Static Demand and Choice Models:

Homogenous Product Demand

Advanced Microeconometrics

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Basic Econometric Issues in Demand and Supply Estimation

Example: Linear Specifications in a Perfectly Competitive Market

- Let's start by thinking about (aggregate) demand in a single market.

- The demand and supply functions

$$\begin{aligned} \text{Demand: } & Q_i = \beta_0 + \beta_1 P_i + u_i, \quad \beta_i < 0 \\ \text{Supply: } & Q_i = \alpha_0 + \alpha_1 P_i + \alpha_2 Z_i + v_i, \quad \alpha_1 > 0 \end{aligned}$$

  are called the **structural equations**.

- Q_i and P_i are **endogenous** variables (determined inside the system).

- Z_i is an **exogenous** variable (assumed to be determined outside the system).

- Through clever substitution, we can solve for the endogenous variables in terms of the exogenous variable Z_i (and the remaining parameters).

Simultaneous causality

- In particular, if we set the two equations equal, solve for P_i , and then plug this P_i into the demand equation to get Q_i , we obtain the following **reduced form** equations

$$P_i = \frac{\alpha_0 - \beta_0}{\beta_1 - \alpha_1} + \frac{\alpha_2}{\beta_1 - \alpha_1} Z_i + \frac{v_i - u_i}{\beta_1 - \alpha_1}$$

$$Q_i = \frac{\beta_1 \alpha_0 - \beta_0 \alpha_1}{\beta_1 - \alpha_1} + \frac{\beta_1 \alpha_2}{\beta_1 - \alpha_1} Z_i + \frac{\beta_1 v_i - \alpha_1 u_i}{\beta_1 - \alpha_1}$$

- Reduced form equations only have exogenous variables and parameters on the right-hand side

Simultaneous causality

- However, by re-writing the reduced form equations

$$P_i = \frac{\alpha_0 - \beta_0}{\beta_1 - \alpha_1} + \frac{\alpha_2}{\beta_1 - \alpha_1} Z_i + \frac{v_i - u_i}{\beta_1 - \alpha_1}$$

$$Q_i = \frac{\beta_1 \alpha_0 - \beta_0 \alpha_1}{\beta_1 - \alpha_1} + \frac{\beta_1 \alpha_2}{\beta_1 - \alpha_1} Z_i + \frac{\beta_1 v_i - \alpha_1 u_i}{\beta_1 - \alpha_1}$$

  more compactly as

$$P_i = \pi_{10} + \pi_{11} Z_i + \varepsilon_{1i}$$
$$Q_i = \pi_{20} + \pi_{21} Z_i + \varepsilon_{2i}$$

  we can see an easy way to estimate β_1: $\pi_{21} = \beta_1 \pi_{11}$, so $\beta_1 = \dfrac{\pi_{21}}{\pi_{11}}$.

- So if we have consistent estimates of π_{21} and π_{11} we can get consistent estimate of β_1.
    - Estimating the parameters this way is called **Indirect Least Squares**.

Instrumental Variables

- In practice, one would estimate the demand model using some form of Instrumental Variables (IV) estimator
- One option is Two Stage Least Squares:

$$\text{Demand: } Q_i = \beta_0 + \beta_1 P_i + \beta_2 W_i + u_i, \quad \beta_1 < 0$$

  where one would use Z as an instrument for P (where I have added W_i).

- Easily done in STATA using

```
ivregress 2sls Q (P=Z) W, robust
```

- How do you do it in two stages?

Instrumental Variables

Two Stage Least Squares in Two Stages

(1) Regress P on a constant, Z **and** W, collect the predicted values of P, $\hat{P}$

(2) Regress Q on a constant, $\hat{P}$ and W

You will not get correct standard errors

A valid and useful instrument is:

(1) **not correlated with** u (the residual in the structural equation of interest).

(2) strongly **correlated with** P (conditional on other control variables).

It is very important to test these conditions if you can!

Instrumental Variables

Testing Condition 2: Correlation with P

Tested using the "first stage" regression (so do the first stage even if you don't use it for 2nd stage 2SLS).

> do an F-test of for the coefficients on the instruments equal to zero; you want an F-statistic ≥ 10 to feel (somewhat) comfortable proceeding.

Instrumental Variables

Testing Condition 1: No Correlation with U

Can be formally tested **only if** you have more instruments than endogenous variables e.g., suppose that you want to instrument for price and advertising; then you need at least three instruments.

If so, do an overidentification test.

In STATA, this is straightforward by doing

```
estat overid
```

after you have estimated a model using 2SLS.

Instrumental Variables

Testing Condition 1: No Correlation with U

- Be cautious when interpreting overidentification tests.
- Approximately it tells you whether subsets of the instruments give you similar estimates.
  - If all are valid then any subset should give consistent estimates, and therefore be similar.
- But people often do overidentification test using multiple similar instruments (e.g., lagged $t-2$, $t-3$ values).
  - If they're correlated with u, they will probably all be correlated in the same way.
  - In this case you won't reject when you do the overidentification test.
- When people use quite different instruments they tend to reject, especially if they have a lot of data.
  - Practical view is that this is OK, as long as your *conclusions* are robust to using different subsets of instruments

Instrumental Variables

Frequently Used Instruments for Price in Demand Equations

- Marginal cost shifters: logic is that these should cause prices to shift whatever the market structure and pricing rule.
  - Input prices likely exogenous for small industries.
  - Often hard to get, do not vary much or a small component of costs (e.g., electricity).
- Market structure: changes in market structure will usually affect mark-ups.
  - Stable conduct or because it changes conduct.
  - The issue is whether these are exogenous to the demand shocks.
- Prices in other markets ("Hausman-style" instruments): may reflect (unobserved) marginal cost shocks.
  - Must assume demand shocks are independent across markets.
  - These are controversial (as we shall see) but are widely used.