Quantifying the effects of NTMs

Xinyi Li
Trade Policies Review Division, WTO Secretariat
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Approaches to quantifying NTMs

- Chen and Novy (2012) described two approaches to quantifying NTMs.
  - Direct approach: collecting observable data on the incidence of NTMs (inventory-based frequency measures), for example, frequency or coverage ratios.
  - Indirect approach: estimating the existence of NTMs from market anomalies (e.g. unexplained price gaps or smaller than expected trade flows).
  - Indirect approach usually requires to calculate an ad valorem equivalent of an NTM.

Price gap method

- Assuming NTMs are adding cost to imports, the price gap method is to compare the domestic price of a good with its international price to obtain an estimate of the price gap.

$$TE = \frac{P_d}{P_w} - (1 + t + c)$$

- This method requires huge amount of data.

Gravity method

- Considering NTMs as factors in the trade cost, the gravity method estimates:
  - The impact of a specific measure on trade flow (e.g. positive, negative, or neutral) or price.
  - The ad valorem equivalent of NTMs, then further to construct a restrictiveness index.

- Gravity method is based on partial equilibrium modelling.

- Computable general equilibrium modelling can also be used, however, treatments of NTMs in CGE must be careful.

Gravity…

Newton

$$F_{ij} = G\frac{M_i M_j}{D_{ij}^2}$$

- Where *F* is the attraction force, *G* is the gravitational constant, *M* is mass, *D* is distance, *i* and *j* index point masses

Gravity

$$X_{ij} = G\frac{Y_i^{\alpha} Y_j^{\beta}}{T_{ij}^{\theta}}$$

- Where X_{ij}= exports from country *i* to *j* or total trade; *Y*=economic size (GDP, POP) and *T*= Trade costs

Naïve gravity

- Naïve estimation of the gravity regression is

$$\ln(Trade_{ij}) = \alpha + \beta_1 \ln(GPD_i) + \beta_2 \ln(GDP_j) + \beta_3 \ln(dist_{ij}) + \varepsilon_{ij}$$

- This regression fits the data very well

- However this naïve version can lead to very biased results
  - Serious omitted variable bias: any *i*- or *j*- characteristic that correlates both with trade and GDP ends up in the error term. The basic OLS assumption of orthogonality between the error term and the explanatory variables is violated

Derive the gravity equation

Step 1: the (Dixit-Stiglitz) demand function

$$x_{ij} = Y_j \frac{p_{ij}^{-\sigma}}{P_j^{1-\sigma}} \qquad (1)$$

where *i* indexes exporter, *j* indexes importer

- LHS = nominal demand by *j*'s consumers for *i*'s goods
- Y_j is *j*'s nominal income
- p_{ij} is imports price

$$P_j \equiv \left[\sum_i \left(p_{ij}\right)^{1-\sigma} \right]^{\frac{1}{1-\sigma}} \qquad (2)$$

is the ideal CES price index in *j,* σ > 1 is the elasticity of substitution across varieties

- (1) can be rewritten in terms of value:

$$p_{ij}x_{ij} \equiv T_{ij} = Y_j \left(\frac{p_{ij}}{P_j} \right)^{1-\sigma} \qquad (3)$$

- Equation (3) could be estimated directly, but researchers often lack good data on trade prices

b. Step 2: adding the pass-through equation

$$p_{ij} = p_i t_{ij} \qquad (4)$$

Where p_i is the producer price in country *i* and t_{ij} are all trade costs

Step 3: Market clearing condition (aggregate supply equals aggregate demand) to eliminate the nominal price

$$Y_i = \sum_j T_{ij} \Leftrightarrow \frac{Y_i}{Y_W} \equiv \theta_i = \sum_j \frac{T_{ij}}{Y_W} \qquad (5)$$

- Where Y_W is world nominal income and $\theta_i \equiv Y_i/Y_W$ is the share of *i*'s nominal income in world nominal income
- Using (3) and (4) into (5) we obtain:

$$\theta_i = (p_i)^{1-\sigma}\Omega_i^{1-\sigma} \qquad (6)$$

In this expression,

$$\Omega_i = \left[\sum_j \left(\frac{t_{ij}}{P_j}\right)^{1-\sigma} \theta_j\right]^{\frac{1}{1-\sigma}} \qquad (7)$$

is the multilateral resistance (openness of *i*'s exports to world markets)

- We now want to get rid of producer prices
- Substitute (6) back into (3) and use (4) to obtain:

$$T_{ij} = \frac{Y_i Y_j}{Y_W} \left(\frac{\tau_{ij}}{\Omega_i P_j} \right)^{1-\sigma} \qquad (8)$$

- Theoretically-founded gravity equation
- Major contribution of Anderson and Van Wincoop (2003): bilateral trade is determined by relative trade costs
- Using (6) into (2), one can derive the price index as:

$$P_j = \left[\sum_j \left(\frac{\tau_{ij}}{\Omega_i} \right)^{1-\sigma} \theta_i \right]^{\frac{1}{1-\sigma}} \qquad (9)$$

Estimate the gravity

- Log linearized (8), we yield

$$\ln(x_{ij}) = \ln(Y_i) + \ln(Y_j) - \ln\left(Y_W\right) + \left(1-\sigma\right)\ln \tau_{ij} - \left(1-\sigma\right)\ln \Omega_i - \left(1-\sigma\right)\ln P_j \quad (9)$$

- Multilateral trade resistance (MTR) terms Ω_i and P_j are not observable.

- Solutions to the problems.
  - Fixed effect estimation
  - Linear approximation of the MTR (Baier and Bergstrand (2009)).

Fixed effect

- Fixed effects control for unobserved characteristics of a country, i.e. any country characteristic that affect its propensity to import (export).

- Re-arrange (9) by exporter and importer, we have

$$\ln(x_{ij}) = -\ln(Y_W) + F_i + F_j + (1-\sigma)\ln\tau_{ij}$$

where $F_i = \ln(Y_i) - (1-\sigma)\ln\Omega_i$ (exporter fixed effect)

and $F_j = \ln(Y_j) - (1-\sigma)\ln P_j$ (importer fixed effect)

- F_i and F_j are dummy variables

- In the gravity literature it is in general assumed that trade costs take the form:

$$\tau_{ij} = d_{ij}^{\delta_1} \exp\left(\delta_2 cont_{ij} + \delta_3 lang_{ij} + \delta_4 ccol_{ij} + \delta_5 col_{ij} + \delta_6 llock_{ij}\right)$$

- Where d_{ij} is bilateral distance, and $cont_{ij}$, $lang_{ij}$, $ccol_{ij}$, col_{ij}, $llock_{ij}$, RTA_{ij} are dummy variables denoting respectively whether the two countries have a common border, common language, common colonizer, whether one was a colony of the other at some point in time, whether one of the two is a landlocked country, etc…

Estimate the gravity (cont)

- The estimated gravity function is now

$$\ln(x_{ij}) = \beta_0 + \beta_1 F_i + \beta_2 F_j + \beta_3 \ln \tau_{ij} + \varepsilon_{ij}$$

- There are 2n dummies; Total observations = n(n-1).

- If the research interest is in a bilateral variable, the strategy works fine;
- If the interested variable is a country-specific one, the strategy fails due to collinearity.

- Time fixed effect and pair fixed dummies may also be included (but still can not capture effect the time-invariant characteristics).

- The foresaid strategy may be used to estimate estimate a gravity model augmented to include policy variables. But **cautions are required**.

- The strategy can also be applied to estimate disaggregated data, in theory. But due to the complexity of the data sets, it is not really practical.

Linear approximation

- Fixed effect approach can not identify effect of the country-specific variables. So…

- Random effect approach? NO!

- Using a linear approximation fully accounts for arbitrary distributions of inward and outward multilateral resistance but without the inclusion of fixed effects.

- The Baier and Bergstrand (2009) methodology makes it possible to consistently estimate a theoretical gravity model that also includes variables such as policy measures that vary by exporter or by importer, but not bilaterally.

Interpretation of results

- Most of the variables are expressed in natural logarithms, so coefficients obtained from linear estimation can be read directly as elasticities

- The elasticity of trade to distance, for instance, is usually between -1 and -1.5, so a 10 per cent increase in distance between two countries cuts their trade, on average, by 10 to 15 per cent.

- Elasticities with respect to importing-country GDPs are also typically unitary, suggesting unitary income elasticities of imports at the aggregate level

- The coefficients for the dummies (e.g. common border) are not elasticities
- They need to be transformed as follows to be interpreted as elasticities:

$$\widehat{p} = \exp(\widehat{\delta}) - 1$$

where $\hat{p}$ is the % change in the dependent variable and $\hat{\delta}$ is the estimated coefficient of the dummy variable

- To derive this formula:
  - Consider that $\ln X_{ij(1)}$ is the predicted value of trade when the dummy = 1 while $\ln X_{ij(0)}$ is the value of trade when dummy = 0
  - The difference $\ln X_{ij(1)} - \ln X_{ij(0)} = \delta$
  - $X_{ij(1)} / X_{ij(0)} = \exp(\delta)$, which in turn implies that the percentage change in trade value due to the dummy switching from 0 to 1 is: $X_{ij(1)} - X_{ij(0)} / X_{ij(0)} = \exp(\delta) - 1$

- You can also estimate $\hat{p} = \frac{\exp[\widehat{\delta}]}{\exp[\frac{1}{2} var(\widehat{\delta})]} - 1$, which is consistent and (almost) unbiased.

Calculating AVEs

- In recent paper estimating AVEs, the specification usually adopts:

$$lnM_{i,j,h,t} = \beta_{0,n} + \beta_{1,n}\ln(1 + t_{i,j,n,t}) + \beta_2 NTM_{i,j,n,t} + \beta_3 C_{i,j,n,t} + \varepsilon_{i,j,n,t}$$

The change in import flows considering NTM exists is

$$lnM|_{NTM=1} - lnM|_{NTM=0} = \widehat{\beta_2}$$

The change in import flows considering tariff exists is

$$lnM|_{t=1} - lnM|_{t=0} = \widehat{\beta_1}\ln(1 + t_{i,j,n,t})$$

- A tariff equivalent is a tariff has the same effect on trade flow.

That is

$$\widehat{\beta_1} \ln(1 + t_{i,j,n,t}) = \widehat{\beta_2}$$

Therefore,

$$t_{i,j,n,t} = \exp\left(\frac{\widehat{\beta_2}}{\widehat{\beta_1}}\right) - 1$$

Calculating AVEs, if we have prices data

- As in Kee, Nicita, and Olarreaga (2009), the ad valorem equivalent is the domestic price changes because of the existence of NTM, as $\frac{\partial P^d}{\partial NTM} \equiv AVE$.
- The impact of an NTM is

$$\widehat{\beta_2} = \frac{\partial lnM}{\partial NTM} = \frac{\partial lnM}{\partial P^d}\frac{\partial P^d}{\partial NTM} = \frac{\partial lnM}{\partial P^d} AVE$$

- The import demand elasticity is defined as $\epsilon \equiv \frac{\partial lnM}{\partial P^d}$
- Therefore, $AVE = \frac{EXP\left(\widehat{\beta_2}\right) - 1}{\epsilon}$

Thank you