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Vertical gravity☆

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ABSTRACT

Vertical gravity deploys as the dependent variable a newly developed indicator of production sharing and processing trade among country pairs. The intensity of this relationship among 73 countries between 1998 and 2005 is assessed in a standard fixed-effects panel setting, with particular focus on trade policy. We find that joint adherence to a preferential trade agreement is associated with a considerably higher degree of processing trade among country pairs, and that such trade is also premised on a lower tariff environment compared to countries that integrate less strongly.

1. Introduction

The progressive integration of world markets has led to the fragmentation of production across countries and the formation of global supply chains. As different stages of production are often performed in different countries, the associated cross-border trade in parts and components, or vertical trade, has come to predominate world merchandize trade (Arndt & Kierzkowski, 2001; Cheng & Kierzkowski, 2001).[1] The internationalization of production processes has been intensifying for several decades and is hardly a new phenomenon. What is relatively new is the analysis and estimation of this phenomenon within the field of economics. This paper constitutes one such effort, in relation to the vertical dimension of the gravity effects in international trade.

Estimating the gravity model in the presence of large intermediates or parts and components flows is not without issues and caveats. This is true for the case of both the standard empirical gravity setting, with bilateral trade flows as the dependent variable, and the unconventional approach that has some indicator or measure of vertical trade on the left-hand side of the equation. Baldwin and Taglioni (2011) demonstrate that use of GDP in origin and destination countries—the core economic mass variable used in gravity estimation—is appropriate in a setting where consumer demand dominates but is a poor proxy when parts and components supply and demand are to be explained. They argue that the optimal solution would

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[1] This type of trade appears under different names in the literature, including vertical trade, network trade, processing trade, and supply chain trade, which we use interchangeably in this paper.

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be for regression analysis to use data on total costs to the sectors buying intermediates, as a proxy for their demand for intermediates imports. Although such data are not widely available, the authors argue that estimation bias from mass-variable misspecification in the presence of vertical trade can be avoided in analyses that include a full set of fixed effects, which is the approach undertaken here.

Such is not the case for several precursor studies of vertical trade. For example, Kimura, Takahashi, and Hayakawa (2007) run gravity regressions for bilateral trade both in final goods and in parts and components, and then (Wald) test whether regression coefficients differ significantly. They find that the two sets of regressions yield different results indeed, but the robustness of their specification is questioned by Baldwin and Taglioni (2011), because the mass variables employed are unadjusted for vertical trade and fixed effects absent from regressions.

Athukorala and Yamashita (2006) fail to include a full set of country and dyadic specific effects, thus exposing themselves to bias, but they point to arguments raised in the literature in defense of using GDP as an explanatory variable when vertical trade is the dependent variable. This is consistent with the theory of international production fragmentation, which posits that the extent of fragmentation depends on the size of the market (Jones, Kierzkowski, & Lurong, 2004), since economic size limits the scale of production and thereby the degree to which the division of labor and fragmentation can proceed. Furthermore, they argue with Grossman and Helpman (2005) that GDP may also be considered a valid proxy for the economic depth of trading nations, which directly relates to their attractiveness as a location of outsourcing activity. Similarly, distance represents a rough proxy for transport and other shipping costs, such as those associated with time lags, spoilage or ignorance about foreign customs and tastes. As such, distance can be thought of as influencing the decision making process by multinational enterprises when they compare the suitability of alternative locations to host fragments of global production processes. The traditional gravity setting is revaluated then in the context also of production fragmentation and vertical trade.

The gravity estimates by a precursor study to ours, by Mirodout and Ragoussis (2009), are robust in the sense of Baldwin and Taglioni. To compare standard and vertical trade regressions, they compute the Hummels, Ishii, and Yi (2001) vertical trade measure on the basis of bilateral trade and input-output data. This vertical trade variable then enters regressions as the dependent variable in lieu of gross bilateral exports, used for the standard comparator gravity regressions. A full set of fixed effects controls for any mass-dependent bias that may arise in the regressions, and Poisson regression addresses the issue of zero trade flows included in the dataset. They find that the two sets of regressions—one involving total trade as the dependent variable, and the other vertical trade—are highly similar.[2] The authors conclude that vertical trade responds to the same determinants as does total exports, and that gravity explains a significant portion of the total variation in the data (the adjusted *R*-squared of their regressions is close to 0.8). Among their findings, they also highlight that distance-related costs play a more prominent role in explaining the volume of trade associated with vertical specialization.

Slightly more intricate are the issues raised by Duenas and Fagiolo (2013), who from a network analytical perspective investigate whether the gravity model is suitable to explain the observed structure of binary and weighted international trade networks. They use a gravity model to predict a weighted-directed representation of the international trade network (essentially, a set of nodes connected by edges, taking different weights), which they then compare to the actually observed network, deducing the fit. They find that the gravity model performs well in terms of predicting the weights of the linkages between nodes, that is the intensity of trade between countries. However, that will only be the case when the binary structure of the network is given and kept constant during analysis. Otherwise, they find that the gravity model performs rather poorly, as it fails to predict weights jointly with the binary structure of the network. That is, the gravity framework appears not fully suitable to explaining the presence of bilateral trade links, or the weight any such link carries, whenever it is tasked with concomitantly defining also the basic skeleton underlying the very network structure of trade.

Notwithstanding these limitations, on balance we find that the extant literature supports the premise that the gravity model continues to represent a relevant and hitherto unrivaled empirical framework with which to investigate the intensity of both final goods and intermediate bilateral trade. Minimizing some of its limitations in the context of vertical trade, in this paper we apply the gravity framework to a newly developed network trade index, our gauge of vertical trade. To avoid the Baldwin and Taglioni (2011) critique, our regressions include a full set of fixed effects. Furthermore, the estimation strategy involves a two-stage Heckman sample selection procedure, to address at least some aspects of the identification issues raised by Duenas and Fagiolo (2013). Essentially, this is achieved by identifying vertical trade links through prior verification, operated by a first-step logit estimation, whether or not countries trade with each other at all, in terms of total trade. Simplifying, we assume that the existence of trade entails the existence of a binary bilateral network link, the intensity or weight of which we then estimate by the second-stage gravity regression.

In the remainder of this paper, we first discuss the calculation of the network trade index in Section 2. We then present our empirical strategy and interpret the gravity estimation results in Section 3. Concluding thoughts and issues for further research are discussed in Section 4.

[2] Miroudot and Ragoussis (2009) also estimate sector-specific regressions and they experiment with several alternative regressands, such as the ratio of vertical trade to FDI, which are not discussed here.