

Border Frictions and Potential Trade in the Structural Gravity Model

Forthcoming in Applied Economics Letters

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November 6th, 2024.

Abstract: I set out a simple, gravity-based approach for estimating a uniform border friction in the exporting country. I relate removal of that friction to the idea of “potential trade” in the policy literature. The analysis makes clear that it is possible to make clear statements about the value of trade in the absence of at least some unobservable frictions in a way that takes account of current theory and empirical practice, and which does not lead to unreasonable counterfactual predictions.

Keywords: International trade; gravity model; trade policy; quantitative model.

JEL Codes: F15; F13; F14.

¹ I am grateful to Tom Zylkin for very helpful conversations.

² Declarations of interest: None.

1 INTRODUCTION

Among trade policy researchers, there is interest in concepts like “export potential” or “trade potential”. Examples include ITC’s “Export Potential Map”,³ and World Bank trade potential analysis using Mulabdic and Yasar (2021). Alternative methods such as stochastic frontier estimation are unlikely to deliver meaningful estimates in the presence of heteroskedasticity (Santos Silva and Tenreyro, 2006), and two-stage gravity models appear not to fit the data well (Santos Silva et al., 2015). Policymakers use this information to identify countries or sectors where efforts to reform trade policies could be particularly fruitful, as well as to identify the effects of policy changes over time.

Analytically, however, these concepts are poorly defined. The basic idea is that observed trade is less than it “could” be due to unobservables. Egger (2002) identifies a number of pitfalls with this. Mulabdic and Yasar (2021) show that a structural gravity model estimated by Poisson Pseudo-Maximum Likelihood (PPML) with exporter and importer fixed effects has exactly zero difference between observed and predicted aggregate flows; that is, there is zero “trade potential” at the country level.

Considerations such as these have led researchers to apply ad hoc approaches. For instance, Export Potential Map uses a gravity-like model, but does not include insights from the recent literature. Mulabdic and Yasar (2021) use atheoretical remoteness terms. Neither approach recognizes the economy’s resource constraint, or that general equilibrium effects could be important. The main risk in using ad hoc techniques is that they may provide uninformative outputs, which in turn could lead to misleading policy advice. A theoretically grounded, empirically rigorous approach, which is what I propose in this paper, would overcome these difficulties and provide the basis for stronger policy recommendations.

My paper has two objectives.

First, I conceptualize “potential trade” as an alternative to ad hoc measures of trade potential or export potential. I use a standard structural gravity model, and frame the issue of potential as a counterfactual in which an unobservable exporter border friction is eliminated. This framing accords with policy work, but has the advantage of being fully consistent with theory and empirical practice.

Second, I follow French (2017) to calculate the exporter border friction using a gravity model for international trade, combined with a single observation for intra-national trade. In an example, the approach produces meaningful results that quantify the trade gains countries could experience if they eliminated exporter border frictions. The approach is straightforward to implement, and provides results that are robust and easy to interpret.

Section 2 operationalizes this definition of potential trade. Section 3 discusses French’s (2017) approach to calculating the exporter border friction. Section 4 presents an empirical application, and the final section concludes.

2 POTENTIAL TRADE

System (1) is a standard structural gravity model (Anderson and Van Wincoop, 2003):

³ <https://exportpotential.intracen.org/en/>.

$$(1a) \quad X_{ij} = \frac{Y_i b_i^{-\theta B_{ij}} E_j}{\Omega_i^{-\theta} P_j^{-\theta}} d_{ij}^{-\theta}$$

$$(1b) \quad \Omega_i^{-\theta} = \sum_j \frac{E_j}{P_j^{-\theta}} d_{ij}^{-\theta} b_i^{-\theta B_{ij}}$$

$$(1c) \quad P_j^{-\theta} = \sum_i \frac{Y_i}{\Omega_i^{-\theta}} d_{ij}^{-\theta} b_i^{-\theta B_{ij}}$$

X_{ij} is exports from country i to country j ; Y is output; E is expenditure; d is country-pair specific iceberg trade costs (i.e., unity plus the ad valorem equivalent); θ is the trade elasticity (the sensitivity of bilateral trade flows to changes in trade costs); Ω is outward multilateral resistance (relative prices across all routes served by an exporter); and P is inward multilateral resistance (relative prices across all routes coming to an importer).

B is a dummy equal to unity for flows crossing an international border. It is interacted with b , a uniform iceberg border friction. This setup is consistent with the evidence in Waugh (2010).⁴ It means that intra-national trade flows are only subject to iceberg trade costs d (because $B_{ii}=0$), while international trade flows are subject both to those costs, and also the border friction b (because $B_{ij}=1 \forall i \neq j$). The border friction could summarize policy-related barriers, as opposed to bilateral frictions that are geographical and historical.

Policy work on trade potential starts from the idea that observed trade flows are lower than they would be in the absence of unobservable frictions. A natural but rigorous definition, therefore, is the level of trade that would prevail if the border friction b were removed, ceteris paribus. Given the above interpretation, this simulation captures the impact of removing a potentially large set of policy barriers.

Following Dekle et al. (2007), I set output equal to expenditure plus an exogenous trade deficit. This approach gives a complete counterfactual solution, using hats to indicate proportional changes (Baier et al., 2019):

$$(2a) \quad \hat{X}_{ij} = \frac{\hat{w}_i^{-\theta} \left(\frac{1}{b_i^{-\theta B_{ij}}} \right) \frac{(Y_j \hat{w}_j + D_j)}{E_j}}{\sum_i \pi_{ij} \hat{w}_i^{-\theta} \left(\frac{1}{b_i^{-\theta B_{ij}}} \right)}$$

$$(2b) \quad \hat{w}_i = \frac{\hat{w}_i^{-\theta}}{Y_i} \sum_j \frac{\pi_{ij} \left(\frac{1}{b_i^{-\theta B_{ij}}} \right)}{\sum_i \pi_{ij} \hat{w}_i^{-\theta} \left(\frac{1}{b_i^{-\theta B_{ij}}} \right)} (Y_j \hat{w}_j + D_j)$$

⁴ An alternative is to model the border friction as importer-specific, which Ramondo et al. (2016) argue is more consistent with international price data. The analysis would be the same.

W is the wage, π_{ij} is the import share, and D is the exogenous deficit. Baier et al. (2019) provide an iterative procedure for solving system (2), which directly calculates potential trade using only observed trade and the change in trade costs as inputs (wages are unobserved). The solution fully respects general equilibrium properties of the system, including real resource constraints.

3 STRUCTURAL GRAVITY

The previous section provided an interpretation of potential trade in terms of an exporter border friction. This section calculates that friction, following French (2017).

For system (1), it is impossible to estimate b directly because it is collinear with the standard exporter fixed effect (e.g., Weidner and Zylkin, 2021).

To calculate b , I first consider the closely related system (2), which French (2017) shows provides identical empirical estimates of d :

$$(2a) \quad X_{ij} = \frac{X_i M_j}{\tilde{\Omega}_i^{-\theta} \tilde{P}_j^{-\theta}} d_{ij}^{-\theta}, \forall i \neq j$$

$$(2b) \quad \tilde{\Omega}_i^{-\theta} = \sum_{j \neq i} \frac{M_j}{\tilde{P}_j^{-\theta}} d_{ij}^{-\theta}$$

$$(2c) \quad \tilde{P}_j^{-\theta} = \sum_{i \neq j} \frac{X_i}{\tilde{\Omega}_i^{-\theta}} d_{ij}^{-\theta}$$

System (2) only includes international trade observations. As a result, output becomes total exports (X) and expenditure becomes total imports (M). The two price indices carry tildes to stress that they cover international routes only.

An estimable version of (2) is:

$$(3) \quad X_{ij} = \exp(\tilde{f}_i + \tilde{g}_j - \theta \log \tilde{d}_{ij}) e_{ij}, \forall i \neq j$$

The f and g terms are exporter and importer fixed effects; d is a trade costs term parametrized in terms of observables; and e is an error term. To estimate (3), standard practice is to use PPML (Santos Silva and Tenreryo, 2006; Weidner and Zylkin, 2021).

I can equate the fixed effect estimates of equation (3) with quantities in system (1), as follows:

$$(4a) \quad \exp(\tilde{f}_i) = \frac{Y_i b_i^{-\theta}}{\Omega_i^{-\theta}} \text{ (from (3) and (1a))}$$

$$(4b) \quad \exp(\tilde{g}_i) = \frac{E_i}{P_i^{-\theta}} \text{ (from (3) and (1a))}$$

From (1a), intra-national trade is:⁵

⁵ Frictionless internal trade is a common assumption, but I depart from it to produce conservative potential trade estimates.

$$(5) \quad X_{ii} = \frac{Y_i E_i d_{ii}^{-\theta}}{\Omega_i^{-\theta} P_i^{-\theta}}$$

Substituting equations (4a) and (4b) into (5) and rearranging gives an expression for the border effect:

$$(6) \quad X_{ii} = \frac{\exp(\tilde{f}_i)}{b_i^{-\theta}} \exp(\tilde{g}) d_{ii}^{-\theta}$$

$$\therefore b_i^{-\theta} = \frac{\exp(\tilde{f}_i + \tilde{g} - \theta \log \tilde{d}_{ii})}{X_{ii}}$$

French (2017) therefore shows that it is possible to use estimates from a gravity model of international trade with an observation for intra-national trade to calculate the exporter-specific border barrier. The fixed effects are exogenous, so with exogenous trade costs and calculation, not estimation, of b , no issue of endogeneity arises.

4 APPLICATION

This section provides an empirical example using the Asian Development Bank's (ADB) Multi-Region Input-Output Table (MRIO) for 2022 aggregate trade. Trade costs come from the CEPII Distance Dataset.

First, I estimate (3) by PPML. I specify trade costs in terms of standard gravity controls. All variables are exogenous with respect to trade. Results are in Table 1, and are typical.

Table 1: Estimation results.

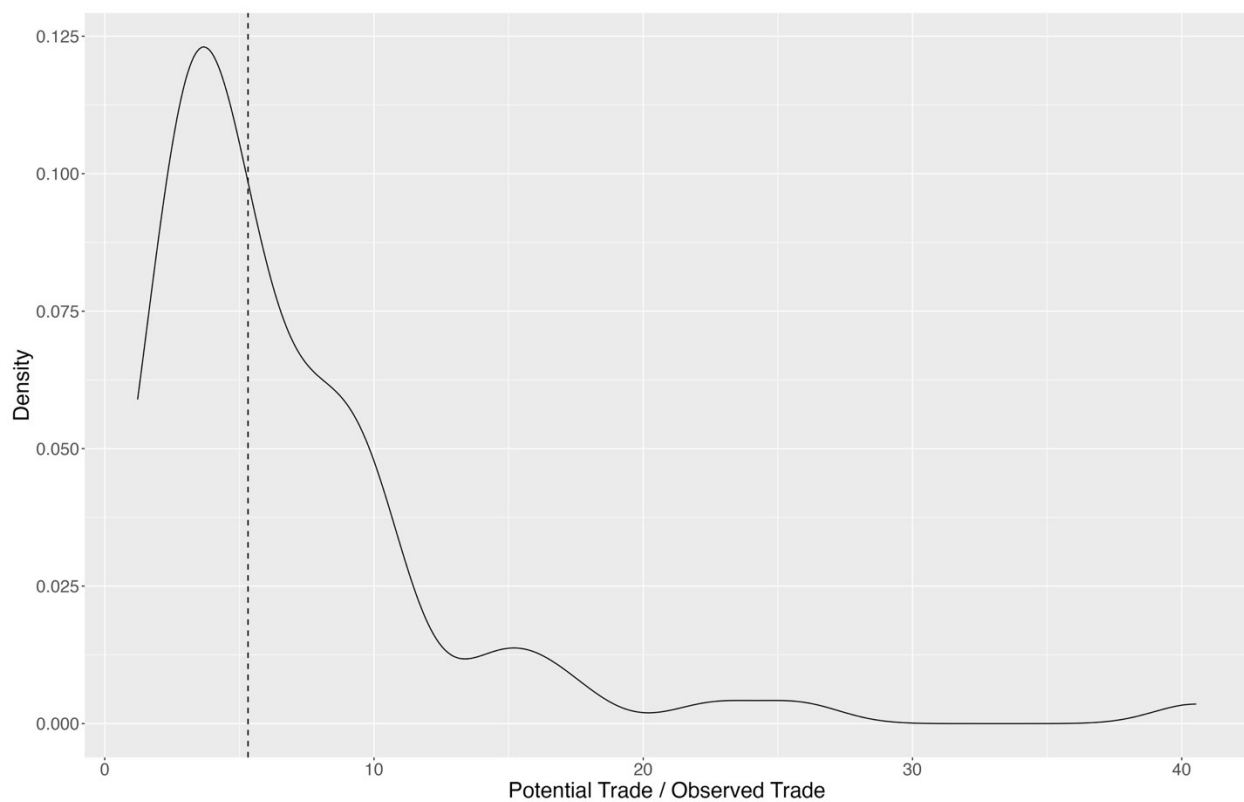
	PPML
Log(Distance)	-0.622*** (0.032)
Common Border	0.353*** (0.113)
Colony	0.086 (0.127)
Common Colonizer	0.299 (0.211)
Common Language	0.357*** (0.102)
Same Country	0.019 (0.111)
N	5112
R2	0.888
Fixed Effects	Exporter, Importer

Note: Robust standard errors corrected for pairwise clustering are below parameter estimates. Statistical significance is: * (10%), ** (5%), and *** (1%).

I then calculate the border friction using (6). Border frictions are large, with a median of 96.0% ad valorem. By way of comparison, the WTO Trade Costs Index suggests that total trade costs are typically three times or more higher than internal trade costs.

Next, I use Baier et al. (2019) to solve the counterfactual of removing the exporter border friction. Figure 1 shows that it produces large increases in aggregate exports (i.e., on international routes), as measured by the ratio of potential to observed trade. At the median, the ratio is over five, although there is considerable variation. The ratio of potential to observed trade for Turkey is 8.016, which compares to 1.530 in Mulabdic and Yasar (2021, p.11). The higher figure is more plausible given the high level of trade costs in the global economy, as indicated by the WTO Trade Costs Index above.

Figure 1: Kernel density of the ratio of potential to observed trade.



Note: Dashed line indicates the median.

In all cases, potential trade is greater than observed trade, which shows that general equilibrium effects (while important; Anderson and Van Wincoop, 2003), are not so strong as to divert trade below what is currently observed. However, all domestic observations fall, because additional international trade must be at the expense of domestic transactions. At a disaggregated level, general equilibrium effects reduce potential trade below observed trade in 2.5% of international observations.

5 CONCLUSION

It is straightforward to calculate an exporter-specific border friction. I have conceptualized simulated trade in the absence of that friction as “potential trade”. Demand in the policy literature for measures of this type can therefore be satisfied in a rigorous way. This approach is superior to ad hoc techniques as it provides more meaningful, robust outputs, which can form the basis for superior policy recommendations.

My approach can easily be generalized to multiple sectors. It is also possible to replicate it at a finer level of detail using other data. Where I have assumed that potential trade is given by removal of an exporter-specific border barrier, it would also be possible to use the same methodology to consider an importer-specific barrier, or even bilateral barriers. The most important factor is framing potential trade as a counterfactual based on the Dekle et al. (2007) approach.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author, BAS, upon reasonable request.

FUNDING

No funding was obtained for this research.

CONFLICT OF INTEREST

There is no conflict of interest in relation to this work.

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