**Time varying parameter models, DLM, Kalman filter, FFBS**

Dynamic Linear Model (DLM) is a generalization of the Kalman filtering approach/model, which can be viewed as a time varying parameter model.

This allows analysis of variables that may or may not be stationary, and more importantly, may transition from stationary to nonstationary and vice versa.

Is it that a variable is either stationary or nonstationary? Could it be a mix, sometimes stationary, sometimes nonstationary? Same with cointegration.

Regime switching models.

IF , then we have a constant parameter model.

Equation (2) can be thought of as the prior distribution for the parameter at each time point – the Kalman filter is then just Bayesian updating.

The prior for the first observation (the “starting distribution”) is , we then update with the 1st observation, and repeat for each additional observation, but the prior for the next step has additional variance due to . This is forward filtering.

FFBS = Forward Filtering Backward Smoothing

Kalman Filter = forward filtering – similar to iterative linear regression estimation, but with some extra variance in the parameter over time.

**CAUSALITY**

Who is Judea Pearl? Causality

What is a do operator?

The do operator do(x), x only changes when we explicitly do something to change it.

Doing x may make y more or less likely to occur (it become more/less plausible that y happens).

We must be careful to “control” how and when x changes (hence the reason for randomized controlled trials, RCTs).

In behavioral sciences, we often cannot conduct RCTs, either not feasible, or not ethical, or too costly, etc.

WE often search for “natural experiments”, i.e., situations that have many of the features of a randomized controlled trial, e.g., one county passes a tax assessment for education, an adjacent county with similar characteristics does not pass a tax assessment. One firm advertises, another, similar firm in the same industry, does not advertise.

Causal inference often uses (or uses something similar to) **difference in difference methodology**

Define two groups as treatment and control. Identify members of each group that have similar characteristics (matching, etc.). The look at the difference in means between the groups.

Suppose we have data on individuals over time, and something happens at time , say they take a test and pass or fail. If you pass, you get a scholarship, if you fail you don’t!

Suppose, for group

outcome variable for individual i in group g at time t, e.g. income, education level, …

Suppose we have an individual from each group:

Take the difference:

We are left with difference in means with everything else (the trend) eliminated. The downside is now we have both errors in the equation.

Dummy indicator variables approach:

where

This can lead to serial correlation in the error, etc.

Suppose something happens (policy change) at time . We create a dummy variable that is 0 up to period , 1 after,

This is the same as “event study” analysis

Do we a window around the event (time period ) for which we can claim observations are otherwise similar.

Suppose the variable is stationary and shifts in period

Variable coeff s.e. pval CrI

cnst -0.034 0.052 0.5159 0.0684 -0.1365

D 1.039 0.074 0.0 1.1845 0.8933

Rsquared = 0.497

What is a DAG (directed acyclic graph)?

Does economic or finance data come from a DGP that is a DAG?

What, if anything, do mediators and moderators have to do with this?

Is statistics all correlation not causation? How do we get causation into the picture?

Deterministic or probabilistic?

All or nothing vs. magnitude of effect?

Should we do diff in diff? If not, what should we do?

PANEL MODELS