transformation

In this section, you will learn how to identify volatility clustering

Command:

```
g dln_wpi = D.ln_wpi
g sqdln_wpi = dln_wpi^2
line sqdln_wpi t
```

Question:

What can you observe from the graph?

4 ARCH Effect Test

First, we fit a constant-only model by OLS and test ARCH effects by using Engle's Lagrange multiplier test:

$$\widehat{u}_t^2 = \gamma_0 + \gamma_1 \widehat{u}_{t-1}^2 + \cdots + \gamma_p \widehat{u}_{t-p}^2 + \epsilon$$

Command:

```
reg dln_wpi
estat archlm,lags(1)
```

Note:

Please notice that the test statistic is TR^2, where T is the number of observations in the sample and R^2 is the R^2 from the regression.

Question:

What can we conclude in this test?

5 Simple ARCH model

Before we produce cointegrating analysis, make sure your variables are stationary. You can use ADF test to examine your variables.

Command:

```
predict e1,resid
g e2 = e1^2
varsoc e2
arch dln_wpi, arch(1/2)
arch dln_wpi, arch(1/2) nolog
arch dln_wpi, arch(1) garch(1) nolog
```

Note:

The estimated ARCH(2) model is:

$$
\begin{aligned}
y_t &= 0.069 + \epsilon_t \\
\sigma_t^2 &= 0.336\epsilon_{t-1}^2 + 0.4\epsilon_{t-2}^2
\end{aligned}
$$

Note:

The estimated GARCH(1,1) model is:

$$
\begin{aligned}
y_t &= 0.061 + \epsilon_t \\
\sigma_t^2 &= 0.436\epsilon_{t-1}^2 + 0.454\sigma_{t-2}^2
\end{aligned}
$$

Note:

`nolog` command will not show the iterations

6 GARCH with ARMA

We can retain the GARCH(1,1) specification for the conditional variance and model the mean as an ARMA process with AR(1) and MA(1) terms

Command:

```
arch dln_wpi, ar(1) ma(1) arch(1) garch(1) nolog
```

Note:

The estimated ARMA(1,1) - GARCH(1,1) model is:

$$
\begin{aligned}
y_t &= 0.006 + 0.89\,(y_{t-1} - 0.006) - 0.447\epsilon_{t-1} + \epsilon_t \\
\sigma_t^2 &= 0.21\epsilon_{t-1}^2 + 0.71\sigma_{t-1}^2
\end{aligned}
$$

7 EGARCH

Continuing with the WPI data, we might be concerned that the economy as a whole responds differently to unanticipated increases in wholesale prices than it does to unanticipated decreases. Perhaps unanticipated increases lead to cash flow issues that affect inventories and lead to more volatility. We can see if the data support this supposition by specifying an ARCH model that allows an asymmetric effect of "news"—innovations or unanticipated changes. One of the most popular such models is EGARCH **?**. The full first-order EGARCH model for the WPI can be specified as follows:

Command:

```
arch dln_wpi, ar(1) ma(1) earch(1) egarch(1) nolog
```

Note:

The estimated EGARCH model is:

$$y_t = 0.009 + 0.89\,(y_{t-1} - 0.009) - 0.47\epsilon_{t-1} + \epsilon_t$$
$$ln(\sigma_t^2) = -1.299 + 0.382 z_{t-1} + 0.252(|z_{t-1}| - \sqrt{2/\pi}) + 0.861\, ln(\sigma_{t-1}^2)$$

Where $z_t = \epsilon_t/\sigma_t$

Question:

What can we conclude in this test?