Session 2: Fixed and Random Effects Estimation

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ARTNeT Capacity Building Workshop for Trade Research: Gravity Modeling

Tuesday, August 24, 2010

Outline

Using Dummies to Capture Multilateral Resistance

The AvW Gravity Model–Aggregate Data

$$X_{ij} = \ln(Y_i) + \ln\left(E_j\right) - \ln(Y) + (1-\sigma)\left[\ln\tau_{ij} + \ln\Pi_i + \ln P_j\right]$$

- The term $-\ln(Y)$ is common across all exporters and importers; thus, it can be captured through a constant in the regression model.
- The term $\ln\left(E_j\right) + \ln P_j$ is constant across all importers for a given exporter; thus, it can be captured through an importer dummy variable (fixed effect).
- The term $\ln\left(Y_i\right) + \ln\Pi_i$ is constant across all exporters for a given importer; thus, it can be captured through an exporter dummy variable (fixed effect).

Using Dummies to Capture Multilateral Resistance

Advantages of Dummy Variables

- An aggregate gravity model with a constant, and dummy variables for each exporter and each importer will therefore take proper account of multilateral resistance, and should produce unbiased estimates.
- Very simple to estimate, but takes account of some sophisticated effects.
- NxN observations, but N+N dummies; degrees of freedom are usually sufficient.

Using Dummies to Capture Multilateral Resistance

Disadvantages of Dummy Variables

- Dimensionality quickly becomes an issue with sectoral models: N+N can be in the hundreds, or thousands.
- Because of collinearity constraints, we cannot identify separate effects due to factors that vary in the exporter or importer dimensions. Only factors varying bilaterally can be identified.

Using Dummies to Capture Multilateral Resistance

- Estimation using panel data techniques can make it possible to reduce the dimensionality problem somewhat, but it remains an issue in large/detailed datasets.
- To deal with the collinearity problem, variables can sometimes be transformed so as to vary by country pair:
  - Sum of exporter and importer values.
  - Average of exporter and importer values, etc.
- Try to go back to theory to see if this is an appropriate thing to do in a given circumstance.

Dummies in Sectoral Gravity Models

- As suggested previously, things get even more complicated with sectoral gravity models.
- Dummy variables need to be specified in the importer-sector, exporter-sector, and sector dimensions, because:

$$\ln\left(X_{ij}^{k}\right) = \ln\left(Y_{i}^{k}\right) + \ln\left(E_{j}^{k}\right) - \ln\left(Y^{k}\right) + (1-\sigma_{k})\left[\ln\tau_{ij}^{k} + \ln\Pi_{i}^{k} + \ln P_{j}^{k}\right]$$

- In addition, trade costs need to be interacted with sector dummies in order to take account of varying elasticities of substitution across sectors.

Dummies in Sectoral Gravity Models

- Depending on the level of sectoral disaggregation used, this approach can result in huge numbers of parameters.
- Models can take a long time, and a big computer, to estimate.
- It is usually much easier to estimate separate models for each sector.

Dummies and Fixed Effects in Stata

- Option 1: enter the dummies manually and use OLS:
  - tab importer, gen(imp_dum_*)
  - reg ln_trade ... imp_dum_*, robust
- Option 2: use a panel estimator (OLS + a trick) to account for one set of dummies:
  - iis importers
  - xtreg ln_trade ..., robust fe

Random Effects: An Alternative to Dummies

- Fixed effects (dummy variables) are one way of accounting for unobserved heterogeneity across countries, in this case due to multilateral resistance.
- A common alternative in the econometrics literature is random effects:
  - Fixed effects allow for free or structureless variation;
  - Random effects require that unobserved heterogeneity obey some probability constraints, i.e. follow a particular distribution.

Random Effects: An Alternative to Dummies

Advantages of Random Effects

- The dimensionality constraint is greatly relaxed: even very large models can be estimated relatively quickly.
- Allows inclusion of variables (like GDP) that vary in the same dimension as the random effects.
- Simple to estimate single-dimensional RE models in Stata:
  - iis importers
  - xtreg ln_trade ln_gdp_imp [etc.], re robust.

Random Effects: An Alternative to Dummies

Disadvantages of Random Effects

- Random effects rely on a strong assumption: multilateral resistance is normally distributed across countries, with a given standard deviation.
- The AvW model tells us that multilateral resistance is important, but it doesn't tell us anything about its distribution.
- In practice, compare RE and FE estimates.

Random Effects: An Alternative to Dummies

- Distance coefficient from the original gravity model without fixed effects = -1.277***.
- Distance coefficient from the fixed effects gravity model = -1.596***.
- Distance coefficient from the random effects (importer) gravity model = -1.313***
  - Not statistically different from OLS, but significantly different from fixed effects. CAUTION!

Summary

- The most common approach to the aggregate gravity model is to use fixed effects (dummy variables) by importer and by exporter.
- Random effects can also be used, but they rely on a stronger–and possibly invalid–assumption.
- For sectoral gravity models, the simplest approach is to estimate separately, sector by sector.