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Estimating border effects in international trade: User beware

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Borders impede trade, and a major objective of research in international trade has been to identify by how much. This column argues that bilateral trade data can give a misleading picture. Larger countries have inherently smaller border effects because their data aggregate over more space and economic activity. Trade economists need to think harder about how slicing up the map at the level of countries drives estimates of important policy variables.

By how much do borders impede trade? It has been a major objective of research in international trade to identify the frictions that hinder the integration of markets, and many policymakers across the globe are keen on reducing them.

Ever since the seminal paper by McCallum (1995), many researchers have used the gravity equation as a workhorse model to estimate so-called border effects. McCallum found that Canadian provinces trade up to 22 times more with each other than with US states. This astounding result has led to a large literature on the trade impediments associated with international borders. Anderson and van Wincoop (2003) famously revisit the US-Canadian border effect with new, theory-consistent estimates. Although they are able to reduce the border effect considerably, the international border remains a large impediment to trade.

While much attention has been focused on international borders, research has found domestic border effects as well. For example, Wolf (2000) and Millimet and Osang (2007) find that after controlling for economic size, distance and a number of additional determinants, trade within individual US states is significantly larger than trade between US states. Similarly, Nitsch (2000) finds that domestic trade within the average EU country is about ten times larger than trade with another EU country.

Gravity and aggregation over space

Our research focuses on how much confidence one should place in these gravity-based estimates of border effects (Coughlin and Novy 2016). In their simplest form, gravity equations with border dummies are estimated based on aggregate bilateral trade data. As aggregates, these data combine the trade flows of spatial sub-units such as boroughs, municipalities and counties into trade flows at a higher level of spatial aggregation such as regions, states and countries.

Research in economic geography, such as Fotheringham and Wong (1991) and Briant *et al*. (2010), has identified potential problems with spatial aggregation and termed it the ‘Modifiable Areal Unit Problem’. The question we attempt to address is how this process of aggregation affects the estimation of border effects. How do border effects depend on the spatial units we find in any given dataset? Put differently, how do border effects depend on the way we slice up the map?

Aggregation leads to systematic heterogeneity

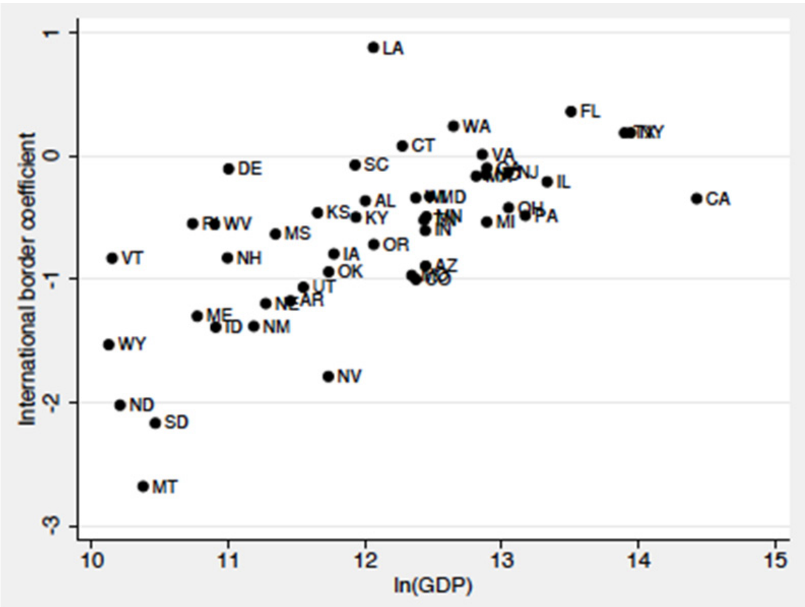
To understand the effects of spatial aggregation, we build a theoretical framework based on a large number of 'micro' regions that trade with each other subject to spatial frictions. We then aggregate these regions into larger 'macro' regions. Due to the spatial frictions, the more micro regions we combine, the more we increase the costs of trading within the newly aggregated regions. As a result, aggregation increases the relative costs of trading within as opposed to across borders. Our theory shows how this shift in relative costs leads to heterogeneous border effect estimates. Smaller regions are associated with strong border effects, and larger regions are associated with moderate border effects. We call this the spatial attenuation effect.

This heterogeneity has important implications for the estimation of border effects as typically found in the literature. First, since standard border effects are averages of the underlying individual border effects, we get sample composition effects. That is, samples that happen to include many large regions (or countries) tend to have moderate border effects, and vice versa. Second, given that samples inevitably vary across different studies, their border effects are not directly comparable to each other since each sample implies a different choice about the relevant spatial unit. We show how border effect estimates can be adjusted so that valid comparisons can be made.

Evidence from US trade flows

On the empirical side, we test the predictions of our theory with a data set of domestic and international trade flows at the level of US states. Our results confirm the model's predictions, in particular the systematic heterogeneity of border effects across states. This finding is illustrated in Figure 1. The figure is a scatterplot of the positive relationship between state size and our estimate of the state's international border effect. (A similar result holds for our estimates of the domestic border effect.) For instance, we find that for a large state like California, removing the US international border would lead to an increase of bilateral trade on average by only 13%, whereas for a small state like Wyoming trade would go up over four times as much (61%).

Figure 1. International border dummy coefficients



We also carry out a hypothetical scenario of aggregating US states into larger spatial units, namely the nine Census divisions as defined by the US Census Bureau. Consistent with our model, we obtain smaller estimated border effects at the level of Census divisions. Overall, we find that spatial aggregation has a strong, first-order quantitative impact on border effects.

It is important to note that our mechanism of spatial aggregation is separate from multilateral resistance effects in general equilibrium as highlighted by Anderson and van Wincoop (2003). Since small regions are typically more exposed to international trade, removing a border tends to have a stronger effect on their price index and hence their multilateral resistance, compared to large regions. In our model, due to symmetry at the level of micro regions, every location faces the same price index, and aggregation does not affect this equilibrium structure. We therefore obtain border effect heterogeneity without multilateral resistance effects at work. In the data, when we have to keep track of varying multilateral resistances across space, we find that the heterogeneity of border effects stemming from spatial aggregation dominates by a large margin the heterogeneity coming from multilateral resistance effects.

The mismatch between micro frictions and macro data

The fundamental problem with gravity estimation of border effects is that researchers attempt to identify a border friction that occurs at the micro level faced by individual economic agents. However, spatial aggregation systematically shifts the estimates that can be recovered through gravity. Our theory sheds light on the precise nature of this mismatch between micro frictions and macro data. We show that in fact, even if no friction exists at the border, standard gravity estimation will still give rise to border effects, and these can be very large.

Overall, our insight is that a trade cost function with a border dummy can mechanically lead to large estimated border effects depending on the choice of spatial unit – even if individual economic agents at the micro level do not face any border friction. Due to spatial aggregation, the border effects estimated with aggregate data systematically vary by country characteristics, in particular economic size. In that light, traditional border effects could be seen as statistical artefacts. Their variation may not be not driven by underlying border frictions at the micro level faced by individual economic agents.

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CAGE's research analyses the reasons for economic outcomes both in developed economies such as the UK and emerging economies such as China and India. The Centre aims to develop a better understanding of how to promote institutions and policies that are conducive to successful economic performance and endeavours to draw lessons for policy-makers from economic history as well as the contemporary world.

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