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Gravity, trade integration, and heterogeneity across industries

Natalie Chen [a,b,*], Dennis Novy [a,c,d]

[a] University of Warwick, Coventry CV4 7AL, United Kingdom
[b] Centre for Economic Policy Research, London, United Kingdom
[c] Centre for Economic Performance, London School of Economics, London, United Kingdom
[d] CESifo, Munich, Germany

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ABSTRACT

We derive a micro-founded measure of bilateral trade integration that is consistent with a broad range of leading gravity models. This measure accounts for cross-industry heterogeneity by incorporating substitution elasticities estimated at the industry level. We then use it to provide a theory-based ranking of trade integration across manufacturing industries in European Union countries. In addition, we explore the determinants of trade integration, finding that substantial Technical Barriers to Trade in certain industries as well as high transportation costs associated with heavy-weight goods are the most notable trade barriers.

1. Introduction

Trade costs are a staple ingredient in today's trade literature. They feature prominently in the vast majority of theoretical papers. Broadly defined, trade costs include any cost of engaging in international trade such as transportation costs, tariffs, non-tariff barriers, informational costs, time costs and different product standards, among others. In addition, a growing empirical literature, surveyed by Anderson and van Wincoop (2004), is devoted to exploring the sources and size of trade costs. A deeper understanding of the causes of trade costs is important because it would enable a better evaluation of their welfare implications. These are suspected to be large: on their own, policy-related trade costs may be worth more than ten percent of national income (Anderson and van Wincoop, 2002).

A major challenge faced by empirical researchers is to measure overall trade costs since "direct measures are remarkably sparse and inaccurate" (Anderson and van Wincoop, 2004, p. 692). Direct measures are only available for a few components, for instance transportation and insurance costs, usually proxied by the ratio of *c.i.f.* and *f.o.b.* trade values (Harrigan, 1993; Hummels, 2001a, 2007), policy barriers such as specific tariff or non-tariff barriers (Chen, 2004; Harrigan, 1993; Head and Mayer, 2000), informational costs (Rauch, 1999) or time costs (Evans and Harrigan, 2005; Harrigan, 2010; Hummels, 2001b).[1] But even for those components, data coverage is often limited to a few countries and years, and it can be hard to gather disaggregated trade cost data at the industry or product level.

Given those difficulties in obtaining accurate measures of trade costs, some researchers indirectly infer the level of trade impediments from trade flows. One way of doing this is to use the "*phi*-ness" of trade to estimate "border effects," which mostly reflect the extent of border-related costs (Head and Ries, 2001; Baldwin et al., 2003; Head and Mayer, 2004).[2] This indirect approach has the obvious advantage of extending the analysis to more countries, years and more finely disaggregated data.

This paper is part of the research effort that attempts to indirectly infer trade impediments from trade flows. Following the lead of Head and Ries (2001) and Head and Mayer (2004), the first contribution of

* Corresponding author at: University of Warwick, Department of Economics, Coventry CV4 7AL, United Kingdom. Tel.: +44 2476 528419; fax: +44 2476 523032.
E-mail addresses: N.A.Chen@warwick.ac.uk (N. Chen), D.Novy@warwick.ac.uk (D. Novy).

[1] Moreover, Limão and Venables (2001) use the quotes from shipping firms for a standard container shipped from Baltimore to several destinations. Combes and Lafourcade (2005) develop a new methodology to compute transportation costs and apply it to road transport by truck in France. Kee et al. (2009) estimate theory-based trade restrictiveness indices based on tariff and non-tariff barriers.

[2] See also Anderson and van Wincoop (2003), Baldwin et al. (2003), Chen (2004), Eaton and Kortum (2002), Evans (2003), Head and Mayer (2000), Head and Ries (2001), McCallum (1995), Nitsch (2000) and Wei (1996).

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the paper is to develop a micro-founded measure of bilateral trade integration that can be applied to disaggregated panel data and that can be computed from observable trade and output data. We derive this measure by modeling disaggregated trade flows at the industry level in the gravity framework pioneered by Anderson and van Wincoop (2003, 2004), allowing trade costs to be heterogeneous across industries. In contrast to the *phi*-ness measure, our measure of bilateral trade integration accounts for heterogeneity across industries by incorporating industry-specific substitution elasticities.

Arguably, the Anderson and van Wincoop monopolistic competition model is one of the most parsimonious trade models of recent years. It rests on the Armington assumption that countries produce differentiated goods and trade is driven by consumers' love of variety, leading to the key gravity equation. However, we extend the micro-foundations of the trade integration measure by showing that an isomorphic measure can also be derived from other models. These include the Ricardian trade model by Eaton and Kortum (2002), Chaney's (2008) extension of the Melitz (2003) heterogeneous firms model as well as the heterogeneous firms model by Melitz and Ottaviano (2008) with linear non-CES demand. This is possible because all these models lead to gravity equations that have a similar structure. Our approach is therefore consistent with a broad range of the recent theoretical trade literature.

The second contribution of the paper is to bring our measure of trade integration to the data. This enables us to document and explain the variation of trade barriers across 163 manufacturing industries in 11 European Union (EU) countries over the period 1999-2003. The case of the EU is appealing since trade integration is expected to be strong among its member states for two reasons. First, these countries have succeeded in dismantling many restrictions on trade, including tariffs and quotas that were completely eliminated by 1968. Second, the situation has been further reinforced by the implementation of the Single Market Programme (SMP), launched in the mid-1980s.

As they are required for the trade integration measure, we first estimate the substitution elasticities across the 163 manufacturing industries using the estimation approach pioneered by Feenstra (1994) and adapted by Broda and Weinstein (2006) and Imbs and Méjean (2009). As expected, we find that the elasticities vary substantially across industries. We then construct our trade integration measure and obtain a theory-based ranking of industries with intuitive results. For example, trade integration appears particularly low for "Bricks," "Plaster" and "Cement" as these industries are characterized by high transportation costs. Trade integration also tends to be low for perishable goods such as "Bread, fresh pastry goods and cakes." On the contrary, industries that are well integrated include a number of high-tech industries such as "Aircraft and spacecraft," "Engines and turbines" and "Computers." Our ranking is thus potentially useful to policymakers who wish to identify industries with poor trade integration.

As the next step, we attempt to explain the variation of trade integration both across countries and industries. Consistent with the standard gravity literature, the variation of trade integration *across countries* can to a large extent be captured by typical gravity variables such as distance and adjacency but also by policy-related variables such as participation in the Schengen Agreement. But our focus lies on the substantial degree of heterogeneity in trade integration *across industries*. Our results confirm that modeling trade costs as a "one-size-fits-all" impediment is clearly at odds with empirical evidence.

In particular, we investigate the role of several industry characteristics in explaining trade integration across industries, with an emphasis on policy-related variables such as the extent of Technical Barriers to Trade (TBTs). Such barriers are a predominant concern in today's global trade negotiations, and for the WTO in particular as it precisely seeks to ensure that "technical regulations and standards, including packaging, marking and labelling requirements […] do not create unnecessary obstacles to international trade."[3] We find that trade integration is indeed lower in industries where TBTs are strong, suggesting that there is room left for policy action and that further increases in market integration are possible through the reduction of those barriers. We also show that trade integration tends to be high for industries characterized by high productivity, low transportation costs and a high degree of transparency in public procurement.

Finally, we contrast our methodology with alternative approaches. We believe this yields important insights. First, it is well-known that in standard gravity regressions of bilateral trade flows, the estimated coefficient on a trade cost proxy such as bilateral distance is a combination of the distance elasticity of trade costs and the elasticity of substitution (Anderson and van Wincoop, 2004; Hummels, 2001a). The distance elasticity of trade costs can only be derived once the substitution elasticity is known. However, in contrast to our measure, gravity equations cannot deliver a *ranking* that captures the extent of trade barriers across industries.

Second, although the *phi*-ness approach to proxy for trade barriers is conceptually closer to our methodology, it also struggles to deliver a meaningful ranking. The reason is that the *phi*-ness approach compares industries only by considering simple trade ratios, thus neglecting other features that might vary across industries such as the substitutability of goods and the degree of competition. In contrast, the trade integration measure that we employ embodies the substitution elasticities estimated at an earlier stage. It is thus able to separate differences in trade barriers from other forms of heterogeneity across industries, making it useful to quantify the extent of trade barriers across industries. Finally and perhaps most importantly, we find that the different approaches lead to conflicting policy conclusions. For example, we are able to identify TBTs as a major trade impediment, while the gravity and *phi*-ness frameworks do not.

Closest to our work are recent papers modeling and measuring trade barriers at the disaggregate level of industries. Anderson and van Wincoop (2004) model disaggregated trade flows and explicitly allow trade costs to vary at the industry level. Head and Ries (2001) and Head and Mayer (2004) rely on the *phi*-ness approach to measure and explain trade barriers across industries.[4] We differ from this literature in that the measure of trade impediments we propose incorporates industry-specific substitution elasticities which, as we argue, are important in capturing cross-industry variation that is distinct from variation in trade costs. This allows us to provide a ranking of trade integration across industries which the gravity and *phi*-ness approaches cannot deliver.

The paper is organized as follows. In Section 2 we use the monopolistic competition model by Anderson and van Wincoop (2004) to derive the trade integration measure. We also show that the measure is consistent with other types of leading trade models. In addition, we conceptually and empirically contrast our methodology with the standard gravity and *phi*-ness approaches. In Section 3 we present our data set, estimate the elasticities of substitution and present the ranking of trade integration across industries. In Section 4 we explain the variation of trade integration by relating it to observable trade cost proxies, draw policy implications and provide robustness checks. Section 5 concludes.

2. A model with industry-specific trade costs

In their seminal paper, Anderson and van Wincoop (2003) set up a general equilibrium model of trade that results in a micro-founded

[3] Agreement on Technical Barriers to Trade (p. 117). This Agreement, negotiated during the Uruguay Round, is an integral part of the WTO Agreement.

[4] See also Harrigan (1996) who examines the openness to trade of OECD manufacturing industries. However, his approach relies on trade to output ratios and is therefore less grounded in theory. For example, trade to output ratios capture not only trade barriers but also multilateral resistance effects.