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De Bonus Vetus OLS: Approximating the international trade-cost effects of red tape

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Abstract

Using a gravity model, we employ a new approximation of multilateral resistance terms to analyse the effects of an exporter's documentation requirements on exports. It provides an ideal setting for employing the approximation and illustrating the specification issues associated with country-specific variables. We derive a specification that gives a consistent estimate of the gravity model parameters and an isomorphic specification yielding the average comparative static effect, which is typically a small fraction of the parameter. Our theoretical results are illustrated with simulations and supported by regressions. Estimates suggest 1 extra signature leads to 7% lower exports on average. However, most countries are much smaller than average, so the median effect is only 0.5%.

1 Introduction

For almost 50 years, gravity models have been used to assess the impact of trade barriers on exports between two countries. Accounting for multilateral barriers, not just bilateral barriers, is important for consistent estimation. Since the explicit modelling of so-called "multilateral resistance" (MR) by Anderson & van Wincoop (2003), this is well understood. Because the non-linear MR terms are difficult to estimate, Baier & Bergstrand (2009) have recently introduced a Taylor approximation to the terms that can be estimated by "good old OLS".

While mutlilateral resistance may matter for estimation, it is arguably more important when deriving comparative statics. The approximation allows one to incorporate the general equilibrium effects of multilateral resistance when calculating the effects of a change in trade frictions. Thus, one may estimate using fixed effects to control for MR (Feenstra, 2004), but calculate the comparative static effects using the approximation, as done by Behar & Nelson (2009). However, this is not an option when the variable of interest is country-specific. Despite this being one of the motivations in Baier & Bergstrand, none of their examples has one.

This paper takes Baier & Bergstrand seriously. We use their approach to assess the impact of export documentation, an exporter-specific variable, on trade flows. Including MR terms in the same way as for a bilateral variable yields consistent estimation of the gravity parameter, but, because we have over 100 countries, *this is of the order of 100 times the average comparative static effect.* One can construct an isomorphic specification which *does* give the average effect: it simply adds the importer's variable to the specification.

We apply the model to export documentation because it has the advantage of being exporter-specific rather than simply country-specific. This allows us to interpret the importer coefficient in terms of MR instead of confounding it with direct importer-specific effects. Furthermore, the documentation required to export is of inherent interest because it provides a good proxy for the red-tape associated with exporting.

Monte Carlo simulations confirm that omitting MR terms leads to underestimates of the coefficients on distance and documents. Including them yields consistent estimation and allows one to compare two isomorphic specifications - one for the gravity parameter and one for the average effect. In our regressions, accounting for MR increases the magnitude of an insignificant documents coefficient five-fold and makes it significant. An additional document required for export would reduce exports by 7% for an average-size country, but most countries are much smaller than average, so the median effect of reduced frictions is only 0.5%.

2 Theory

2.1 Model

Following Baier & Bergstrand (2009), we specify log exports from country 2 to country 1 (adjusted for GDP in the importer and exporter) as follows

$$x_{12} = K-(\sigma-1)\ln t_{12}-\sum_j s_j \sum_i s_i (\sigma-1)\ln t_{ij}+\sum_j s_j (\sigma-1)\ln t_{1j}+\sum_i s_i (\sigma-1)\ln t_{i2} \tag{1}$$

K is a constant, t_{ij} are trade frictions, s_k is the share of country k in world GDP and σ is the elasticity of substitution. The summation terms approximate multilateral resistance. We specify trade frictions in terms of (log) bilateral distance and the documents required for exports in the exporting country. When $i = j = k$ we have d_{kk} represented by a measure of internal distance but $E_k = 0$ because no export documents are needed when one is not exporting. Let $(\sigma-1)\ln t_{ij} = \gamma d_{ij} + \beta E_j + \mu_{ij}$. μ_{ij} is a classical error term that can be interpreted as the log of unobserved trade frictions. Thus,

$$
\begin{aligned}
x_{12} &= K - \gamma d_{ij} - \beta E_j && \text{(2a)} \\
&\quad - \sum_j s_j \sum_i s_i \gamma d_{ij} - \sum_j s_j \sum_i s_i \beta E_j && \text{(2b)} \\
&\quad + \sum_j s_j \gamma d_{1j} + \sum_j s_j \beta E_j && \text{(2c)} \\
&\quad + \sum_i s_i \gamma d_{i2} + \sum_i s_i \beta E_2 && \text{(2d)} \\
&\quad + \mu_{12} && \text{(2e)}
\end{aligned}
$$

2.2 Comparative Statics

When the number of documents required for exports rises, $\partial E_2 = 0$ for $i = j$, so

$$
\begin{aligned}
\frac{\partial x_{12}}{\partial E_2} &= -\beta \left\{1 + s_2 (1 - s_2) - s_2 - (1 - s_2)\right\} && \text{(3a)} \\
&= -s_2 (1 - s_2) \beta && \text{(3b)} \\
&\approx -s_2 \beta && \text{(3c)}
\end{aligned}
$$

The first term in the {} brackets gives the partial effect. The third term is the effect operating through the importer's multilateral resistance; it rises by the exporter's share, which mitigates against the partial effect. The fourth term is the exporter's multilateral resistance. Intuitively, a rise in the documents required for exports affects trade frictions with all of country $2's$ destinations. Therefore, the rise in frictions of exporting to 1 has not risen relative to exporting anywhere else, *except* the domestic market. The second term is the effect operating through "world resistance". It is also the net general equilibrium effect after one allows for terms to cancel. It shows that, because exporting to all external destinations has become equally less attractive, the overall effect on bilateral trade is not between external desitinations, but away from external destinations towards internal trade. The comparative statics clearly show that the comparative static effect is not β, but something *much* smaller.

As in Anderson & van Wincoop (2003), the comparative static effect is increasing in country size. We can also show that

$$
\frac{\partial x_{12}}{\partial E_1} = -s_1 (1 - s_1) \beta \tag{4}
$$

This means that, the documents required for country 1 to export have an impact on exports from country 2. The net effect of a rise in documentation operates through world resistance. Because exporting from 1 becomes less attractive for country 1, exports from country 1 fall. Because of the trade balance condition,[1] imports by 1 must fall by the same amount. Hence, exports from 2 to 1 must fall.

2.3 Implications for estimation

For the purposes of simulation and estimation, assume that all countries have equal shares[2] such that $s_k = \frac{1}{n}$. When constructing MR for documents, one can invoke the analogue of (2) and construct

$$MR_{12}^{docs} = -\frac{1}{n^2}\sum_i \sum_j E_j + \frac{1}{n}\sum_j E_j + \frac{n-1}{n}E_2 \tag{5}$$

The first term on the right hand side is a constant, the second term is 1-specific and includes $E_1 = 0$, while the third term is 2-specific and allows for the fact that $E_2 = 0$ when $i = 2$. This yields an analague to equation 23 in Baier & Bergstrand (2009):

$$\begin{aligned} x_{12} &= -y - \gamma\left(d_{12} - MR_{12}^{dist}\right) && \text{(6a)} \\ &\quad -\beta\left(E_2 - MR_{12}^{docs}\right) + \mu_{12} && \text{(6b)} \end{aligned}$$

The coefficient on documents is β, which is the gravity parameter but not $-s_2\beta$ or $\frac{1}{n}\beta$. The coefficient on distance does (approximately) give the comparative static effect for a bilateral reduction in distance.[3] Given that the first term is a constant, the second term differs from a constant only by E_1 and that the third term is just E_2, we can collect terms such that

$$\begin{aligned} x_{12} &= k - \gamma\left(d_{12} - MR_{12}^{dist}\right) && (7) \\ &\quad -\frac{\beta}{n}\left(E_1 + E_2\right) + \mu_{12} && (8) \end{aligned}$$

where $k = -y - \frac{1}{n^2}\sum_i \sum_j E_j$. Hence, instead of constructing full MR terms, one need only include the partner (importer) documents term. Many reduced-form specifications include importer characteristics anyway, but MR offers a novel interpretation of the importer coefficient. In the case of an exporter-specific variable, it provides a rationale for inclusion on the importer side.[4] Coinciding with the comparative static results (3) and (4), the coefficients on E_1 and E_2 are equal. The coefficient is $\frac{\beta}{n}$, which is the comparative static effect for a country of average size $\frac{1}{n}$. Obviously, it is n times smaller than in the isomorphic specification (6), which gives the gravity parameter estimate.

[1] This is needed to derive the Anderson & van Wincoop (2003) system.

[2] This was done by Baier & Bergstrand in their working paper version. Email correspondence with Scott Baier suggested this is an equally valid approach.

[3] A bilateral reduction refers to a situation where d_{12} and d_{21} fall.

[4] To be clear, this motivates inclusion of the importer's documentation required for *export*, not the documentation for import, which is also available.

3 Empirics

3.1 Simulations

We use real data for documents and for distance.[5] We construct a value for x assuming the data generating process specified in (2), but assume equal shares. We deterministically set the true coefficients $\gamma = 1$ and $\beta = 119$. Because our sample has 119 countries in total, this means the true value of $\frac{\beta}{n} = 1$. We add an error term drawn from the standard normall distribution error term 1000 times. We apply three regressions each time. c is a vector of ones, $\hat{x}$ refers to predicted values and a tilde refers to the empirical coefficient on the variable of interest.

1. $\hat{x}_{12} = c - \tilde{\gamma} d_{12} - \tilde{\beta} E_2$
2. $\hat{x}_{12} = c - \tilde{\gamma} \left(d_{12} - MR_{12}^{dist} \right) - \tilde{\beta} E_2$
3. $\hat{x}_{12} = c - \tilde{\gamma} \left(d_{12} - MR_{12}^{dist} \right) - \tilde{\beta}_1 \left(E_1 \right) - \tilde{\beta}_2 \left(E_2 \right)$

The results are in Table 1, in the columns corresponding to the bullets above. The key statistic is the mean coefficient estimate taken from our 1000 estimates. We also present the 50th highest and 50th lowest estimate. In specification 1, we have no adjustment for MR. On average the distance coefficient (0.836) is much lower than the expected true coefficient coefficient of 1.Even the 5th percentile is below unity. The coefficient on documents is supposed to be 1 and is underestimated slightly. The second specification includes full MR terms. The distance coefficient is at its true value and the true value on documentation of 119 is consistently estimated. Finally, we use the importer's documents to adjust for MR. The true coefficient of 1 is accurately estimated.

3.2 Regressions

Using IMF export data from 2005, we depart from the specification by including importer and exporter GDP on the right hand side. The results in table 2 follow the bulleted specifications. The first specification is our benchmark, where we see that the documents variable is negative as expected, but insignificant at 10%.

In specifications 2 and 3, the coefficient on distance is more negative. The documents coefficient in specification 3 is about five times higher than in specification 1 and significant. In specification 2, the estimate of β is 129 times the estimate of $\frac{\beta}{n}$ in specification 3. We can see that the coefficient on the partner's documents in specification 3 is almost the same as on the exporter's documents, as predicted by the theory. In a specification we have not presented, restricting them to be equal yields a coefficient exactly $\frac{1}{n}$ times the coefficient in specification 2, so the isomorphism of specifications 2 and 3 is apparent in the regressions as well.

[5] Documents data has been produced by the World Bank as part of their *Doing Business* surveys while now distance data is taken from CEPII.

4 Conclusion: bias vs interpretation

We have applied the Baier & Bergstrand approximation of multilateral resistance to measure the impact of documentation on exports. Our simulation and regression results have produced evidence of bias consistent with the theory and econometric predictions (see Wooldridge, 2002:61). Whether or not the bias on the exporter term is important is debatable, but it pales in comparison to the interpretation implications generated by multilateral resistance. We have shown the documentation coefficient can give the *average* effect of a rise in documentation requirements, albeit in a roundabout way: specification 3 implies an average impact of -0.07: 1 extra document reduces exports by 7% for an average-size country. However, most countries are much smaller than average. African countries are less than 5% as big as the world average, so using the average from the whole sample would be woefully inappropriate if studying African exports. Even the median country share is only 7% of the average share, so the *median* impact is only -0.005.

Thus, while accounting for MR in estimation has generated a significant and larger coefficient, accounting for MR in comparative statics ironically suggests frictions are less detrimental to most countries than we thought.

References

[1] Anderson & Van Wincoop (2003), "Gravity with Gravitas: A Solution to the Border Puzzle"; *American Economic Review*

[2] Baier & Bergstrand (2009); "Bonus Vetus OLS: A Simple Method for Approximating International Trade-Cost Effects using the Gravity Equation"; *Journal of International Economics*

[3] Behar & Nelson (2009); "How Multilateral Resistance and Firm Heterogeneity Affect Trade Elasticities"; *mimeo*

[4] Feenstra (2004); "Advanced International Trade: Theory and Evidence"; *Princeton University Press*

[5] Wooldridge (2002); "Econometric Analysis of Cross Section and Panel Data"; *The MIT Press*

	-1		-2		-3		
	Dist	Docs	Dist-MR_{dist}	Docs-MR_{docs}	Dist-MR_{dist}	Docs	Docs (imp)
mean	-0.8361504	-0.9809879	-1.002184	-119.0001	-1.002188	-0.9998872	-1.00011
5^{th} percentile	-0.9255406	-1.010506	-1.211809	-121.632	-1.211813	-1.029428	-1.033675
95^{th} percentile	-0.7424932	-0.9500039	-0.7834932	-116.3182	-0.7834972	-0.9691857	-0.9674106

Table 1: Simulations. 1 has no MR adjustment, 2 has MR terms for distance and documents, 3 has an MR term for distance but the importer's documents. Mean is the mean of the 1000 estimates, the 5th percentile is the 50th highest estimate and the 95th percentile is the 50th lowest estimate.

	-1	-2	-3
	Exports	Exports	Exports
GDP exporter	1.267***	1.215***	1.218***
GDP importer	0.930***	0.871***	0.868***
Distance	-1.478***		
Documents	-0.0128		-0.0651***
Distance-$MR_{distance}$		-1.662***	-1.663***
Documents-$MR_{documents}$		-8.409***	
Documents importer			-0.0763***
Constant	-25.31***	-35.09***	-34.61***
Adjusted R^2	0.675	0.674	0.674
N	10057	10057	10057

Table 2: Regressions. See table 1 for specification notes. In -3, F-Test that Documents = Documents importer: 0.5204. Stars indicate significance at 5% (*), 1% (**) and 0.01% (***).