Session 2: Consolidation and Best Practice

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ARTNeT Capacity Building Workshop for Trade Research:
"Behind the Border" Gravity Modeling

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Outline

The Gravity Model–From Empirics to Theory

- Gravity modeling started as a sensible, intuitive way of understanding the factors that influence bilateral trade.
- The basic intuition is sound, and captures some important stylized facts that are present in the data.
- However, the basic model is deficient in a number of respects. In broad terms, its deficiencies can be said to relate to its failure to take account of general equilibrium effects.

The Gravity Model–From Empirics to Theory

- In addition to its strong empirics, the gravity model now also stands on solid theoretical foundations.
- Anderson and Van Wincoop (2003, 2004) present a general microeconomic framework incorporating monopolistic competition. They show that it can be used to derive a gravity-like equation.
- Other contributions have shown that similar equations can be derived from a wide range of theoretical models. However, as more features are introduced, the model usually becomes more complex.

The Gravity Model–From Empirics to Theory

- The AvW model brings gravity more closely into contact with the general equilibrium nature of trade in a many country world.
- It emphasizes that it is relative prices that matter, and thus, relative trade costs.
- AvW's theoretical model introduces two new unobservable terms into gravity:
  - Outward multilateral resistance: Exports from i to j depend on all barriers faced by i's exporters;
  - Inward multilateral resistance: Exports from i to j depend on all barriers faced by j's importers.

The Gravity Model–From Empirics to Theory

- Including multilateral resistance terms in the model makes it possible to:
  - Highlight the importance of relative price effects;
  - Account for the fact that trade costs between i and j can affect trade with third parties;
  - Account for the fact that trade costs with third parties can affect trade between i and j.
- All of these effects are highly intuitive and theoretically grounded. But they are absent from the basic (traditional) gravity model.

The Gravity Model–From Theory to Empirics

- The AvW model also has important implications for the way in which empirical researchers estimate and interpret gravity models.
- These implications cover:
  - Data;
  - Estimation methods.

The Gravity Model–From Theory to Empirics

Data Implications of the AvW Model

- Traditional gravity models used various combinations of import and export data.
- The AvW model suggests that what we want is unidirectional trade, i.e. treat exports from i to j as one observation, and exports from j to i as another observation.
- Using total trade (exports + imports) or averaging over exports and imports generally does not fit with the theory.

The Gravity Model–From Theory to Empirics

Data Implications of the AvW Model

- AvW's multilateral resistance terms effectively take care of the question of deflating prices, whether we are talking about trade values, GDP, etc.
- Thus, it is appropriate to use value data in nominal terms...
- Provided, of course, that we properly take account of multilateral resistance when estimating the model.

The Gravity Model–From Theory to Empirics

Data Implications of the AvW Model

- Although the AvW MR terms are effectively price indices, they cannot be directly observed. They do not correspond to common measures of prices, such as CPI, PPI, etc.
- Some traditional gravity models used atheoretical "remoteness" indices to capture effects similar to those captured by the MR terms. However, the MR terms are defined in a very precise way, and are generally not equivalent to remoteness indices used elsewhere.
- In addition to the exclusion of price and remoteness terms, AvW theory suggests that per capita GDP should probably not be systematically included in gravity models.
    - If you are interested in income effects, justify this variable explicitly via a theory!

The Gravity Model–From Theory to Empirics

Econometric Implications of the AvW Model

- The AvW MR terms are unobservable.
- In econometric terms, they represent a particular manifestation of the more general problem of unobserved heterogeneity.
- Panel data methods are particularly well-suited to dealing with such problems.

The Gravity Model–From Theory to Empirics

Econometric Implications of the AvW Model

- The most common panel data method in the gravity context is the fixed effects estimator.
- It is usually preferred to random effects estimation because:
  - It imposes less structure on the data;
  - Is simple and transparent to estimate, even in multiple dimensions.
- The main disadvantage of fixed effects estimation is that it makes it impossible to separately identify variables that are collinear with the fixed effects.

The Gravity Model–From Theory to Empirics

Econometric Implications of the AvW Model

- Fixed effects models need to be set up so as to include fixed effects that vary in the same dimensions as the MR terms they are supposed to be capturing.
- In a basic model using a single year of data on total trade (all products), fixed effects in the exporter dimension and the importer dimension are appropriate.
- In a total trade model with more than one year of data, fixed effects in the exporter-year, importer-year, and year dimensions are required.

The Gravity Model–From Theory to Empirics

Econometric Implications of the AvW Model

- In a sectoral model with a single year of data, fixed effects in the exporter-sector, importer-sector, and sector dimensions are appropriate. In addition, trade cost variables should be interacted with sector dummies, to allow for possible changes in the intra-sectoral elasticity of substitution.
- Alternatively, sectoral models can be estimated individually for each sector, with fixed effects by exporter and importer.

The Gravity Model–From Theory to Empirics

Econometric Implications of the AvW Model

- If sectoral data and multiple years are used, fixed effects by exporter-sector-year, importer-sector-year, and sector-year are required. Interactions between sector dummies and trade costs are again required.
- Again, an alternative is to estimate sectoral models individually, with fixed effects by exporter-year, importer-year, and year.

The Gravity Model–From Theory to Empirics

Econometric Implications of the AvW Model

- In general terms, the gravity literature is going more and more towards sectoral models.
- To make these models "talk", think about using sectoral disaggregations that are of particular relevance for the research question being studied:
  - Djankov et al. (2008) look at time sensitive products, using the Hummels classification;
  - Helble et al. (2008) look at differentiated vs. homogeneous goods, using the Levinsohn classification.
- In sectoral models, issues of aggregation and clustering are particularly important: make sure that results are robust to different assumptions regarding the errors, and to different levels of aggregation.

Data and "Behind the Border" Gravity Modeling

- Traditionally, data accessibility has been a major constraint for applied researchers in this area, particularly in a development context.
- This constraint is getting looser by the year:
  - Data available for free through the web: World Bank, UNCTAD, UN Comtrade, NBER trade and tariff data, ComExt, Doing Business, Enterprise Surveys, ITC Market Access Tools, ...
  - Datasets made available by other researchers: for a good deal of policy work, it is no longer necessary to reinvent the wheel for basic data (distance, colony dummies, language, country groups, etc.)
- Theory makes some clear suggestions regarding data, but applied research is always a compromise between theoretical purity and analytical tractability/feasibility.

Data and "Behind the Border" Gravity Modeling

- Some of the most interesting applications of gravity in recent years have been to behind the border barriers:
  - Djankov et al.: export/import times
  - Ranjan Lee: contract enforcement
  - Anderson Marcouiller: corruption and insecurity
  - Manova: financial sector development and credit constraints
  - Freund/Weinhold: internet availability
  - HMR: costs of domestic market entry (indirectly...)
  - Moenius, Chen/Mattoo, (and me): product standards and harmonization.

Data and "Behind the Border" Gravity Modeling

- WMO started the trade facilitation ball rolling with a set of very broad indicators that arguably capture much broader features of the economy than just TF.
- More recently, the literature seems to be going towards more focused, objective measures:
  - Doing Business
  - Blonigen & (Wesley, not John) Wilson: measures of port efficiency
  - Hummels: direct measures of trade and transport costs
  - Corruption is also moving towards firm level data on bribe prevalence and amount.

Conclusion

- Best practice is changing all the time. Here is my attempt at a rough guide.
- Data and estimation: basic issues–
  - It's fine to start with the basic gravity model, but make sure you don't end with it.
  - At a minimum, take account of the implications of the AvW model: estimate using fixed effects.
  - Look for interesting sectoral splits in the data, and estimate a separate model for each sector.

Conclusion

- Data and estimation: advanced issues–
  - Compare OLS and fixed effects estimates with Poisson, whether zeros are a big issue or not.
  - If zeros are an issue, compare Poisson and Heckman.
  - If possible, try to identify strong and exogenous instruments for policy variables, then estimate by TSLS.
- Complementarities:
  - If applicable, try using inverse gravity to obtain a simple "story" that supports your main claims.
  - If firm-level data are available in the area you're researching, they can be an effective way to buttress gravity findings.

Conclusion

- Technical prowess is important, but it's not enough to write a good paper.
- The returns are particularly high to:
  - Thinking long and hard about the research question you are asking, and whether or not gravity is the right tool.
  - Spending a lot of time with your dataset to assess its strengths and weaknesses, and to look for simple evidence of the relations you expect to see.
  - If possible, identifying complementary methods you can use to support your results.