Nontariff Barriers as Bridge to Cross

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Abstract

Importing country standards emerge as an effective trade barrier when they exceed those of the exporting country's domestic market. We introduce a new concept: *bridge to cross* (BTC), the regulatory gap between the exporting and importing countries. Importer regulations cannot be identified in a gravity model when multilateral resistance is correctly accounted for with exporter-time and importer-time fixed-effects. BTC, however, can be identified because it varies over time and by trading pair. As an application we apply the method to an SPS regulation regarding Aflatoxin contamination in maize. We find that the effect of BTC is higher for poorer countries.

Keywords: Nontariff barrier, sanitary and phytosanitary standards (SPS), gravity model, multilateral resistance, bridge to cross

JEL Classification: F13, F14, Q17

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I. Introduction

This paper assesses the effects of nontariff barriers on trade, in particular the sanitary and phytosanitary (SPS) measures. According to the World Trade Organization (WTO) rules, countries can choose their own SPS standards to protect human, animal, and plant health—along with other objectives such as protection of environment—as long as they are nondiscriminatory and can be justified by science. The near-perfect sovereignty in choosing SPS measures has meant that several disputes under the SPS and Technical Barriers to Trade (TBT) agreements have occurred (see Josling et al 2004). Yet, a scant literature exists on the assessment of the effects of standards on trade, owing to various reasons that have been cited in Clougherty and Grajek (2008). The most important obstacle has been measurability, especially in a form that captures the intensity of product standards. Deardorff and Stern (1998) list standards as the most difficult nontariff barriers to quantify, an argument that has been seconded by several other studies (Laird and Yeats 1990; Maskus, Wilson, and Otsuki 2001; Blind 2004; Shepherd 2007).

In the absence of a quantifiable measure to capture the SPS regulation, most studies use an inventory approach, that is counts of the number of standards, the number of documents, or the number of import refusals (Clougherty and Grajek 2008; Baylis, Nogueira, and Pace 2010). This approach is obviously inadequate to capture the intensity of product standards across markets.

In the reduced-form empirical trade models, the now-well-established need to account for unobserved multilateral resistance requires inclusion of exporter-time and importer-time fixed effects.[1] With the inclusion of these fixed effects, the effect of any covariate that does not vary by trading pairs over time cannot be identified: since the national treatment rule under the WTO

[1] We use the phrase 'exporter-time fixed effect' to indicate a different fixed effect for each exporter at each time period as opposed to the traditional 'exporter fixed effect' which is an exporter specific dummy variable for all time periods. Same explanation applies to 'importer-time fixed effect'.

mandates that each importing country applies the same standards to all exporters, an importing country regulation would be subsumed in importer-time fixed effects in a well specified gravity model thereby precluding identification of its effects on trade.

A handful of papers that have looked at the effects of SPS measures have focused only on importing country regulations and used various proxies of SPS measures. Baylis, Nogueira, and Pace (2010), for example, show that a greater number of import refusals at the European ports has a negative effect on trade flows. They account for the multilateral resistance in their gravity specification (as import refusals vary over time) by adding importer and exporter fixed effects. Their analysis has two basic problems. First, the nature of their data does not allow accounting for zero trade (import refusals can occur only when trade happens), which makes their results susceptible to sample selection bias and bias from firm selection into exporting. Secondly, and more importantly, if fixed effects methodology is to be employed properly to account for multilateral resistance, exporter-time fixed effects would absorb all the refusals and identification would break down. Last but not least, the number of import refusals is an imperfect measure of the intensity of SPS measures because they are driven by several other factors including the exporter's reputation.

This paper proposes an alternative method for assessing the impacts of product standards by introducing a trading-pair-time-varying measure of product standards in the form of a regulatory gap. The basic principle behind this measure of SPS regulation is that the gap between the importing country standards and the domestic standards is what determines the burden on the exporters. With this idea we term the regulatory gap in its empirically applied form a *bridge to cross* (BTC). Being a regulatory gap, there are two time varying nodes in the BTC measure, one related to the importer and other to the exporter. With added dimensionality, the scope for variation is higher in this measure compared to something that is importer specific. Further, the

BTC measure turns out to be distinct from either exporter-time or importer-time fixed effects both of which are the ideal fixed effects to control for multilateral resistance. Apart from this technical rationale, we think that a BTC measure in regulation has an intuitive appeal. An importing country standard that is weaker than the domestic standard in the exporting country is not an effective trade barrier for the exporting country. Only when there is a bridge to cross should we expect SPS regulation to translate into a trade barrier.

Some papers have posed another empirical challenge in the assessment of the effect of product standards on trade – the issue of reverse causality (Casella 1996; Blind 2002). The BTC measure as defined above is less likely to be subject to such concerns. For the bilateral BTC measure to be endogenous in a regression of exports, it must be true that changes in pair-specific trade flows have an effect on the standard chosen by the exporter, by the importer, or by both. However, such an induced change in regulation in one county would affect its BTC with all its trading pairs. Suppose any country j (exporting or importing country) does change its SPS regulation in response to its trade with country i. This change will affect its BTC not only with country i but also with all other countries k that country j trades with. The fact that standards, even if chosen in response to increases or decreases in trade flows, would apply to all countries implies that such induced variation in BTC is not likely to be systematic. BTC, therefore, is not likely to be endogenous in a gravity estimation for trade flows.

This paper is closest in spirit to Moenius (2004, 2006), which assess the effect of bilaterally shared and country-specific standards. Moenius (2004) focuses on industrial products in 12 countries during the period 1980–1995, while in Moenius (2006) the focus is on SPS measures in agricultural trade during the same time period.

The specification in both Moenius papers (2004, 2006) measures harmonized versus country-specific standards in terms of an indicator variable. Thus, there is no role of exporting country standards when the standard is import-country specific (and not harmonized with the exporter). This is in sharp contrast to the formalization in this paper where, by construction, the BTC value is available in all cases, regardless of whether the standards are harmonized or not. In this paper harmonized standards would eliminate the regulatory gap, thereby drawing the BTC measure to zero. If standards are not harmonized then BTC will either be nonzero for exporting country or equal zero (when the importing country standard is weaker).

Further, as a measure of regulatory barrier, the indicator variable for harmonization cannot capture the intensity when country-specific standards exist, but the BTC measure captures the intensity of standards in all cases. Assuming that stricter standards are achieved with higher costs, the level of trade barrier because of BTC in accessing markets will vary positively with the size of the bridge.

Another difference yet is in the identification strategy in this paper, where the variation that is being exploited is across trading pairs for the same product over time. The effects in Moenius (2004, 2006) are also identified using pairwise variation, that is, whether the importing and exporting country standards are shared or not, but the variation that it used for identification is across different products.

We apply the method of BTC to the case of regulations related to aflatoxin (a type of mycotoxin) contamination in maize to illustrate its applicability.[2] There are several reasons for this choice of product and SPS regulation. Standards related to aflatoxin contamination are specified in parts per billion and hence represent one of the few exceptions where intensity of standards is directly measured. Summary evidence exists on the market losses following greater stringency of mycotoxin regulations. Thailand, for example, was at one time among the world's

[2] Aflatoxins are highly toxic metabolites produced by the soilborne fungi *Aspergillus flavus* that, when in food supply, contribute to developmental delays, morbidity, and mortality in humans and domestic animals. The Food and Agriculture Organization of the United Nations (FAO) estimates that 25 percent of the world food exports are affected by mycotoxins each year (Scholthof 2004).

leading corn exporters, regularly ranking among the top five exporters during the 1970s and 1980s. But partly due to aflatoxin problems, Thai corn regularly sold at a discount on international markets, costing Thailand about $50 million per year in lost export value (Tangthirasunan 1998). According to the Food and Agriculture Organization of the United Nations (FAO), the direct costs of mycotoxin contamination of corn and peanuts in Southeast Asia (Thailand, Indonesia, and the Philippines) amounted to several hundred million dollars annually (Bhat and Vasanthi 1999). Total peanut meal imports by the European Union (EU) member countries fell from more than one million tons in the mid-1970s to just 200,000–400,000 tons annually after 1982, when the mycotoxin regulations were tightened in the EU.

In the literature as well as in policy discourses, the potential of these standards to limit trade has been widely discussed (Otsuki et al 2001a, 2001b). In 2001, then Secretary General of the United Nations Kofi Anan had the following remark on European harmonization of aflatoxin standards, the *ex-ante* effect of which was assessed in Otsuki et al (2001a, 2001b): "*A World Bank study has calculated that the European Union regulation on aflatoxins costs Africa $750 million each year in exports of cereals, dried fruit and nuts. And what does it achieve? It may possibly save the life of one citizen of the European Union every two years … Surely a more reasonable balance can be found.*"[3,4]

These widely cited figures were based on a basic gravity model that ignored some fundamental specification requirements, viz., accounting for multilateral resistance and

[3] Kofi Anan (2001) – UN conference on Least Developed Economies, 2001.

[4] Otsuki et al (2001a) explored the trade effect of the European Commission (EC) proposal to harmonize aflatoxin standards, announced in 1998, that would tighten the average level of aflatoxin standards in the EU. It was later implemented in 2002. The paper predicted the trade effect of setting aflatoxin standards under three regulatory scenarios: standards set at pre-EU harmonized levels (status quo), the harmonized EU standard adopted across Europe, and a standard set by the Codex. Their findings suggested that the trade of nine African countries would potentially decline by $400 million under the proposed stringent new EU standards, whereas this trade would have increased by $670 million had the EU based its new harmonized standards on Codex guidelines that were less stringent. A second study, focusing only on edible groundnut exports from Africa by the same authors, estimated that the new EU standard for aflatoxin would result in an 11 percent decline in EU imports from Africa and a trade flow some 63 percent lower than it would have been had the Codex standards been adopted (Otsuki et al 2001b).

adjustments for zero trade (Anderson and van Wincoop 2003, Helpman, melitz and Rubeinstein 2008). Anderson and van Wincoop (2003) show that trade costs have to be measured as a "multilateral resistance" term (as opposed to a bilateral cost), a term that is reflected in exporter and importer price indices (in fact an ideal price index of composite goods).

These price indices are unobserved and are time-varying. Hence controlling for them in regressions is difficult. Following the seminal work of Feenstra (2004), exporter and importer fixed effects have been commonly used to account for multilateral resistance in gravity models. Yet, given that price indices are time varying, appropriate controls would be best employed in terms of exporter-time and importer-time fixed effects. Only recently, empirical papers in trade have started employing such fixed effects to control for multilateral resistance. The recent papers include Pomfret (2010), Martinez-Zarzoso and Wilmsmeier (2010), Fidrmuc (2009), Novy (2010), Aidt and Gassebner (2010), in addition to Baldwin (2006). This paper adds to this emerging strand of literature that has more appropriate specifications of the gravity model in their empirical analyses.[5]

Furthermore, zero trade is an extremely important feature of the data on trade flows. Both at the product and at the aggregate level many countries do not trade with each other on a sustained basis. Following Melitz (2003) and Helpman et al (2008), gravity models of international trade have been derived that can accommodate the presence of zero trade flows between countries. With the product level analysis here, the presence of zero trade flows is ubiquitous.

[5] An alternative approach to account for multilateral resistance has been suggested by Baier and Bergstarnd involving a first order log-linear Taylor-series expansion to approximate the multilateral price terms in the gravity equation (Baier and Bergstrand 2009). One of the reasons constraining the use of fixed effects proposed in Baier and Bergstrand (2009) is that many variables of interest in gravity model are region specific and using region-specific fixed effects precludes direct estimation of their partial effects. They list examples of exporter and importer populations, foreign aid, or internal infrastructure measures on bilateral trade. These variables will be subsumed in the fixed effects. In this paper, however, this rationale for not using fixed effects methodology does not hold since our variable of interest, the BTC measure, is pair-varying. Secondly, and importantly, the fixed effects need to be time varying to capture time-varying multilateral resistance.

We believe a framework that incorporates zero trade is a clear improvement in empirical analysis of trade flows. Hence, the empirical model that we use for estimation is based on Melitz (2003), Helpman, Melitz, and Rubinstein (2008), and Djankov, Freund, and Pham (2010), all of which consider the fixed costs of exporting. In our case we assume that the level of these costs of exporting vis-à-vis aflatoxin regulations is a function of the BTC.

Our BTC measure, particularly for the poor countries and for African exporters shows a significant negative effect on exports. Compared with the global sample, the effects of the BTC are greater in case of poor and African countries.

The paper is organized as follows. The next section outlines the methodology for estimating the effect of SPS measures as a bridge to cross. Section 3 presents details on data and descriptive statistics related to these data. Section 4 presents the results of regression analysis, and Section 5 concludes and provides the possible policy implications.

2. Methodology for Estimating the Effects of SPS Regulations on Exports

The basic specification in this paper for assessing the effects of sanitary and phytosanitary (SPS) standards on trade is presented as a two-stage Heckman estimation process as given in equations (1) and (2),

$$T_{ijt} = \gamma_1 + \pi_{it} + \tau_{jt} + \mathbf{Z}_{ijt}\boldsymbol{\theta} + \rho H_{ijt} + \varphi BTC_{ijt} + \varepsilon_{ijt}, \quad (1)$$

$$X_{ijt} = \gamma_2 + \pi_{it} + \tau_{jt} + \alpha BTC_{ijt} + \mathbf{Z}_{ij}\boldsymbol{\theta} + \vartheta \mu_{ijt} + \varepsilon_{ijt}, \quad (2)$$

where T_{ijt} is a binary variable that equals 1 if maize exports from country j to country i at time t is nonzero and equals 0 otherwise, and X_{ijt} is the value of exports from country j to country i at time t. The intercepts are γ_1 and γ_2; the importer-time and exporter-time fixed effects are

π_{it} and τ_{jt}, respectively; $\mathbf{Z}_{ij}$ is a vector of pair-varying controls such as bilateral distance and other measures of trade costs (for example, common border, common language, whether or not the trading partners belong to the World Trade Organization – or GATT depending on the time period, whether or not the two countries belong to the same legal origin, and partnerships in a preferential trading arrangement); H_{ijt} is the exclusion variable that does not enter the second-stage regression (more on this later); and μ_{ijt} is the inverse Mills ratio from the first stage. Note that the importer-time and exporter-time fixed effects control for multilateral resistance and are likely determinants of both propensity to export as well as the actual value of realized exports. Furthermore, the selection equation also includes the time and pair-varying bridge to cross (BTC) variable.

Using importer-time and exporter-time fixed effects allows controlling for other possible NTBs in maize such as export quotas, embargoes or food contamination scares and other country specific events over time such as the Starlink controversy in maize trade. StarLink, a trademark for a variety of bio-engineered maize was approved in 1998 by the authorities in the United States but only for animal feed and non-food purposes. However, when traces of Starlink were found in food in 2000, first in the US and then in Japan, it had a strong negative effect on imports of US maize by Japan and South Korea. There was a shift by these countries towards non-GM maize producers in South America. Similarly, on the exporter side, changes in biofuel mandates such as in the US or the Common Agricultural Policy (CAP) in the European Union that have significant effect on maize and other prices are controlled for with exporter- time fixed effects.

The first stage of the regression models whether or not countries trade with each other is specified as a probit regression. The second stage models the value of trade flows, taking into account the selection into trading captured in the first stage (by adding the inverse Mills ratio as one of the regressors in the second stage).

If fixed costs are to be incurred that are monotonic with the size of BTC, the marginal effect of BTC can be hypothesized to be greater for the smaller producers. The majority of smaller producers are present in poor countries. A negative and significant coefficient of BTC, α, implies larger the size of the bridge to cross in accessing markets smaller the value of trade flows.

As for the excluded variable in the Heckman regressions, it is challenging to find variables that are highly correlated with a country's propensity to export and not correlated with the actual levels of exports.[6] The exclusions variable that we employ is historical frequency of nonzero trade with respect to time t (H_{ijt}), that is, a proportion of years in a moving window that the two countries traded with each other. Thus, for 1998, the historical frequency of positive trade for any trading pairs will be given by the proportion of years in the five-year window beginning 1993 that nonzero trade occurred. Subsequently, for 1999, the window would start in 1994. The premise is that higher the frequency of positive trade in the past the greater the likelihood of two countries having a nonzero trade flow in the current period. This fraction of positive trade in the past moreover can be argued to affect the likelihood of trade but not necessarily the current level of trade flows. In our sample, the correlation between non-zero trade and historical trade frequency is 0.72 and the correlation between trade volume and historical trade frequency is 0.15.

[6] Most variables that affect whether or not two countries trade are also likely to affect the amount of trade between them. Different exclusion variables have been used in the literature. Helpman, Melitz, and Rubinstein (2008), in their pioneering work on deriving the empirical specifications of the gravity model from theory, use common religion as an exclusion variable. But common religion, like common language, can reduce trade costs and hence can affect both the outcomes—that is, whether a pair of countries trade or not—and the value of trade that is realized.

Equations (1) and (2) are thus a standard gravity model, at the product or sector level. Estimation of trade flows with a gravity model is usually subject to two kinds of biases (Helpman, Melitz, and Rubinstein 2008). The first is the standard sample selection problem in a regression such as in equation (2), where the sample of nonzero exports is nonrandom. The Heckman correction through the inclusion of the inverse Mills ratio as a regressor in the second stage has been employed for addressing this bias in the coefficients in the second stage.

Another bias that relates to the extensive margins in trade, where not accounting for the number of firms exporting within an industry, potentially results in omitted variable bias (Helpman, Melitz, and Rubinstein 2008). The number of firms exporting is jointly determined by the bilateral fixed costs of exporting and the productivity distribution of firms. Owing to the fixed costs, only firms with a level of productivity beyond a threshold end up exporting. In our setting, SPS standard and by extension the BTC would directly result in introducing fixed costs in exporting and thereby affect the extensive margin of trade. In models like Krugman-Dixit-Stiglitz, with fixed costs of exporting, the size of the extensive margin of trade, however, is a direct function of the elasticity of substitution across varieties in a sector that tends to be high in agriculture.

Belenkiy (2009) decomposes the biases in gravity models in the manufacturing, mining, and agriculture industries and shows that the extensive margin correction bias in standard gravity models does not hold uniformly across all industries. In agriculture, characterized by high elasticity of substitution between the exported varieties, the extensive margin correction is not a significant determinant of trade flows. At the same time, Belenkiy (2009) finds that the nonrandom selection (Heckman) correction is significant in agricultural exports. The estimation strategy in equations (1) and (2) is in line with these findings.

Additionally, note that the identification strategy for the effects on trade is based on exploiting cross-sectional trading pairwise variation over time. Recall that standards tend to be sluggish over time. As argued above, the construction of BTC as the non-tariff barrier mitigates this problem by adding nodes over which the variation can occur. If in case importing country regulation is languid, BTC could still have variation via the changes in exporting country regulation. For this reason, our empirical strategy allows identification of the effects of non-tariff barrier without compromising on the propriety of specification of the gravity model.

Finally we could make the BTC measure itself a more qualitative one by posing that what matters is not the difference between the two standards but whether or not the importing country standard is higher than that of the exporting country. We use this modified BTC as an alternative specification though our principal measure continues to be the one as defined above. In the results we will refer to this measure as BTC^m.

3. Data and Descriptive Statistics

As discussed above, we chose to study aflatoxin regulation because of its uniqueness as a continuous measure of sanitary and phytosanitary (SPS) standards. Maize trade is chosen because it is one of the most highly traded staples in the world, both as food as well as feed. Globally, more than one third of cereals trade comprises maize. Maize is moreover highly prone to mycotoxin (including aflatoxin) contamination, and regulations apply to both food and feed trade. Wu (2008) points out that the issue of mycotoxins has been historically observed for a long time but the real recognition came from the 1960 discovery of aflatoxins in the United Kingdom that resulted in the deaths of 100,000 turkeys. Wu (2008) further points out that now several dozen mycotoxins have been identified. This paper focuses only on aflatoxins, which has drawn the maximum attention with regard to food safety. The SPS regulations related to food and feed in aflatoxin contamination, however, are different among countries, and in some cases quite significantly. In this paper we try to account for this distinction (see below).

According to Dohlman (2003), food contaminated with mycotoxins, and particularly with aflatoxins, can cause acute illnesses that are sometimes fatal and are associated with increased cancer risk. Dohlman (2003) further states that diverging perceptions of tolerable health risks—associated largely with a nation's level of economic development and susceptibility of crops to contamination—have led to widely varying standards among different national or multilateral agencies. Considering a set of 48 countries with established limits for total aflatoxins in food, Dohlman (2003) states that standards varied widely, ranging from 0 to 50 parts per billion.

This paper uses secondary data from several sources. Data on maize trade flows is obtained from United Nations Comtrade database over the period 1998-2007. Agricultural trade is often subject to seasonal fluctuations. We therefore average the data over five years to control for the possibility of abnormal trade flows.[7]

The level of mycotoxin regulations is obtained from two publications from the Food and Agriculture Organization of the United Nations (FAO) titled *Worldwide Regulations for Mycotoxins in Food and Feed*—one in 1995 (FAO 1997) and the other in 2003 (FAO 2004). The data on the regulations are from the responses to queries that were sent to different governments. Note that some countries in the dataset at some points followed the Codex standard.[8] For those countries, the Codex standard was assigned to the countries. Also, a good number of low-income countries do not have any official aflatoxin regulations. Another set of countries includes those

[7] There are several exogenous factors that can cause significant production shocks in maize. For example, one factor is the occurrence of El Niño, a weather phenomenon which is associated with significant abnormal warming of sea-surface temperatures in the Pacific Ocean. During El Niño events of the 1980s and 1990s, for example, maize production in the South Africa fell by as much as 40 to 60 percent. Brazil is another significant southern hemisphere maize producer which has suffered from floods and drought driven by El Niño situations in the past (FAO 2006).

[8] The Codex standard is specified only for the aggregate level of mycotoxins and not specifically aflatoxins. Assuming a 60 percent share of aflatoxins in total mycotoxins, the level employed is $6 \mu g/kg$.

that did not respond to the query sent by FAO/WHO (World Health Organization). The regulation data are missing for these countries and hence we do not include them in our sample.

As discussed above, even though the aflatoxin regulations constitute a continuous measure of regulation (as opposed to count measures in inventory approaches), the construction of the SPS measure as a trade barrier needs some explanation. The aflatoxin regulations are specified as permissible limits in terms of parts per billion or micrograms per kilogram. Suppose the permissible limit in country i is μ_i. We define the regulation in country i to equal $(1/\mu_i)$; that is, the smaller the permissible limit of contamination, the tighter the standard. We then assign a value equal to 0 for countries that have reported to the FAO/WHO inquiry stating that they do not have any restriction on the permissible limits. Defined in this way, our regulation variable takes a value between 0 and 1 (with 1 being the lowest permissible limit in parts per billion in the data and the most stringent regulation, and 0 depicting the weakest regulation). There is significant variation in the data on regulation; see the example of a few countries in Table 1.

Moreover, the stringency of regulations in different countries has changed over time. The European Union (EU) harmonized their regulation in 2002. After that, as new members joined the EU, they were required to apply the regulation that existed as per the harmonized regulations. When the new members joined the EU, it changed their regulation usually towards more stringency. In our five-year slabs, this factor is particularly important for countries joining the EU in 2004. In the Czech Republic, for example, the permissible limits on aflatoxins went down to 2, from 5 (the limit when it was not a member of the EU). Hence, both the harmonization of standards in 2002 as well as entry of new members into the EU implies that globally the average level of regulation related to aflatoxins would have scaled up. Since our data on trade flows is until 2008, we do not make adjustments for Bulgaria and Romania joining the EU in the dataset.

Apart from the regulation in the importing country, our modified SPS measure captures a bridge to cross (BTC) in terms of the regulatory gap. The regulatory gap is the difference in the aflatoxins standard between the importing country and the exporting country. In construction of the *BTC* variable we follow the scheme as given in Table 2, which lists the combination of possible scenarios regarding the regulatory situation in the exporting and importing countries and the corresponding BTC that it leads to.

The bridge as defined in Table 2 has the following features. It equals zero if the exporting and importing countries have the same standard, including no regulation in both countries. In situations where the importing country has a regulation but the exporting country has no regulation, we define the importing country standard as the bridge. Finally, in other cases it is the difference between the importing and exporting country standards with the proviso that the bridge is zero if the importing country has a laxer standard than the exporter. The BTC measure constructed like this increases with the stringency of the standard in the importing country relative to the exporting country and is bound between 0 and 1.

The BTC variable as constructed has the feature of capturing the benefits of the harmonization of standards between the exporting and importing countries as in Moenius (2004) and other papers. At the same time, the BTC variable mitigates the problem in harmonization measures where an even lower standard in the importing country would imply a trade barrier. With BTC, SPS measure becomes a trade barrier only when it is more stringent than the one in the exporting country. Harmonization equaling a reduction in barriers could be plausible in some cases (mainly where standards impose horizontal differentiation, that is, not high or low standards but different standards; for example, left-side drive versus right-side drive vehicles), it is certainly not suitable in most SPS measures. In SPS measures, the more stringent the regulation the higher the cost of compliance and, consequently, greater the non-tariff barrier to trade. In this situation, we would argue that BTC is the logical measure for capturing the effect of SPS regulations on trade. See Table 3 for a few examples where the BTC is higher for the poorer countries.

An important point to note particularly in maize trade is the distinction between traded maize with different end uses, i.e., as food and as feed. A large portion of global trade in maize is in fact as feed. Globally, around 460 million tons, or 65 percent, of total world maize production is used for feed purposes while around 15 percent is used for food and the remaining mainly destined for various types of industrial uses (FAO 2006). The regulations between maize as food and as feed are different in all countries that report permissible limits. In the feed category, regulations vary as well. For example, feed for very young animals are often subject to a tighter regulation than feed for matured animals. We choose the weakest regulation among feed for the importing country where available.

The Comtrade data do not make a distinction between the two types of maize. Since the maize trade flow data are aggregated between food and feed, it is difficult to say what the relevant regulation is for recorded trade. In the absence of such a distinction in the trade flows data, we draw from FAOSTAT, the FAO agricultural and food database, which gives the share of maize production for food and for feed in most countries. We have no way of dividing the trade into food and feed components and to subject them to different standards; therefore, we create a new regulation variable by taking a weighted average of regulation for food and for feed, where the weight is the food-to-feed ratio in the exporting country.

Figure 1 shows the distribution of the ln(BTC) variable for countries where the variable takes a nonzero value. Since $\text{BTC} \in (0,1]$, ln(BTC) plotted in Figure 1 takes on negative values. Where BTC equals zero we assign a value equal to 0.0001 such that log of BTC is defined. The frequency of country pairs is high with bigger regulatory gaps, which comes from a large set of countries with notifications of no regulation.

See Figure 3 for the distribution of the BTC measure. It presents the kernel density plot of BTC measure in three scenarios. First as a weighted average of feed and food regulation (discussed above) then as food regulation and feed regulation *per se* respectively. Comparatively there is more similarity in densities between weighted regulation and feed only regulation compared with food regulation. This is in large part due to significant share of feed in domestic production in many countries which comprises the weight in taking the average of food and feed.

In our empirical analysis we are interested in effects across three samples, namely, global, low-income exporters, and African countries. In the first and third case we also look at samples without USA and South Africa, respectively, given their importance in exports in the relevant sample. Note that given the two-stage specification, the sample in the second-stage regression is much smaller because it includes only nonzero exports.

Table 4 presents the summary statistics from the maize trade data. A large number of bilateral pairs do not engage in maize trade. Maize trades take place among 22 percent of the trading pairs in the global sample, but only 11 percent and 12 percent in the case of poor countries and African exporters, respectively.

According to FAO (2006), the structure of the world maize market can be characterized as one with a high level of concentration in terms of exports but very low concentration on the side of imports.[9] The main reason for this is that few countries usually have a significant maize surplus for exports, while many rely on international markets to meet their needs mostly for

[9] In terms of volume, aggregate imports by countries in Asia make up over one-half of total world maize imports. Japan is usually the world's leading importer followed by the Republic of Korea. Other major importers in Asia include Indonesia, Islamic Republic of Iran, Malaysia and Saudi Arabia. Egypt is Africa's top importer in spite of being also the third largest producer after South Africa and Nigeria. In 1994, with the signing of NAFTA, there was a significant boost to maize exports from US to Mexico (FAO 2006).

domestic animal feeding purposes by importing maize, a primary feed ingredient (FAO 2006). The United States is the world's largest maize exporter and accounts for roughly 60 percent of the global share (in 2006), down from more than 70 percent a decade ago, followed by Argentina and China. Brazil, the Republic of South Africa, and Ukraine are among a few other countries that often have surplus for exports. This structure of world maize trade leads us to consider effects in a global sample without USA and a sample of African exporters without South Africa in assessing the average effect of BTC on maize trade flows.

The regulation regarding permissible limits is on average weakest in Africa, followed by other poor countries relative to the world as a whole. These countries while exporting to developed nations would face bigger BTC barriers. On a worldwide basis, at least 99 countries had mycotoxin regulations for food, feed, or both in 2003—an increase of approximately 30 percent compared with 1995. In fact, in 2003, all countries with mycotoxin regulations have regulatory limits at least for Aflatoxin B1 or the sum of Aflatoxins B1, B2, G1, and G2 (other mycotoxins) in food, feed, or both.

The number of countries regulating mycotoxins has significantly increased over the years. Only 15 African countries have any regulation. Thus, in terms of the BTC, to meet the regulation of the trading partner, poor countries in general and Africa in particular have longer bridges to cross vis-à-vis the rest of the world.

Figure 2 presents the exports of maize from low and high income countries and from Africa. The pattern is that the relatively well-off nations export to both poor and rich countries, while the poorer countries are confined mostly to exporting to low income economies. Thus, poor exporters could have a small BTC if only non-zero trade sample were considered since they export mostly to countries with weak regulation.

In addition to the variables related to trade, several economic variables were used in the analysis and were obtained from the *World Development Indicators* publication of the World Bank. The distance between the trading partners and other pairwise variables such as whether or not countries share a common border, etc., have been obtained from the CEPII dataset. Other pairwise variables include shared ethnicity; colonial link or heritage; whether the pair contains both landlocked countries, both coastal countries, both with the same legal origin, and both being members in a currency union; and, finally, whether the countries had ever been involved in a conflict with each other at a particular time.

4. Results

It is important to start the analysis with the traditional gravity model regressions that have been used to estimate the effect of SPS regulations on trade. These models typically include only the importing country regulation. In their primitive form they do not include any fixed effects to account for multilateral resistance terms and exclude zero trade values which are extremely common at the disaggregated level. In many cases the importing country regulation tends to get subsumed in the importer fixed effect since often there is little variation in standards over time. Owing to this reason, to keep uniformity we include importer income group fixed effects as opposed to importer fixed effects in all regressions listed in tables 5 and 6. Just because the SPS issue related to aflatoxins has been analyzed with gravity models of pre Anderson and van Wincoop (2003) and Melitz (2003) vintage, we list the results from the naïve gravity models as well in Tables 5 and 6.[10] Subsequently, we build on this basic specification modifying our

[10] The Otsuki, Wilson, and Sewadeh (2001a) paper on trade-inhibiting effects of SPS regulations that received a lot of attention in the press (see the discussion above), and subsequently also in the literature (with more than 40 citations), was based on this naïve empirical model of trade. Though the sample and the product in our case are different from both Otsuki, Wilson, and Sewadeh (2001a) and Otsuki, Wilson, and Sewadeh (2001b), we do not find any significant negative effect on trade from importing country regulation.

regulation measure to be BTC and also include exporter- time and importer-time fixed effects in a two stage model including zero trade values.

In both its most primitive form as well as in a Heckman specification that controls for multilateral resistance by including importer and exporter fixed effects, results in tables 5 and 6 show no effect of importing country regulation. The results hold for the global sample as well as different sub-samples that we are interested in.

Different explanations can be offered for the lack of significant marginal effect of SPS barrier on trade in these models. Most importantly, if the exporters are disadvantaged in meeting the standard for a whole range of regulations, then at the margin the standards might not have any effect on trade (e.g., if exporters cannot meet the standard of 2 ppb as well as 20 ppb, then over this range [2,20] there is likely to be no significant effect). Diaz, Rios and Jaffee (2008) highlight this point in case of groundnut exports from Africa into European Union where the intercepted consignments had excessively high contamination relative to European standards. A slightly weaker regulation would not result in any significant increase in trade implying that the marginal effect of standards on trade could turn out to be not significant. .

A further reason could be lack of sufficient over-time variation in the regulation measure as used in regressions in tables 5 and 6. This lack of variation in the NTBs as well as the contamination regulation wedge lead us into conceptualizing regulation as a BTC. Results below will show that even though in a model with importing country regulation, there are no effects on trade, in a well specified gravity model, the BTC measure does show negative and significant effects on trade.

Tables 7 and 8 present the results of our main specification with BTC as the measure of non-tariff barrier. With the coefficient of interest being that of BTC, we are able to add more appropriate controls for multilateral resistance. Apart from BTC measure, the regressions in both

Tables 7 and 8 include several pair varying variables. These variables are the same as the ones employed in Helpman, Melitz and Rubeinstein (2008) which provides the most comprehensive list of such variables to be used in gravity regressions.

Except for the naïve model (the column with OLS regressions), all other Heckman regressions incorporate exporter-time and importer-time fixed effects. There is no significant effect of BTC on trade flows in the global sample that includes US, the largest maize exporter in the world.

As we move successively across samples with smaller and poorer exporters we find that BTC begins to have more significant and quantitatively larger effects on trade. By just excluding US from the global sample, significant effect of BTC on trade flows is obtained. In a global sample excluding the United States, a 1 percent increase in the BTC is associated with a 0.07 percent reduction in the value of trade measured in constant dollars. Results show stronger effects in a sample of poor country (low income exporters based on World Bank definition) exporters. A 10 percent increase in BTC for the low income exporters is associated with as much as 2.8 percent reduction in exports. In this sample of poor country exporters this effect corresponds to a little more than one fifth the effect of bilateral distance.

Focusing only on African exporters, the corresponding reduction in exports equals 2.7 percent. Akin to the exclusion of the United States in the global sample, exclusion of South Africa from the sample of African countries also turns out to be important. As it is in the global sample, among African exporters South Africa has a highly disproportionate share of total maize exports in the continent. In the sample of African exporters excluding South Africa, a 10% increase in BTC reduces trade by 3.2 percent.

In all these regressions, we do not find any significant effect of BTC on whether or not the countries trade in the first place (the first stage of Heckman regressions). Given that BTC is likely to be associated with fixed costs of exporting from jj to$i$ i, a priori we hypothesized that it would have a negative effect on the probability of non-zero exports from j to iji. The results however do not provide evidence supporting this hypothesis. The effect of BTC on the extensive margin turns out to be not significant.

In all Heckman regressions there is strong evidence for the possibility of selection bias by excluding zero trade. Our exclusion variable, historical frequency of non-zero trade, performs well *ex post*. It has a strong positive association with the existence of non-zero trade in the first stage of the Heckman regressions. The strongest effect of historical frequency of non-zero trade on probability of current trade flow to be different from zero happens in case of poor countries.

We also present the results of similar regressions with a modified BTC measure BTC^m discussed above. In the two samples that comprise the low income countries and Africa without South Africa, the effects of BTC on trade are much larger than in case of BTC measure. The exception is the global sample without the US where no significant effect is obtained in case of BTC^{m} while a weakly significant effect was obtained with the BTC as a measure of barrier. The regression results for these three cases are presented in Table 9.

Finally, given the data limitation that prevents making a distinction between food and feed trade in maize, we also estimate the effect of BTC under two extreme assumptions where once we assume all trade to be in food and then in feed (Table 9). The effects are stronger under the construction of BTC based on feed regulation. This is expected since the differences in feed regulation across countries are starker vis-à-vis food regulation. Taking only the feed regulation, there is significant effect of BTC in all samples including the one with United States. This could be due to the fact that the US, the largest exporter of maize in the world also trades in largely in feed.

Further, several countries export maize for feed purposes to markets with tighter regulations while maize as food exports go to markets with weaker regulations (for example, South Africa exports maize as feed to several European countries and as food to different poor African countries). This implies that even though, for each country, feed regulations are laxer than those for food, in the end feed exporters might face more stringent regulations.

5. Conclusions and Policy Implications

In this paper we introduced the concept of a *bridge to cross* (BTC) for estimating the effects of sanitary and phytosanitary (SPS) regulations measures. Our gravity model specification incorporates the recent developments in the empirical trade literature to mitigate the problem of biased estimates in gravity models by including the "best practice" controls for multilateral resistance in gravity models, namely, the exporter-time and importer-time fixed effects. With their inclusion, BTC provides a feasible way of specifying NTB barriers such that their effects are still identified. Because of its construction, we feel that BTC is also a more reasonable way of modeling regulations as trade barriers – only when importing country imposes standards more stringent than the exporting country, one would expect them to be an effective barrier to trade.

We apply the proposed method of looking at NTBs as a BTC to aflatoxin regulations to illustrate an application. With the proper specification of the gravity model and improved data, we find evidence that the BTC measure does have a significant negative effect on trade flows particularly in a sample of poor countries. These results are in sharp contrast to existing studies that find a lack of any significant effect of importing country regulation. The reduced form model used for assessing the effect of importing country regulation, of course, suffers inherently from mis-specification.

The effects of BTC that we obtained are on the intensive margin. Which margin gets affected by BTC depends on the types of costs involved in mitigating aflatoxins contamination. The first line of defense against the introduction of mycotoxins is at the farm level and starts with the implementation of good agricultural practices to prevent infection. Preventive strategies should be implemented from pre through post harvest (Murphy et al 2006).[11] If the costs are largely variable in nature then comparatively large effects on intensive margin would be more likely.

At some level, while importing country regulation can be a rigid policy measure for the exporting country, the regulatory gap, i.e. BTC, could change because of actions by the exporting country itself. This is because an effective regulatory gap contains the domestic standard as well. There could be some positive effects on exports from bridging the regulatory gap. In many developing countries, the two (their standard and that of the importer) diverge; and consequently the burden of the regulatory gap is enhanced. Further, in these countries *de facto* standards could be much less stringent in practice and BTC could in effect be higher.

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Figures

Figure 1: Distribution of log of BTC

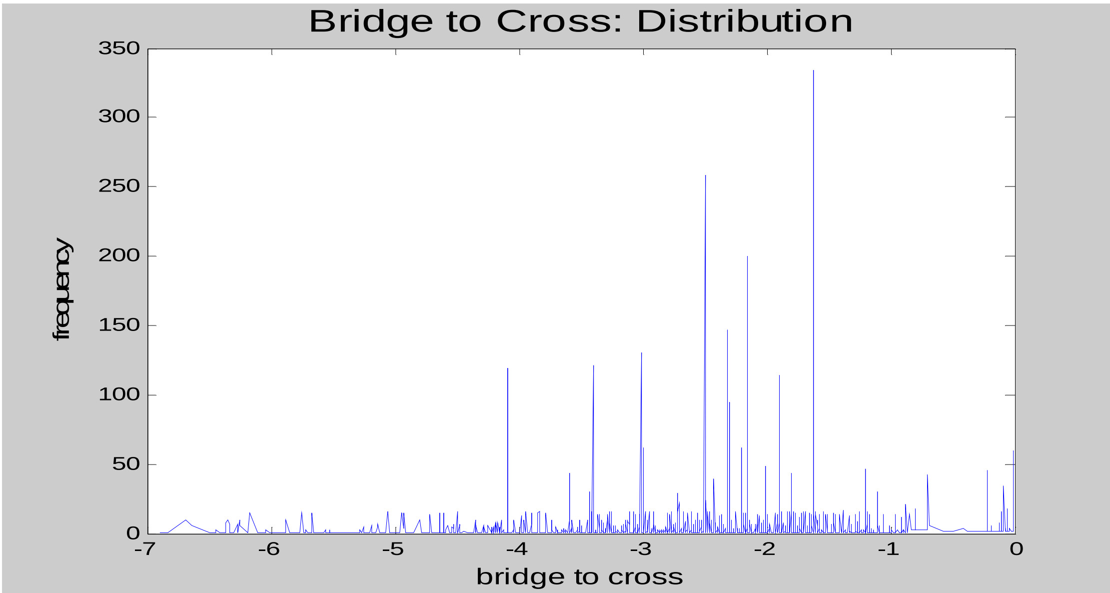
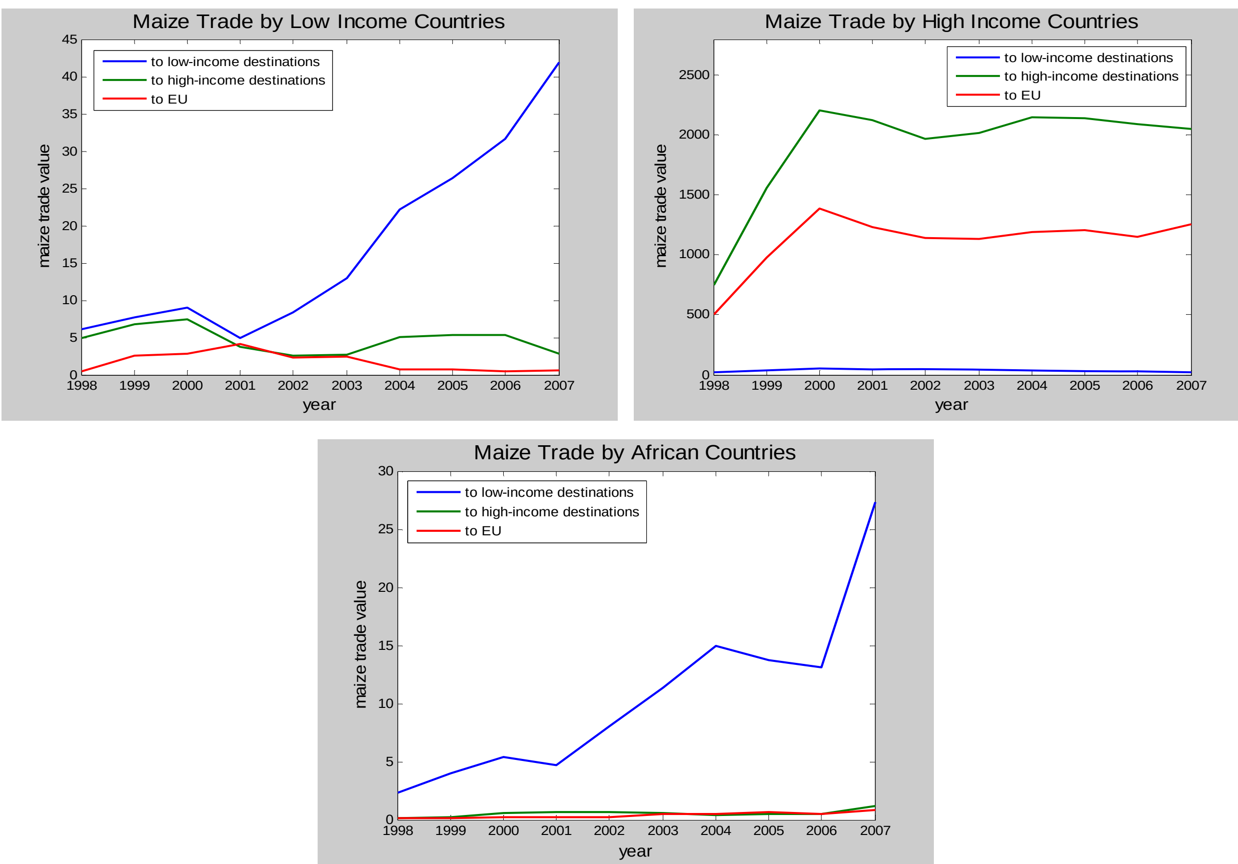
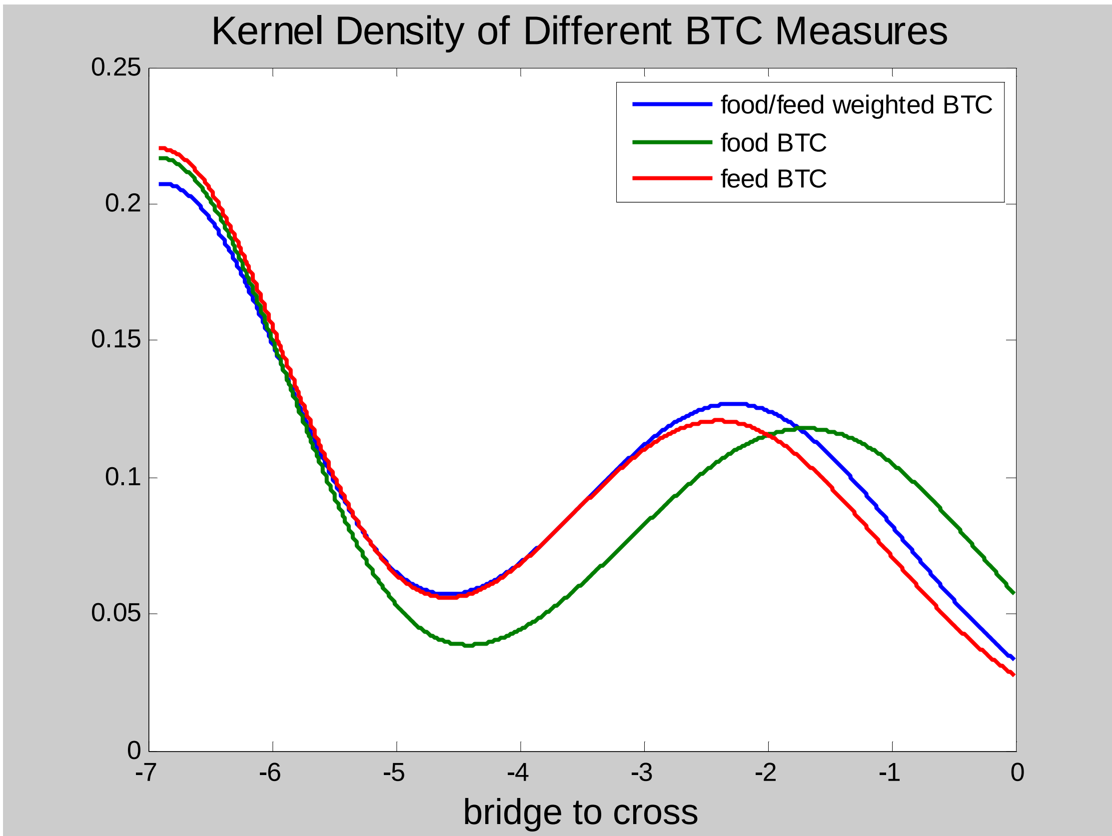


Figure 2: Maize exports 3-year moving average (thousand US dollars)



Source: UN Comtrade data

Figure 3: Density of different BTC measures (weighted average, food and feed)



Tables

Table 1: Aflatoxin Standards in Select Countries, 2003

Country/region	Aflatoxings limit in human food (parts per billion)	Standard regulation defined in the paper
Australia	5	0.20
China	20	0.05
European Union	4*	0.25
Guatemala	20	0.05
India	30	0.03
United States	20	0.05

Notes: (a) Source is Wu and Bryden (2009). (b) * applied to cereals and cereal products, nuts not subject to further processing and dried fruit.

Table 2: Scheme for construction of bridge to cross (BTC) based on regulatory gap

Regulation in		Bridge to cross (BTC)
exporting country	importing country	
✓	×	= 0
×	✓	= import country standard
✓	✓	= (importer standard – exporter standard) if difference > 0
✓	✓	= 0, if difference ≤0
×	×	= 0

Note: (×) denotes no regulation, (✓) denotes presence of regulation.

Table 3: Examples of Domestic Regulations and Bilateral BTC

Country	Trading role	1998-2003		2004-2007	
		Regulation	BTC	Regulation	BTC
Brazil	exporter	0.18	0.00	0.04	0.17
Netherlands	importer	0.08		0.21	
Argentina	exporter	0.08	0.02	0.13	0.00
Japan	importer	0.10		0.09	
Nigeria	exporter	0.04	0.10	0.05	0.26
Ireland	importer	0.14		0.31	
Sweden	exporter	0.31	0.00	0.39	0.00
Ireland	importer	0.14		0.31	

Note: Regulations are food-feed weighted.

Table 4: Summary Statistics

	All countries				Low income exporters				African exporters			
	Full sample (N=17069)		Non-zero trade (N=3759)		Full sample (N=2531)		Non-zero trade (N=267)		Full sample (N=3217)		Non-zero trade (N=397)	
	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
Bilateral maize trade	1058.74	22325.42	4807.55	47388.87	35.88	497.83	340.15	1501.11	93.44	1656.84	757.19	4667.96
Proportion of nonzero trade	0.22	0.41	1.00	0.00	0.11	0.31	1.00	0.00	0.12	0.33	1.00	0.00
Historical trade frequency	1.34	3.17	5.61	4.55	0.36	1.33	2.98	2.89	0.54	1.83	3.88	3.66
Regulation index importers	0.13	0.14	0.14	0.12	0.07	0.08	0.08	0.09	0.10	0.11	0.13	0.08
Regulation index exporters	0.13	0.16	0.14	0.15	0.13	0.16	0.13	0.12	0.13	0.16	0.13	0.11
The bridge-to-cross index	-4.82	2.36	-4.99	2.29	-4.11	2.36	-4.17	2.32	-4.60	2.41	-4.94	2.35
GDP	11738.76	14090.04	16484.30	15193.63	466.75	181.92	481.00	168.85	1266.43	1401.73	1832.48	1727.10
Contiguous	0.02	0.15	0.09	0.29	0.02	0.14	0.16	0.36	0.02	0.13	0.11	0.31
Ethno-lingual commonality	0.16	0.37	0.23	0.42	0.21	0.41	0.43	0.50	0.24	0.43	0.45	0.50
Trading pair has colony ties	0.02	0.14	0.07	0.25	0.01	0.10	0.08	0.28	0.01	0.11	0.08	0.27
Both countries landlocked	0.02	0.12	0.02	0.12	0.04	0.19	0.06	0.24	0.03	0.17	0.04	0.20
Both countries have coasts	0.76	0.43	0.83	0.38	0.61	0.49	0.65	0.48	0.66	0.47	0.72	0.45
Same legal structure	0.31	0.46	0.40	0.49	0.34	0.47	0.56	0.50	0.36	0.48	0.53	0.50
Same currency	0.01	0.10	0.04	0.19	0.00	0.03	0.00	0.00	0.00	0.04	0.00	0.00
History of conflict	0.01	0.08	0.02	0.15	0.00	0.03	0.00	0.06	0.00	0.03	0.01	0.09
Both trading pair In GATT	0.81	0.38	0.86	0.33	0.80	0.39	0.87	0.32	0.80	0.39	0.90	0.30
log (bilateral distance)	8.70	0.83	8.19	1.04	8.79	0.64	8.19	0.93	8.73	0.64	8.33	0.88

Notes: (a) Bilateral trade in deflated 1,000 USD. (b) GDP in 2005 USD. (c) Regulation indices are weighted by food-feed ratio. (d) The bridge-to-cross index is log(BTC).

Table 5: Effect of Importer Regulation on Trade Flow (world sample with and without USA)

	Full sample			Full sample w|o US		
		Heckman			Heckman	
	WOS-OLS	2nd stage	1st stage	WOS-OLS	2nd stage	1st stage
log of importer regulation	0.00999	0.0117	0.0790	0.00567	0.0164	0.0779
	(0.0414)	(0.129)	(0.0525)	(0.0412)	(0.134)	(0.0525)
Log GDP	0.221***	0.281	0.000681	-0.0143	0.229	-0.0116
	(0.0438)	(0.351)	(0.156)	(0.0439)	(0.360)	(0.156)
Contiguous		1.253***	0.487***		1.242***	0.490***
		(0.193)	(0.157)		(0.197)	(0.157)
Ethno-lingual commonality		0.405***	0.264***		0.356**	0.268***
		(0.153)	(0.0665)		(0.160)	(0.0666)
Trading pair has colony ties	-0.203	-0.348	0.221	-0.0946	-0.365	0.218
	(0.253)	(0.253)	(0.147)	(0.247)	(0.264)	(0.147)
Both countries landlocked		-2.196	0.0370		-2.673*	0.130
		(1.443)	(0.794)		(1.487)	(0.865)
Both countries have coasts		2.783**	0.108		3.205**	0.0133
		(1.410)	(0.772)		(1.454)	(0.844)
Same legal structure		0.309***	0.168***		0.364***	0.168***
		(0.105)	(0.0454)		(0.110)	(0.0454)
Same currency		1.580***	0.128		1.639***	0.130
		(0.297)	(0.221)		(0.310)	(0.221)
History of conflict		-0.126	0.468		-0.0779	0.470
		(0.384)	(0.298)		(0.398)	(0.298)
Both trading pair In GATT		1.855***	0.291*		1.836***	0.302*
		(0.476)	(0.176)		(0.485)	(0.176)
log (bilateral distance)	-0.627***	-1.252***	-0.540***	-0.848***	-1.210***	-0.539***
	(0.0616)	(0.0828)	(0.0331)	(0.0609)	(0.0856)	(0.0332)
eta		-1.409***			-1.445***	
		(0.105)			(0.107)	
Historical trade frequency			0.523***			0.523***
			(0.0151)			(0.0151)
Importer income group FE	yes	yes	yes	yes	yes	yes
Time FE	yes	yes	yes	yes	yes	yes
Exporter FE		yes	yes		yes	yes
Importer FE		yes	yes		yes	yes
Observations	3759	17069	17069	3579	16881	16881
N-censored		13310	13310		13302	13302
R-squared	0.051	0.747		0.066	0.715	

Notes: (a) Each regression includes a constant. (b) These regression have exporter GDP but not importer GDP because of collinearity with importer standard. Instead, importer income group dummies have been used. (c) WOS stands for Wilson-Otsuki-Sewadeh. (c) *** p<0.01, ** p<0.05, * p<0.1.

Table 6: Effect of Importer Regulation on Trade Flow (low income and African exporters)

	Low income exporters			Africa		
		Heckman			Heckman	
	WOS-OLS	2nd stage	1st stage	WOS-OLS	2nd stage	1st stage
log of importer regulation	0.111	-0.0866	-0.0726	0.108	0.194	0.209
	(0.0892)	(0.306)	(0.123)	(0.101)	(0.416)	(0.213)
Log GDP	-0.438	1.393	-0.375	0.542***	-0.631	0.370
	(0.300)	(0.885)	(0.361)	(0.170)	(0.979)	(0.393)
Contiguous		0.0275	0.577*		0.941	-0.495
		(0.448)	(0.307)		(0.670)	(0.524)
Ethno-lingual commonality		0.524	0.208		0.600	0.0733
		(0.392)	(0.147)		(0.567)	(0.210)
Trading pair has colony ties	-0.0592	-0.884	0.744**	1.276**	0.404	1.060**
	(0.667)	(0.689)	(0.345)	(0.641)	(1.095)	(0.473)
Both countries landlocked		9.746***	-4.886**		4.154	-3.934
		(3.721)	(1.972)		(6.872)	(2.725)
Both countries have coasts		-6.330**	4.928**		-6.285	4.200
		(3.220)	(1.926)		(6.808)	(2.710)
Same legal structure		0.0460	0.0852		0.197	0.425***
		(0.275)	(0.110)		(0.389)	(0.143)
History of conflict		0.449	0.374		0.194	5.570
		(1.028)	(0.618)		(1.906)	(0)
Both trading pair In GATT		2.569***	0.713**		-6.585	0.668
		(0.750)	(0.313)		(5.549)	(0.889)
log (bilateral distance)	-1.118***	-1.272***	-0.428***	-0.835***	-1.236***	-0.562***
	(0.143)	(0.211)	(0.0717)	(0.240)	(0.417)	(0.151)
eta		-2.065***			-1.226***	
		(0.251)			(0.406)	
Historical trade frequency			0.837***			0.914***
			(0.0471)			(0.0758)
Importer income group FE	yes	yes	yes	yes	yes	yes
Time FE	yes	yes	yes	yes	yes	yes
Exporter FE		yes	yes		yes	yes
Importer FE		yes	yes		yes	yes
Observations	776	4734	4734	397	3217	3217
N-censored		3958	3958		2820	2820
R-squared	0.172	0.741		0.198	0.695	

Notes: (a) Each regression includes a constant. (b) These regression have exporter GDP but not importer GDP because of collinearity with importer standard. Instead, importer income group dummies have been used. (c) WOS stands for Wilson-Otsuki-Sewadeh. (c) *** p<0.01, ** p<0.05, * p<0.1.

Table 7: Effect of BTC on Trade Flow with Time Varying Multilateral Resistance (world sample with and without USA)

	Full sample			Full sample w|o US		
		Heckman			Heckman	
	OLS	2nd stage	1st stage	OLS	2nd stage	1st stage
BTC	0.0350	-0.0531	-0.0225	-0.0208	-0.0722*	-0.0214
	(0.0298)	(0.0418)	(0.0171)	(0.0283)	(0.0432)	(0.0171)
Contiguous	2.229***	1.274***	0.464***	2.199***	1.272***	0.462***
	(0.290)	(0.214)	(0.165)	(0.287)	(0.217)	(0.165)
Ethno-lingual commonality	0.575***	0.434***	0.277***	-0.0729	0.389**	0.283***
	(0.201)	(0.160)	(0.0626)	(0.184)	(0.167)	(0.0626)
Trading pair has colony ties	-0.778**	-0.270	0.181	-0.466	-0.288	0.178
	(0.354)	(0.263)	(0.169)	(0.343)	(0.279)	(0.168)
Both countries landlocked	0.631	3.729***	-0.484	0.563	-5.989***	-0.524*
	(0.636)	(0.981)	(0.338)	(0.633)	(1.481)	(0.285)
Both countries have coasts	0.776***	-3.050***	0.559*	0.721***	6.610***	0.600***
	(0.203)	(0.931)	(0.286)	(0.200)	(1.400)	(0.217)
Same legal structure	0.420**	0.378***	0.160***	0.658***	0.438***	0.156***
	(0.164)	(0.112)	(0.0436)	(0.156)	(0.118)	(0.0436)
Same currency	2.584***	1.464***	0.0896	2.424***	1.527***	0.0851
	(0.374)	(0.326)	(0.241)	(0.370)	(0.340)	(0.241)
History of conflict	0.00918	-0.120	0.418	-0.193	-0.0699	0.418
	(0.555)	(0.421)	(0.303)	(0.538)	(0.441)	(0.303)
Both trading pair In GATT	-0.0907	2.505***	0.162	-0.0807	2.444***	0.161
	(0.222)	(0.557)	(0.237)	(0.220)	(0.561)	(0.237)
log (bilateral distance)	-0.210**	-1.386***	-0.492***	-0.432***	-1.336***	-0.491***
	(0.0875)	(0.0957)	(0.0341)	(0.0864)	(0.0992)	(0.0341)
eta		-1.503***			-1.541***	
		(0.116)			(0.118)	
Historical trade frequency			0.573***			0.571***
			(0.0290)			(0.0290)
Year FE	yes	no	no	yes	no	no
Exporter*time FE	no	yes	yes	no	yes	yes
Importer*time FE	no	yes	yes	no	yes	yes
Clustered SE	yes	yes	yes	yes	yes	yes
R-square	0.430	0.763	.	0.421	0.735	.
MSE	3.747	2.539	.	3.591	2.563	.
Observations	3,759	17,069	17,069	3,579	16,881	16,881
N-censored		13310	13310		13302	13302

Notes: (a) Each regression includes a constant. (b) *** p<0.01, ** p<0.05, * p<0.1.

Table 8: Effect of BTC on Trade Flow with Time Varying Multilateral Resistance (low income and African exporters)

	Low income countries			Africa			Africa w|o South Africa		
		Heckman			Heckman			Heckman	
	OLS	2nd stage	1st stage	OLS	2nd stage	1st stage	OLS	2nd stage	1st stage
BTC	-0.225***	-0.443***	0.0372	-0.420***	-0.273**	0.0412	-0.246***	-0.321**	0.0666
	(0.0823)	(0.162)	(0.0926)	(0.0747)	(0.132)	(0.0583)	(0.0726)	(0.152)	(0.0659)
Contiguous	1.607**	1.124	0.498	2.709***	1.357**	-0.425	2.163***	1.748**	-0.232
	(0.668)	(0.701)	(0.991)	(0.690)	(0.628)	(0.651)	(0.625)	(0.696)	(0.768)
Ethno-lingual commonality	-0.183	0.753	0.619*	0.113	0.481	-0.00595	0.169	0.848	-0.172
	(0.453)	(0.589)	(0.358)	(0.380)	(0.542)	(0.237)	(0.376)	(0.574)	(0.258)
Trading pair has colony ties	1.618**	2.880**	2.421**	1.209*	1.028	1.585***	1.353**	0.603	1.778***
	(0.731)	(1.217)	(0.977)	(0.688)	(1.035)	(0.582)	(0.613)	(1.092)	(0.615)
Both countries landlocked	-0.640	-8.225	-5.442	-0.594	-12.51***	-1.249	-0.432	-5.338*	3.916
	(0.806)	(6.465)	(810.9)	(0.881)	(3.125)	(1.139)	(0.758)	(2.734)	(4,899)
Both countries have coasts	0.285	6.925	7.282	0.0663	10.06***	1.530	-0.468	3.630	-3.572
	(0.423)	(6.209)	(810.9)	(0.413)	(2.975)	(1.071)	(0.393)	(2.533)	(4,899)
Same legal structure	0.552	0.194	0.183	0.671*	0.246	0.509***	0.682*	0.669*	0.519***
	(0.463)	(0.530)	(0.277)	(0.393)	(0.372)	(0.160)	(0.394)	(0.395)	(0.170)
History of conflict	-0.170	-2.639	-4.488	-0.248	-0.315	4.959	-8.229***	-7.202***	5.197
	(2.993)	(2.566)	(0)	(1.993)	(1.777)	(0)	(2.850)	(2.771)	(0)
Both trading pair In GATT	0.221	1.345	1.164	0.543	6.385**	-4.134***	0.242	-1.245	-3.439
	(0.615)	(3.254)	(1.590)	(0.566)	(2.713)	(0.920)	(0.591)	(2.611)	(4,899)
log (bilateral distance)	-1.416***	-1.119**	-1.382***	-0.692***	-1.313***	-0.642***	-1.071***	-0.600	-0.618***
	(0.277)	(0.510)	(0.343)	(0.252)	(0.408)	(0.174)	(0.250)	(0.448)	(0.190)
eta		-1.631***			-1.246***			-1.692***	
		(0.492)			(0.458)			(0.513)	
Historical trade frequency			2.440***			1.125***			1.397***
			(0.224)			(0.0963)			(0.120)
Year FE	yes	no	no	yes	no	no	yes	no	no
Exporter*time FE	no	yes	yes	no	yes	yes	no	yes	yes
Importer*time FE	no	yes	yes	no	yes	yes	no	yes	yes
R-square	0.506	0.793	.	0.421	0.754	.	0.470	0.767	.
MSE	2.884	2.570	.	3.241	2.786	.	2.732	2.523	.
Observations	267	2,531	2,531	397	3,217	3,217	277	3,028	3,028
N-censored		2264	2264		2820	2820		2751	2751

Notes: (a) Each regression includes a constant. (b) *** p<0.01, ** p<0.05, * p<0.1.

Table 9: Effect of Different Measures of BTC on Trade Flow with Time Varying Multilateral Resistance (2-stage Heckman)

	Full sample		Without U.S.		Low income		Africa		Africa w|o S. Africa	
Qualitative BTC: Dummy variable for any BTC										
	2nd stage	1st stage	2nd stage	1st stage	2nd stage	1st stage	2nd stage	1st stage	2nd stage	1st stage
BTC dummy	0.0468	-0.0712	-0.0135	-0.0669	-2.332***	0.397	-0.676	0.142	-1.082*	0.283
	(0.152)	(0.0649)	(0.156)	(0.0649)	(0.639)	(0.341)	(0.508)	(0.222)	(0.572)	(0.245)
Historical trade		0.573***		0.571***		2.466***		1.127***		1.402***
frequency		(0.0290)		(0.0289)		(0.226)		(0.0965)		(0.121)
eta	-1.502***		-1.540***		-1.546***		-1.246***		-1.666***	
	(0.116)		(0.118)		(0.489)		(0.459)		(0.515)	
Observations	3,759	17,069	3,579	16,881	267	2,531	397	3,217	277	3,028
R-squared	0.763		0.734		0.796		0.753		0.765	
Food regulations as BTC										
	Full sample		Without U.S.		Low income		Africa		Africa w|o S. Africa	
	2nd stage	1st stage	2nd stage	1st stage	2nd stage	1st stage	2nd stage	1st stage	2nd stage	1st stage
Food BTC	-0.0548	-0.0147	-0.0680*	-0.0138	-0.221	0.0339	-0.259**	-0.0939*	-0.243*	-0.0484
	(0.0351)	(0.0151)	(0.0363)	(0.0151)	(0.145)	(0.0825)	(0.123)	(0.0539)	(0.140)	(0.0605)
Historical trade		0.573***		0.571***		2.441***		1.132***		1.397***
frequency		(0.0290)		(0.0289)		(0.224)		(0.0971)		(0.121)
eta	-1.503***		-1.542***		-1.565***		-1.216***		-1.646***	
	(0.116)		(0.118)		(0.503)		(0.450)		(0.508)	
Observations	3,759	17,069	3,579	16,881	267	2,531	397	3,217	277	3,028
R-squared	0.763		0.735		0.788		0.755		0.767	
Feed regulations as BTC										
	Full sample		Without U.S.		Low income		Africa		Africa w|o S. Africa	
	2nd stage	1st stage	2nd stage	1st stage	2nd stage	1st stage	2nd stage	1st stage	2nd stage	1st stage
Feed BTC	-0.102**	-0.00127	-0.103**	-0.00117	-0.427***	0.139	-0.383***	0.0471	-0.380***	0.102
	(0.0421)	(0.0167)	(0.0434)	(0.0167)	(0.157)	(0.0983)	(0.124)	(0.0583)	(0.148)	(0.0668)
Historical trade		0.573***		0.571***		2.456***		1.121***		1.392***
frequency		(0.0289)		(0.0289)		(0.225)		(0.0963)		(0.120)
eta	-1.504***		-1.545***		-1.626***		-1.249***		-1.671***	
	(0.116)		(0.118)		(0.495)		(0.456)		(0.515)	
Observations	3,759	17,069	3,579	16,881	267	2,531	397	3,217	277	3,028
R-squared	0.764		0.735		0.791		0.757		0.767	

Notes: (a) Each regression has export*time and importer*time fixed effects (time varying multilateral resistance). (b) Each regression has the same right-hand-side variables as the regressions in Tables 7 and 8. (c) Each regression includes a constant. (d) *** p<0.01, ** p<0.05, * p<0.1.

List of Exporters

Algeria	Ghana	Panama
Argentina	Greece	Paraguay
Armenia	Guatemala	Peru
Australia	Honduras	Philippines
Austria	Hungary	Poland
Bahamas, The	Iceland	Portugal
Bangladesh	India	Russian Federation
Barbados	Indonesia	Saudi Arabia
Belarus	Iran, Islamic Rep	Slovak Republic
Belgium	Ireland	Slovenia
Belize	Israel	South Africa
Benin	Italy	Spain
Bolivia	Jamaica	Sri Lanka
Brazil	Japan	Suriname
Bulgaria	Jordan	Sweden
Cameroon	Kenya	Switzerland
Canada	Korea, Rep	Syrian Arab Republic
Chile	Kuwait	Tanzania
China	Latvia	Thailand
Colombia	Lithuania	Trinidad and Tobago
Costa Rica	Madagascar	Tunisia
Cuba	Malawi	Turkey
Cyprus	Malaysia	Uganda
Czech Republic	Malta	Ukraine
Denmark	Mauritius	United Arab Emirates
Dominican Republic	Moldova	United Kingdom
Ecuador	Morocco	United States
Egypt, Arab Rep	Mozambique	Uruguay
El Salvador	Netherlands	Venezuela, RB
Estonia	New Zealand	Zambia
Finland	Nicaragua	Zimbabwe
France	Nigeria	
Germany	Norway	

List of Importers

Algeria	Ghana	Pakistan
Argentina	Greece	Panama
Armenia	Guatemala	Paraguay
Australia	Honduras	Peru
Austria	Hungary	Philippines
Bahamas, The	Iceland	Poland
Bangladesh	India	Portugal
Barbados	Indonesia	Russian Federation
Belarus	Iran, Islamic Rep	Saudi Arabia
Belgium	Ireland	Slovak Republic
Belize	Israel	Slovenia
Benin	Italy	South Africa
Bolivia	Jamaica	Spain
Bosnia and Herzegovina	Japan	Sri Lanka
Brazil	Jordan	Suriname
Bulgaria	Kenya	Sweden
Cameroon	Korea, Rep	Switzerland
Canada	Kuwait	Syrian Arab Republic
Chile	Latvia	Tanzania
China	Lithuania	Thailand
Colombia	Luxembourg	Trinidad and Tobago
Costa Rica	Madagascar	Tunisia
Cuba	Malawi	Turkey
Cyprus	Malaysia	Uganda
Czech Republic	Malta	Ukraine
Denmark	Mauritius	United Arab Emirates
Dominican Republic	Moldova	United Kingdom
Ecuador	Morocco	United States
Egypt, Arab Rep	Mozambique	Uruguay
El Salvador	Netherlands	Venezuela, RB
Estonia	New Zealand	Vietnam
Finland	Nicaragua	Yemen, Rep
France	Nigeria	Zambia
Germany	Norway	Zimbabwe