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From micro to macro: Demand, supply, and heterogeneity in the trade elasticity☆

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ABSTRACT

Models of heterogeneous firms with selection into export market participation generically exhibit aggregate trade elasticities that vary across country-pairs. Only when heterogeneity is assumed Pareto-distributed do all elasticities collapse into a unique elasticity, estimable with a gravity equation. This paper provides a theory-consistent methodology for quantifying country-pair specific aggregate elasticities when moving away from Pareto, i.e. when gravity does not hold. Combining two firm-level customs datasets for which we observe French and Chinese individual sales on the same destination market over the 2000–2006 period, we are able to estimate all the components of the bilateral aggregate elasticity: i) the demand-side parameter that governs the intensive margin and ii) the supply side parameters that drive the extensive margin. These components are then used to calculate theoretical predictions of bilateral aggregate elasticities over the whole set of destinations, and how those elasticities decompose into different margins. Our predictions fit well with econometric estimates, supporting our view that micro-data is a key element in the quantification of aggregate trade elasticities.

1. Introduction

The response of trade flows to a change in trade costs, the aggregate trade elasticity, is a central element in any evaluation of the welfare impacts of trade liberalization. Arkolakis et al. (2012) recently showed that this parameter, let us call it ε for the rest of the paper, is actually one of the (only) two sufficient statistics needed to calculate Gains From Trade (GFT) under a surprisingly large set of alternative modeling assumptions. Measuring those elasticities has therefore been the topic of a long-standing literature in international economics. The most common practice (and the one recommended by Arkolakis et al., 2012) is to estimate this elasticity in a *macro-level* bilateral trade equation referred to as structural gravity in the literature following the initial impulse by Anderson and van Wincoop (2003). In order for this estimate of ε to be relevant for a particular experiment of trade liberalization, it is crucial for this bilateral trade equation to be correctly specified as a structural gravity model with, in particular, a *unique* elasticity to be estimated across country pairs.

Our starting point is that the model of heterogeneous firms with selection into export market participation (Melitz, 2003) will in general exhibit a *bilateral-specific* aggregate trade elasticity, i.e. an ε_{ni}, which applies to each country pair, where i denotes the origin and n the destination of the flow. Only when heterogeneity is assumed Pareto-distributed[1] do all ε_{ni} collapse to a single ε. Under any other (commonly-used) distributional assumption, obtaining an estimate of the aggregate trade elasticity from a macro-level bilateral trade

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[1] Unless otherwise specified, Pareto is understood here as the *unbounded version* used by most of the literature. See Helpman et al. (2008) and Melitz and Redding (2015) for results with the bounded version, where the trade elasticity recovers a bilateral dimension.

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equation becomes problematic: first because a whole set of ε_{ni} has to be estimated, and second because structural gravity does not hold anymore. We argue that in this case quantifying trade elasticities at the aggregate level makes it necessary to use micro-level information. To this purpose, we combine sales of French and Chinese exporters in many destination-product combinations for which we also observe the relevant tariff applied. We propose a theory-consistent methodology using this firm-level export data for quantifying all the components of the bilateral aggregate trade elasticity: i) the demand-side parameter that governs the intensive margin and ii) the supply side parameters that drive the extensive margin. These components are then assembled under theoretical guidance to calculate the bilateral aggregate elasticities over the whole set of destinations.

Taking into account country pair heterogeneity in aggregate trade elasticities is crucial for quantifying the expected impact of various trade policy experiments.[2] Consider the example of envisioned Transatlantic or Transpacific trade agreements (TTIP or TPP). Under the simplifying assumption of a unique elasticity, whether the trade liberalization takes place with a proximate vs distant, large vs small economy, is irrelevant in terms of trade-promoting effect or welfare gains calculations. By contrast, our results suggest that the relevant ε_{ni} should be smaller (in absolute value) when trade liberalization concerns country-pairs where the volume of bilateral trade is already large. Regarding welfare, Head et al. (2014) and Melitz and Redding (2015) have shown theoretically that the GFT can be substantially mis-estimated if one assumes a constant trade elasticity when the "true" elasticity is variable (the margin of error can exceed 100% in both papers). The expected changes in trade patterns and welfare effects of agreements such as TTIP or TPP will therefore be different compared to the unique elasticity case. One of the main objectives of our paper is to quantify how wrong can one be when making predictions based on a constant trade elasticity assumption. Naturally, this point also applies to the case of potential breakups of existing agreements such as the EU or NAFTA.

Our approach maintains the traditional CES (σ) demand system combined with monopolistic competition. It features several steps that are structured around the following decomposition of the aggregate trade elasticity into the sum of the intensive margin and the (weighted) extensive margin:

$$\varepsilon_{ni} = \underbrace{1-\sigma}_{\text{intensive margin}} + \frac{1}{\underbrace{\bar{x}_{ni}/x_{ni}^{\text{MIN}}}_{\text{mean-to-min}}} \times \underbrace{\frac{d\ln N_{ni}}{d\ln \tau_{ni}}}_{\text{extensive margin}} \quad . \tag{1}$$

The weight is the inverse of the *mean-to-min ratio*, our observable measuring the dispersion of firm-level performance, that is defined as the ratio of average to minimum sales across markets. As the market gets easier, the model predicts a larger presence of weak firms, which augments productivity dispersion, captured by $\bar{x}_{ni}/x_{ni}^{\text{MIN}}$. This lowers the weight of the extensive margin in the overall trade elasticity, which is intuitive: in extremely easy markets, all potential exporters should be active and the extensive margin of a small change in trade costs should be close to 0. When assuming Pareto with shape parameter θ, the last part of the elasticity reduces to $\sigma-1-\theta$, and the overall elasticity becomes constant and reflects only the parameter controlling dispersion in the distribution of productivity: $\varepsilon_{ni}^P = \varepsilon^P = -\theta$ (Chaney, 2008). Without the Pareto assumption, one needs to calculate the two components of the aggregate elasticity (Eq. (1)). We do so in two steps.

Our first step aims to estimate the demand side parameter σ using firm-level exports. Since protection is imposed on all firms from a given origin, higher demand and lower protection are not separately identifiable when using only one exporting country. With CES, firms are all faced with the same aggregate demand conditions. Thus, considering a second country of origin enables to isolate the effects of trade policy, if the latter is discriminatory. We therefore combine shipments by French and Chinese exporters to destinations that confront those firms with different levels of tariffs. Our setup yields a *firm-level* gravity equation which raises serious estimation challenges. The main issue is the combination of a selection bias (inherent in any firm-level estimation of the Melitz (2003) model) with a very large set of fixed effects to be included in the regression. We use adapted versions of three estimators that have been proposed in the literature to deal with different aspects of the problem. Those three methods are evaluated with Monte Carlo simulations of our theoretical setup, before being implemented on our data. Our preferred estimates of the firm-level trade elasticity imply an average value of $(1-\hat{\sigma})$ around -4.

Our second and main step applies Eq. (1) and combines the estimate of the firm-level elasticity $(1-\hat{\sigma})$ with the central supply side parameter—reflecting dispersion in the distribution of productivity—to obtain theoretical predictions of the aggregate elasticities of total export, number of exporters and average exports per firm to each destination. Those predictions (one elasticity for each exporter-importer combination) require knowledge of the bilateral export productivity cutoff under which firms find exports to be unprofitable. We make use of the mean-to-min ratio to reveal those cutoffs. A key element of our procedure is the calibration of the productivity distribution. As an alternative to Pareto we consider the log-normal distribution that fits the micro-data on firm-level sales very well.[3]

A related contribution of our paper is to discriminate between Pareto and log-normal as potential distributions for the underlying firm-level heterogeneity, suggesting that log-normal does a better job at matching the non-unique response of exports to changes in trade costs. Two pieces of evidence in that direction are provided. The first provides direct evidence that aggregate trade elasticities are non-constant across country pairs. The second is a strong correlation across industries between firm-level and aggregate elasticities—at odds with the prediction of a null correlation under Pareto. We also find that the heterogeneity in trade elasticities is quantitatively important: Although the average of bilateral elasticities is quite well approximated by a standard gravity model constraining the estimated parameter to be constant, deviations from this average level can be large. We show that under log-normal the ε_{ni} are larger (in absolute value) for pairs with low volumes of trade. Hence the trade-promoting impact of liberalization is expected to be larger for this kind of trade partners. For Chinese exports, assuming a unique elasticity would underestimate the trade impact of a tariff liberalization by about 25% for countries with initially very small trade flows (Somalia, Chad or Azerbaijan for instance). By contrast, the error would be to overestimate by around 20% the exports created when the United States or Japan reduce their trade costs.

The next section relates our paper to the existing literature. Section 3 describes our model and empirical strategy. Section 4 deals with the estimation challenges of the firm-level gravity regressions and reports the estimates of the intensive margin elasticity.

[2] Imbs and Méjean (2015) and Ossa (2015) recently argued that another source of heterogeneity, the cross-sectoral one, raises important aggregation issues that matter for aggregate outcomes of trade liberalization. We abstract from this particular kind of aggregation issue (which would reinforce the importance of heterogeneity for aggregate outcomes) in our paper and omit cross-sectoral variation in ε until Section 6 where we present industry-level estimates and use those to show that both demand and supply side determinants enter aggregate elasticities.

[3] Head et al. (2014) provide evidence and references for several micro-level data sets that individual sales are much better approximated by a log-normal distribution when the entire distribution is considered (without left-tail truncation). Freund and Pierola (2015) is a recent example showing, for all of the 32 countries used, very large deviations from Pareto if the data is not vastly truncated to focus on the very largest firms.