INFRASTRUCTURE QUALITY AND TRADE LIBERALIZATION

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Abstract

It is difficult to establish the impact infrastructure has on trade balances due to confounding factors. Our empirical approach leverages on episodes of trade liberalization, interacting such episodes with infrastructure. Providing a simple extension to the gravity model, we find that infrastructure quality differences between trade partners result in trade imbalances, which liberalization then accentuates. For robustness checks, we interact the liberalization indicator against other confounding variables and do not find such consistent effects. We conclude that lack of quality infrastructure in developing economies contributes to larger trade deficits, and infrastructure development should be supported alongside trade liberalization.

The data that support the findings of this study are openly available in http://dx.doi.org/10.17632/2vvn2rxc7x.1.

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1. Introduction

There is extensive literature documenting the effects of infrastructure on international trade. The literature largely agrees on the positive impact infrastructure has on trade volumes, competition, productivity and welfare gains. The central question we pose in this paper is whether infrastructure quality (specifically ports and roads) affects a country's trade balance. The hypothesis here is that countries with poorer infrastructure quality will, on average, face an exporting disadvantage that shows up as a negative impact on trade balance. As countries' trade balance is no doubt a function of many macroeconomic factors, it is difficult to establish this this hypothesis empirically. Our approach is to use episodes of bilateral trade liberalization, interacted with infrastructure quality, as the identification channel.

We first provide some intuition to this. When bilateral tariffs are high, infrastructure quality has a relatively smaller impact on trade balances, because exports (in either direction) are restricted by high tariffs. When tariffs fall bilaterally, the differences in infrastructure quality between country pairs—to the extent that these impact bilateral trade costs asymmetrically—then show up more readily in trade balances, given that exports are now less constricted by tariffs. Our key contribution is to provide evidence of this, and in doing so, highlight how differences in infrastructure quality can create trade imbalances. While bilateral trade liberalization is used as an identification channel for the estimation, there is also an important policy message. For developing economies with poorer infrastructure, the implication is that opening up to trade can potentially worsen macroeconomic outcomes. This underscores the importance to investing in and improving infrastructure quality in order to better benefit from trade liberalization.

In this research, we bring together three strands of trade literature. The first strand relates to development economics, specifically, the effect trade liberalization has on trade and macroeconomic performance for developing economies. The macroeconomic impact of trade liberalization on developing economies is well studied. Wacziarg & Welch (2008) find that over the period from 1950 to 1998, countries that underwent liberalization enjoyed higher annual growth and increased trade openness (measured by trade-to-GDP ratio) than prior to liberalization. Santos-Paulino & Thirlwall (2004) and Parikh (2007) show that developing economies saw higher exports and imports post-liberalization, but with import growth outstripping exports and hence resulting in a worsened trade balance. Waugh (2010) shows that trade costs are in fact asymmetric and poorer countries face higher exporting frictions.

While it is widely acknowledged that current account or trade deficits are not inherently bad, developing economies are at the same time more likely to be credit-constrained, especially in the face of negative economic shocks. Large current account deficits need to be examined closely as these could result in greater financial risks [Obstfeld (2012), Blanchard & Milesi-Ferretti (2012)]. To the extent that this may pose balance of payment risks, trade liberalization can end up impacting growth negatively. Wu & Zeng

(2010) find that the evidence is more mixed, though trade liberalization has a negative impact on trade balance in some regression specifications.

Secondly, our paper relates to the trade and infrastructure literature. There is a large body of evidence that shows that better infrastructure leads to more international trade [Nuno & Venables (2001); Celbis, Nijkamp, & Poot (2013); Normaz Wana & Jamilah Mohd (2015); Nordas & Piermartini (2004); Francois & Manchin (2013)]. However, the fact that poorer infrastructure could lead to a worsened trade balance when a country opens itself to trade is not well established in literature. There are several reasons for this.

A country's trade balance is often thought to reflect fundamental macroeconomic imbalances between savings and investments in the economy. International trade models do not typically link such trade imbalances—whether aggregate or bilateral—to differences in trade costs or infrastructure quality. For example, a recent decomposition study through the gravity model (IMF, 2019) finds that macroeconomic conditions remain the main drivers of bilateral trade imbalances, while bilateral tariffs have a smaller impact. This argues against policies that target bilateral trade imbalances since these do not address the more fundamental macroeconomic imbalances. Furthermore, while most trade models recognize the importance of infrastructure in lowering trade cost and promoting more trade, there has been relatively less attention paid to the asymmetric effect infrastructure might have on exporting versus importing. If home infrastructure assists in exporting more than it does for importing, countries with superior infrastructure compared to trade partners will get an advantage.

Third, it is important to also link our study with the new economic geography literature. Improved infrastructure in the home country not only facilitates international trade via the reduction in international trade cost, it can also create agglomeration effects that give the home country an exporting advantage in the industrial sector, leading to unequal developmental outcomes across countries [Krugman (1981); Krugman & Venables (1995); Baldwin, Martin, & Ottaviano (2001); Redding & Venables (2004); Yeaple & Golub (2007)]. Yet there are important caveats too. Agglomeration models typically abstract from discussing aggregate trade balance, and any imbalance in the industrial sector is absorbed by the outside sector (typically agriculture).[1] In other words, infrastructure quality—through its effects on the agglomeration of industries—affects only the composition of exports, not trade balance. There are obvious welfare consequences, but these do not arise from the trade balance itself.[2]

[1] For example, (Thia, 2016) shows that more urbanized economies (that is, more agglomeration) export more industrial goods while importing more primary goods, consistent with predictions of new economic geography models.

[2] There is also extensive research on the local effects of infrastructure and industrial growth [Greenstone, Hornbeck, & Moretti (2010); Kline & Moretti (2014)] but these do not typically address trade balance.

To develop the intuition more formally, we start with the standard gravity model to derive a model for bilateral trade balances. The advantage is that the gravity model provides a natural point to work with trade costs. The key assumption here is that trade costs are not bilaterally symmetric and are affected by the quality of infrastructure between the home and destination countries. Using an extension of the gravity model where home infrastructure is used intensively in the export of a good, we show that countries with poorer infrastructure quality will face higher exporting trade costs, with attending effect on bilateral trade balances.

However, there is a natural concern that trade balances are affected by many other variables, and the infrastructure variable (specifically, the difference in infrastructure quality) is merely picking up the effects of other omitted variables. There are also natural concerns with the endogeneity between infrastructure provision and economic outcomes, with researchers employing a variety of techniques to purge estimates from such confounding effects [Donaldson (2018); Donaldson & Hornbeck (2016); Banerjee, Duflo, & Qian (2020)].

Here, we describe what is the key part of this research. Based on model prediction, bilateral trade liberalization where trade in both directions is freed up due to tariff reductions will result in a larger trade imbalance between a trading pair with different infrastructure quality. Empirically, we construct a measure of bilateral liberalization measure using tariff data that is then interacted with infrastructure quality differences. The key is that this interaction term is positive—which confirms that bilateral trade liberalization amplifies the differences in infrastructure quality.

First, this empirical method gives us more confidence that infrastructure differences are indeed affecting trade and contributing to observed trade imbalances, as opposed to just picking up the effects of other variables. Second, this also corroborates earlier research that show that developing economies see greater trade deficits post-trade liberalization, which in the context of this paper arise due to poorer infrastructure quality.

We perform several robustness checks, including running regressions with different tiering of economies by different infrastructure quality to account for heterogeneity, and using different thresholds for the liberalization measure. Furthermore, we interact the bilateral trade liberalization measure with other potential confounding (or omitted) variables, in a series of "placebo" tests. We find no clear effects from such interaction terms, giving us greater confidence that infrastructure quality differences are indeed contributing to bilateral trade imbalances.[3]

Our findings can potentially explain why some poorer developing countries are reluctant to open more fully to trade. This also points to the fact that helping poorer developing economies narrow the infrastructure gap with developed economies is an important part of providing greater impetus towards trade liberalization.

[3] The results of "placebo" tests are provided in Appendix 2.

The rest of the paper is organized as follows: Section 2 provides a detailed explanation of the data, with emphasis on how the liberalization measure is derived. Section 3 provides the theoretical model, which is extended from the standard gravity model, that underpins the subsequent regressions. Section 4 provides the results of various regression specifications. Section 5 discusses the results, including the policy implications as well as limitations of this study. This is followed by our conclusion in Section 6. We provide further details in three Appendices, covering data issues, robustness checks ("placebo" tests), and a discussion on an alternative trade cost model, respectively.

2. Data

We assemble a panel dataset between 2006 and 2017, determined by data availability for indicators collected from various sources. Specifically, the earliest data year for our variable of interest, infrastructure quality, was in 2006. The latest available dataset for the outcome variable, trade, was in 2017.

2.1. Trade Balance

Import and export values come from the Center for Prospective Studies and International Information's (CEPII) Base pour l'Analyse du Commerce International (BACI) dataset, which contains data for 232 countries and 5,202 product categories classified using the Harmonized System at the 6-digit level [Gaulier & Zignago (2010)]. By data construction, BACI reconciles the declarations of the exporter and the importer at a detailed product level. The use of mirror flows results in improved completeness of the data.

We denote export values as X_{ijt}, corresponding to exports by country i to country j at time t. We add unit value to all export figures to avoid zero log points, as a convenient treatment. This will allow us to express trade balance as the log difference in exports ($\ln X_{ijt} - \ln X_{jit}$), as will be explained later. The literature has devoted much attention to the treatment of zero trade values, which would bias any estimates if not properly dealt with [Head & Mayer (2014)]. Note that for this research, the key variable is the log difference in exports ($\ln X_{ijt} - \ln X_{jit}$). Should zero trade be recorded for the bilateral pair in both directions, ($\ln X_{ijt} - \ln X_{jit}$) will be zero based on this setup of adding unit value. As ($\ln X_{ijt} - \ln X_{jit}$) can be positive or negative depending on the direction of trade balance, there would be less concern of bias that would typically arise due to censoring at zero.[4]

The final dataset gathers more than 20,500 bilateral pairs for 12 years from 2006 to 2017. In the dataset, 35 percent of the samples have positive trade balances (35

[4] As will be explained later, we present a version of the regression where trade balances are recorded at gross levels (as opposed to logs). Zero trade balances can also be dealt with in that setup.

percent have negative balances correspondingly) and the remaining 30 percent have zero trade balances.

2.2. Infrastructure Quality

Our infrastructure quality data comes from the World Economic Forum's (WEF) Global Competitiveness Index (GCI). The GCI contains measures of quality of road and port infrastructures. These are experts' assessment of the extensiveness and condition of a country's land and sea transport infrastructures. Scores range from 1 to 7, with 7 indicating that a country has achieved the best infrastructure (i.e., well-developed by international standards). The mean road quality score was 3.9 between 2006 and 2017, ranging from as low as 1.3 to as high as 6.7. The average port quality score was 4.1 over the same time period, with 1.2 and 6.8 as the lowest and highest scores respectively.

We use two infrastructure quality measures—roads and ports—to generate a principal component for infrastructure, thus combining both into a single infrastructure quality score variable. The principal component analysis (PCA) shows that roads and ports are equally weighted in the new component, which explains 90 percent of the variation in road and port infrastructure quality data.[5] Using this new principal component, we further classify the economies into three different infrastructure tiers (low, middle, high) based on their average score over 2006 to 2017. We do this in order to run regressions for the subgroups (i.e., at the tier level) to account for potential heterogeneity). As to be expected, those in the high tier are developed economies, while those in the low tier are lower income developing economies. As will be seen later, the results are robust against this source of heterogeneity. The average PCA score for each tier is presented in Table 1. The average score of economies in the high tier is around 1.6 points higher than those in the middle tier, and 2.8 points higher than those in the low tier. Table 6 in the Appendix 1 provides a full list of economies in each of the tiers.

Table 1. Principal Component Analysis (PCA) Scores by Infrastructure Tiers

	Low Tier	Middle Tier	High Tier
Average PCA score	-1.4	-0.2	1.4

We begin with some high-level description of the relationship between infrastructure quality and trade balance by providing a simple classification of deficit versus surplus economies against infrastructure quality tiers. We first took the trade balance for every bilateral pair for the duration of the data sample and counted how many partners with which a country has positive, negative, or zero trade balances. Countries are

[5] In our research, we also used the overall infrastructure quality scores as captured by WEF (as opposed to just principal components of roads and ports). The results are in the same direction, but somewhat less sharp. This could be due to the fact that roads and ports infrastructure (rather than overall infrastructure, which captures either infrastructure types including airports and utility, e.g., telephone, ICT and electricity) are more relevant for trade costs. The results for overall infrastructure will be available on request.

categorized based on the count of positive and negative bilateral trade balances.[6] To illustrate this categorization at a country level, and taking Australia as an example, the country is in trade surplus with 117 partners, in trade deficit with 82 partners, and has zero trade balances with three partners—based on this, Australia is a surplus country.

Out of 64 countries which mainly have trade deficits with their partners, 50 percent (or 32 countries) are in the low infrastructure tier, 33 percent (or 21 countries) in the middle tier, and 17 percent (or 11 countries) are in the high tier. Conversely, out of 80 countries which mainly have trade surpluses with their partners, close to half (48 percent or 38 countries) are in the high tier, 34 percent (or 27 countries) are in the middle, and 19 percent (or 15 countries) are in the low tier.

Finally, out of 49 economies in the low tier, 65 percent are considered deficit countries. In the high tier, however, a sizeable 78 percent are in the trade surplus category. This provides prima facie evidence that countries with poorer infrastructure quality face more negative trade balances, whereas economies with better infrastructure quality face more positive trade balances.

2.3. Tariff Trade Liberalization

Trade liberalization is constructed from tariff data by the Trade Analysis Information System (TRAINS). Specifically, the database contains effectively applied tariff rates imposed by countries at the six- and eight-digit product level. These rates are averaged for all products for each country-year, using simple averaging. Note that there are missing data in this dataset. Where possible, we fill in the gaps with the last known tariff rate. For example, if tariff is recorded as five percent for 2006, and three percent for 2010, but with missing data in between, we would populate the missing data as five percent, which is the last known tariff rate.

Creating the liberalization indicator involves non-trivial tradeoffs. If trade liberalization is defined too loosely with a low threshold for tariff reduction, there will be too many episodes of minor tariff reduction being picked up as liberalization (i.e., false positives). On the other hand, if the threshold for trade liberalization is set too high, there will be too few switches in the indicator (i.e., false negatives). Setting the threshold too low or too high will both lead to low efficiency of the indicator and poorer regression estimation. Here, we are guided by practical considerations.

Globally, the average tariff rate in 2006 was 9.4 percent, which declined to 6.6 percent in 2017. This is the average figure for all countries, regardless of whether they are identified as having gone through liberalization. For this paper, unilateral liberalization

[6] We acknowledge that this is not a typical way of classifying surplus or deficit countries—a country with bilateral trade deficits with many countries may nonetheless be in aggregate trade surplus. We are using bilateral surplus or deficit counts to define deficit or surplus country here because our research is on bilateral trade balances. To be clear, whether a country is classified as surplus or deficit under this approach has <u>no</u> bearing on subsequent regression analysis.

occurs when an economy reduces the average tariff rate for a trade partner cumulatively by 60 percent over a 3-year rolling window. This threshold is deliberately set above the changes in average tariff rates so that we capture the significant episodes of liberalization.

As an example, if we observe tariff reduction from 10 percent to 4 percent between 2010 to 2013, which is within the 3-year window, we consider this a unilateral liberalization, and the indicator for unilateral liberalization is set to 1 from 2010 onwards (0 in prior years). This is recorded for every $i - j$ pair, thereby giving a very rich set of liberalization indicators.

The summary statistics are provided in Table 2, grouped by the level of tariff protection prior to liberalization. It can be observed that countries which reported tariff rates above 10 percent experienced the largest percentage point reduction in tariff rates (i.e., from 14.7 percent to 4.8 percent). Yet, the average number of bilateral liberalization episodes is less than half for the high-tariff group compared to the middle and low-tariff groups. Across tariff groups, 25 percent of liberalization actions by a country translate into a bilateral liberalization episode (that is, its partners also participated in liberalization efforts). In Table 7 of the Appendix 1, we further report average tariff rates before and after liberalization for each economy, as well as the number of liberalization episodes, when a country liberalizes (regardless of whether its bilateral partner liberalized or not).

Table 2: Trade Liberalization by Degree of Tariff Protection

	Mean Tariff Rate Prior to Liberalization	Mean Tariff Rate After Liberalization
Economies with tariff rates from 0% to 5% prior to liberalization	2.5	0.7
Economies with tariff rates above 5% and below 10% prior to liberalization	7.3	2.3
Economies with tariffs above 10% before liberalization	14.7	4.8
All economies	9.8	3.1

Bilateral liberalization is deemed to have occurred when both unilateral liberalization indicators are observed to be 1 [i.e., both sides have reduced tariff rates cumulatively by at least 60 percent (though the timing of reduction does not need to be exact)]. When this is observed, the bilateral liberalization indicator is set to 1, with 0 in prior years. For robustness checks, we will present results for thresholds at 50 percent and 70 percent reduction.

In regressions, we will include both the average tariff rates of i against j and j against i. These are important as they help absorb changes to trade balances that arise from one-sided changes in tariffs by either i or j. But the key is the bilateral liberalization indicator, which is interacted against infrastructure quality differences. This will isolate the potential effects of infrastructure-related trade costs on trade balance, rather than changes in trade balance caused by unilateral tariff changes.

The data shows that 1,392 bilateral pairs (involving 163 countries) engaged in bilateral liberalization at some point between 2006 and 2017. We observe that this bilateral liberalization period is characterized by tariff reduction with trade partners. Albania, for example, liberalized trade with neighboring European Union partners, such as Austria, Greece, Spain and others. Latin American countries such as Bolivia, Costa Rica, Honduras and Mexico engaged in bilateral liberalization primarily with other Latin American neighbors as well as major trade partners in North America. East and Southeast Asian countries such as China, Japan, Lao PDR, Malaysia, Philippines and Viet Nam liberalized trade with each other.

Another notable observation is that episodes of trade liberalization often occur in bunches, such as between Guatemala with African countries (e.g., Kenya, Madagascar, Zambia). Also, countries such as Egypt and Vanuatu engaged in liberalization with their European counterparts.

For countries which reduced tariff rates for at least one partner since 2006, the mean number of exporting partners these countries liberalized with is 26. Mauritius reduced tariff rates for 109 of its partners (the highest number of bilateral reductions recorded by a country), followed by Bulgaria (91) and Romania (64). Out of 107 countries which had a liberalization episode in 2006, half (53 countries) liberalized with 15 partners or less in 2006. This suggests that liberalization is not broad-based (with all countries) but imposed bilaterally.

There are quite a few countries that liberalized in 2006. This implies that the unilateral liberalization indicator is set at 1 right from 2006, which is the starting year of the panel dataset (due to the availability of infrastructure quality data). This potentially presents an estimation issue. We need to ensure that those that liberalized early are not systematically different from the rest. Otherwise, the subsequent liberalization episodes recorded in the dataset may comprise of countries that are no longer representative. We checked for this source of potential bias and confirm that countries which liberalized in 2006 comprise a mix of countries in all three infrastructure tiers, thereby providing some assurance that the liberalization episodes post-2006 will be representative.[7] To be clear, non-tariff measures are not part of this analysis.

2.3.1. Reversals in Trade Liberalization

Here, it is also important to discuss reversals in liberalization. That is, we observe some tariff rate increases in some years after liberalization. Post-liberalization, if a country is observed to raise the tariff rate for a trade partner by two percentage points, we revert the unilateral liberalization indicator to 0. By the same logic, when one side increases the tariff rate by two percentage points, bilateral trade liberalization no longer holds,

[7] Out of 107 countries which liberalized with at least one partner in 2006, 42 are in the high tier, while 31 and 27 countries are in the middle and low tiers respectively (7 did not have infrastructure quality data). For those in the high tier, 22 percent of their liberalization episodes involve tariff reduction with similarly high tier countries, and the rest (78 percent) with middle tier countries (32 percent) and low tier countries (46 percent).

and the bilateral liberalization indicator is set back to 0. There will be changes to trade balance that can no longer be cleanly isolated to infrastructure-related trade costs. Based on this definition, nine percent of liberalization episodes had a reversal in our dataset.

2.4. Infrastructure Liberalization Episode Linkage

Countries which are in the high infrastructure tier have the highest liberalization episodes, with an average of 90 episodes per country. Around 60 percent of countries in the high infrastructure tier have tariff rates less than or equal to 5 percent, followed by around a quarter which have tariff rates between 5 percent and 10 percent, and 16 percent of countries having tariff rates greater than 10 percent. The highest liberalization episodes can be seen in Mauritius (164 episodes), Iceland (138) and Croatia (133). In contrast, the lowest liberalization episodes among high infrastructure economies can be found in Suriname (19), Panama (26) and Jamaica (35).

The situation is the opposite for countries which have poor infrastructure (i.e., those in the low infrastructure tier). The average number liberalization episodes is 54 per country. Around 60 percent of these countries have tariff rates greater than 10 percent while only 6 percent have tariff rates less than or equal to 5 percent. Liberalization episodes among poor infrastructure countries vary significantly—some countries have liberalization episodes that match high infrastructure countries, such as Peru (130 episodes), Ukraine (114) and Romania (110). Some countries have single-digit liberalization episodes, such as the Democratic Republic of the Congo (4), Mongolia (5), Tajikistan (5), Guinea (6), Sierra Leone (6) and Bhutan (9). This points to greater heterogeneity in liberalization episodes for countries with poor infrastructure.

2.5. Confounding Variables and Placebo Tests

As mentioned, we also test for robustness through placebo tests on potentially confounding variables. Placebo variables include gross domestic product (GDP) per capita and urbanization rate (i.e., urban population as a share of total population), of which both are also sourced from the World Bank's WDI. We also consider institutions and human capital variables—these are reflected as part of WEF GCI's Institutions, Health and Primary Education, and Higher Education and Training competitiveness pillars. Specifically, the Institutions pillar reflects both the maturity of public and private institutions in a country. The Health and Primary Education pillar accounts for the quantity and quality of health and basic education outcomes in a population, whereas the Higher Education and Training pillar measures the educational (i.e., secondary and tertiary education) and training preparedness of a country's workforce. Table 8 of Appendix 1 provides a summary of the variables used in this paper.

3. The Model

3.1. The Gravity Model

Following Anderson and van Wincoop (2003), and assuming a 1-sector economy, the exports of country i to country j in year t is given by

Equation 1

$$X_{ijt} = \frac{Y_{it} Y_{jt} T_{ijt}^{1-\sigma}}{Y_{Wt} \prod_{it}^{1-\sigma} P_{jt}^{1-\sigma}}$$

Y_i , Y_j , Y_W : are the GDPs of countries i, j and the world respectively
T_{ij} : is the iceberg trade cost between i and j
σ : is the constant elasticity of substitution

and where $\prod_{it}^{1-\sigma} Y_{Wt} = \sum_j P_{jt}^{\sigma-1} Y_{jt} T_{ijt}^{1-\sigma} \forall i$ and $P_{jt}^{1-\sigma} Y_{Wt} = \sum_i \prod_i^{\sigma-1} Y_{jt} T_{ijt}^{1-\sigma} \forall j$, and t as the time subscript.

As explained by Anderson & van Wincoop (2004), $\prod_i$ measures the outward resistance of country i's trade—the harder for country i to export to the rest of the world, the higher its exports to country j. As it is well known, P_j is the price aggregator of CES demand functions, reflecting how competitive a market j is, or its inward resistance. A more competitive market is represented by a lower price index, and it will reduce the exports from i to j.

3.2. Effects of Asymmetric Infrastructure Costs

We start by considering the bilateral export ratio between two trade partners (dropping time subscript for ease of exposition). From Equation 1

Equation 2

$$\frac{X_{ij}}{X_{ji}} = \frac{T_{ij}^{1-\sigma} \prod_j^{1-\sigma} P_i^{1-\sigma}}{\prod_i^{1-\sigma} P_j^{1-\sigma} T_{ji}^{1-\sigma}}$$

Note that a ratio greater than 1 would indicate trade surplus for country i, while a ratio below 1 would indicate a deficit. By definition, between any country pair, one would have a bilateral surplus while the other a deficit. Notice firstly that common variables (Y_i , Y_j , Y_W) drop out. In other words, these variables scale exports from both sides, but do not define whether which economy has bilateral surplus or deficit. We focus on the effects of trade costs (which infrastructure costs would be part of) and their effects on this export ratio. Typical in literature, trade cost T_{ij} is modelled as a function of distance together with other variables.[8] We model trade costs as

Equation 3

$$T_{ij}^{1-\sigma} = {d_{ij}}^{\delta} Z_{ij} \left(t_{ij} + \omega_i^{\alpha} \omega_j^{\beta}\right)^{1-\sigma}$$

Where d_{ij} is the bilateral trade distance, Z_{ij} the vector of terms would include common border, common language, colonial ties and so on, which are typical in the literature. These are symmetric terms, common to both i and j. As these are symmetric, they again do not have a direct impact on the export ratio $\frac{X_{ij}}{X_{ji}}$. What remains to determine the direction of this ratio are asymmetric factors.

The home country (i) exporting to destination country (j) will face an iceberg form cost that includes a tariff and infrastructure user costs ($t_{ij} + \omega_i^{\alpha} \omega_j^{\beta}$). It means that a good shipped from i to j will have to incur a tariff t_{ij}, and ω_i^{α} which is the infrastructure use cost of the home country during transit, and ω_j^{β} the infrastructure use cost in the destination country during transit. In Cobb-Douglas form, $\omega_i^{\alpha} \omega_j^{\beta}$ is in effect the cost minimization function of infrastructure use in both home and destination economies during the exporting process.[9] This functional form in

Equation 2 also means that tariffs and infrastructure costs are not log separable.[10] A good shipped has to incur both tariffs and infrastructure costs. Poor infrastructure quality during the shipping process contributes to the iceberg cost.

Here, we assume home infrastructure is used more intensively in the exporting economy, and hence $\alpha > \beta$. This assumption is not unusual and is critical to our empirical strategy. For example, home infrastructure is used for the import of raw materials or intermediate goods, and by different suppliers in the domestic value chain, before the shipment of the good to its destination. In general, there is consensus in the literature that home country infrastructure has a stronger effect on both home country exports and imports than destination country infrastructure [Celbis, Nijkamp, & Poot (2013)].

Because infrastructure quality between home and destination are different, bilateral trade costs will not be equal. Higher quality home infrastructure will result in home

[8] Disdier and Head (2008) document that most estimates lie between -0.28 and -1.55, with a mean of -0.9. Redding and Venables (2004) find that the distance elasticity increases to -1.8 when gravity regressions account for zero bilateral trade through censored regression. Estimates of δ, which is the elasticity of exports to distance, varies but can be taken to be around -0.9 to -1.8.

[9] Here we have assumed a Cobb-Douglas form for the infrastructure use cost function and as an illustration, but this is a more general result so long as infrastructure use cost is higher for the home country with poorer infrastructure.

[10] An alternative functional form is presented in Appendix 3.

exporters having a systematic trade cost advantage (through lower infrastructure use cost). To be clear, if home and destination countries have the same infrastructure quality $\omega_i = \omega_j$ (specific case) or if $\alpha = \beta$ (more general case), there will be no advantage either way.

As can be seen from

Equation 2, bilateral export ratio $\frac{X_{ij}}{X_{ji}}$ is positively correlated with trade cost ratio. Let $\emptyset_{ij}$ denote the ratio of trade costs, with the numerator being the export cost from i to j , and the dominator for the reverse direction from j to i.

Equation 4

$$\emptyset_{ij} = \frac{{d_{ij}}^{\delta} Z_{ij} \left(t_{ij} + \omega_i^{\alpha} \omega_j^{\beta}\right)^{1-\sigma}}{{d_{ji}}^{\delta} Z_{ji} \left(t_{ji} + \omega_j^{\alpha} \omega_i^{\beta}\right)^{1-\sigma}} = \left[\frac{t_{ij} + \omega_i^{\alpha} \omega_j^{\beta}}{t_{ji} + \omega_j^{\alpha} \omega_i^{\beta}}\right]^{1-\sigma}$$

where $d_{ij} = d_{ji}$ the common bilateral distance (with δ assuming the standard negative sign) and $Z_{ij} = Z_{ji}$.[11] As a result, these also do not have an impact on $\frac{X_{ij}}{X_{ji}}$.

3.3. Trade Liberalization and Asymmetric Infrastructure Cost

From Equation 4, we can express in logs

$$\ln \emptyset = (1-\sigma) \ln \left(t_{ij} + \omega_i^{\alpha} \omega_j^{\beta}\right) - (1-\sigma) \ln \left(t_{ji} + \omega_j^{\alpha} \omega_i^{\beta}\right)$$

Equation 5

$$\partial ln\emptyset = (1-\sigma)\left[\frac{1}{t_{ij} + \omega_i^{\alpha} \omega_j^{\beta}}\right] \partial t_{ij}$$

As $\partial t_{ij} < 0$ (being a tariff reduction by trade partner), the right-hand side is positive. As the destination country lowers tariff, this should increase the trade advantage through $\emptyset$. Notice that the size of the increase depends on the size of $\omega_i^{\alpha} \omega_j^{\beta}$. An economy facing high infrastructure use costs will see a smaller positive impact on $\emptyset$. To complete the picture, consider what happens when the home country lowers tariff for its trade partner ($\partial t_{ji} < 0$).

Equation 6

$$\partial ln\emptyset = (\sigma - 1)\left[\frac{1}{t_{ji} + \omega_j^{\alpha} \omega_i^{\beta}}\right] \quad \partial t_{ji}$$

[11] This has to be mentioned with a caveat. The usual distance elasticity δ estimated in the literature would capture a range of effects.

The right-hand side will be negative, as it should be, as the decline in home tariff will lower ∅. In a situation where there is bilateral liberalization, the overall effect would be the addition of Equation 6 and Equation 7, giving us

Equation 7

$$(1-\sigma)\left[\frac{1}{t_{ij}+\omega_i^{\alpha}\omega_j^{\beta}}\right]\ \partial t_{ij}-(1-\sigma)\left[\frac{1}{t_{ji}+\omega_j^{\alpha}\omega_i^{\beta}}\right]\ \partial t_{ji}$$

The overall effect will depend on various terms, including the level of tariffs. Assuming the bilateral tariff reductions are equal ($\partial t_{ij}=\partial t_{ji}$) the net impact of such bilateral tariff reductions boils down to the differences in the square brackets.

Equation 8

$$\left[\frac{1}{t_{ij}+\omega_i^{\alpha}\omega_j^{\beta}}\right]-\left[\frac{1}{t_{ji}+\omega_j^{\alpha}\omega_i^{\beta}}\right]$$

If the home country has a lower cost of infrastructure use (i.e., better infrastructure quality), this term will tend to be positive. A bilateral tariff reduction will increase giving the home country an exporting advantage, as seen by the positive net effect on ∅ and hence $\frac{X_{ij}}{X_{ji}}$. Conversely, if the home country has a higher cost of infrastructure use (i.e., poorer infrastructure quality), the net effect will be negative. This logic also holds for the destination country.

The logic of Equation 8 is that post bilateral liberalization, in any bilateral country pair, the economy with better infrastructure quality should gain a trade advantage against the other. The size of this advantage is proportional to the infrastructure cost difference between bilateral trade partners (or infrastructure quality differences). While there are other terms determining bilateral trade balances, this effect should be observed over large samples of bilateral trade pairs. This provides the basis for our empirical strategy.

3.4. Impact of Multilateral Resistance

As with all gravity model estimations, one would have to account for both outward and inward multilateral resistance (MRT). Outward MRT ($\prod_i$) is the trade barrier faced by a country with all its trade partners. A reduction of outward MRT for country i will result in trade diversion of its exports to j (and vice versa). Inward MRT (P_i), on the other hand, measures how competitive the destination market is, making it more difficult for imports to penetrate. When all inward and outward trade costs are completely symmetric for an economy i, the result is that $\prod_{\mathrm{i}}=\mathrm{P}_{\mathrm{i}}$ *and they cancel out as seen in*

Equation 2.

Given that the key assumption of this paper rests on asymmetric bi-directional trade costs, we naturally do not assume that inward and outward trade costs are symmetric such that the outward and inward resistance terms cancel out for every economy. Following (IMF, 2019), for each economy, we compute a single MRT term for each economy

Equation 9

$$MRT_{it} = \left[\sum_j \left(\frac{Y_{jt}}{Y_{Wt}} \right) {d_{ij}}^{1-\sigma} \right]^{\frac{1}{1-\sigma}}$$

where we set $\sigma = 3$. As MRT_{it} is supposed to be a function of full trade costs rather than distances, the above characterization serves as an approximation only, assuming any trade frictions scale according to distances. Note that the MRT of i and j would be different (i.e., asymmetric). Exporter and importer outward MRT will enter separately into the regression on trade balances.

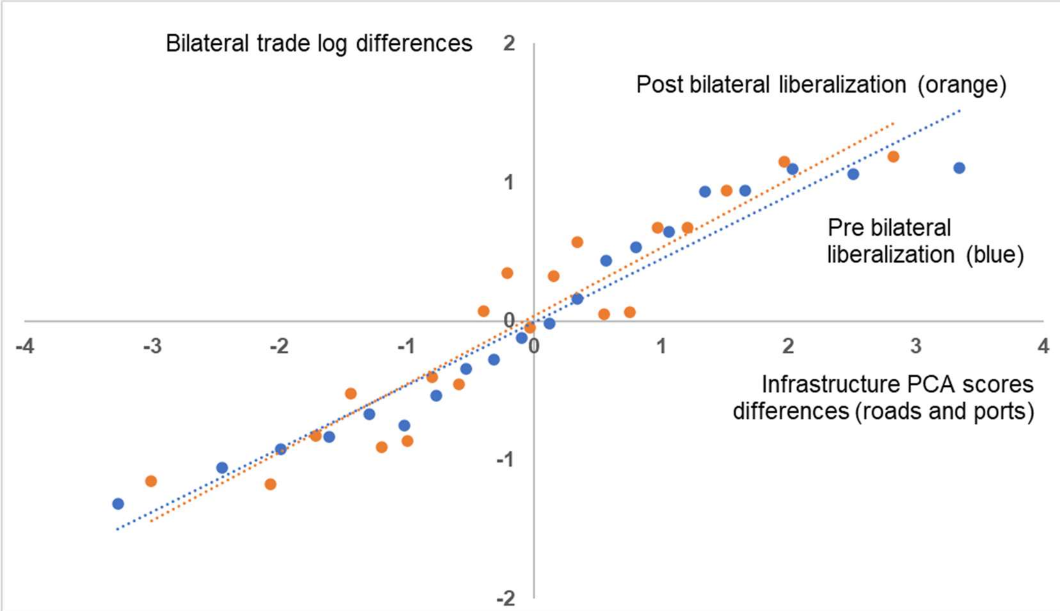
3.5. Selection of Samples

Because bilateral trade balances are mirror flows, we need to pay specific attention to the sample points entering into the regression. This is to prevent the bilateral trade balance of a country pair entering into the regression twice, thereby overstating the statistical significance of the result.

For each $i - j$ pair of countries, we generate a random number for i and another for j. For each bilateral pair of trade partners, we assign a categorical variable for these random numbers. The lower of the generated random numbers is assigned to category "one", whereas the higher number is assigned to category "two". In short, for every pair of bilateral trade partners, we randomize the selection of one of the two to enter into the regression while dropping the other.[12] There are a large number of bilateral trade balance sample points. Using one of the two randomized sets, we present the binscatter plot between bilateral trade balances and bilateral differences in Figure 1. On the y-axis, we have bilateral trade balance (in log difference) for 2017. On the x-axis, we have the bilateral difference in road and port PCA scores. The pre- and post-liberalization (bilateral liberalization) are presented in separate binscatter plots, highlighting the more positive slope post-liberalization.

[12] Note that the regression results for the other set will be the same, since this is the "mirror" dataset. However, a slightly different regression will result with a different randomization, as a different set of economies will be randomized into the regression. Over large samples, the results will remain largely the same.

Figure 1: Bilateral Trade Balance and Infrastructure Difference



3.6. Empirical Strategy

With the above, we complete the characterization of the empirical approach. Our regression is

$$ln\emptyset_{ijt} = \gamma_0 + \gamma_2 \ln(1 + t_{ijt}) + \gamma_3 \ln(1 + t_{jit}) + \gamma_4(PCA_{it} - PCA_{jt}) + \gamma_5(PCA_{it} - PCA_{jt}).D_{ijt} + \gamma_6 \ln MRT_{it} + \gamma_7 \ln MRT_{jt} + e_{ijt}$$

Where PCA is the infrastructure quality as measured by the PCA scores, D is the bilateral liberalization indicator (set to 1 if bilateral liberalization occurred), and MRT the outward multilateral resistance terms.

Firstly, we expect the infrastructure difference term to yield a positive coefficient (γ_4), in line with Equation 4. The country with superior infrastructure will have a lower minimized cost for infrastructure use and gain an exporting advantage. Secondly, we expect the interaction term between liberalization and infrastructure to yield positive coefficients (γ_5), in line with the logic in Equation 8. A positive interaction term will confirm that infrastructure effects are accentuated post liberalization.

We consider an alternative form of trade cost that is not log separable and show how a similar logic would hold, though there would be a need to modify the estimation strategy. This is presented in Appendix 3.

4. Results

All regressions are carried out using fixed effects regressions for each country-pair, and with clustered standard errors. The first set of results is presented in Table 3.

Regression (1) shows results for the whole sample, while regressions (2) to (4) are carried out using sub-samples, as stated in the table.[13]

From regression (1), an approximation here is that a 1-point improvement in infrastructure score against a trade partner, with a coefficient of 0.084, is associated with an increased trade balance by around 8 percent. The coefficients for all sub-samples are all positive, with those for exporters in the high tier registering the strongest coefficient at 0.105. The interaction term is positive and weakly significant at 0.116 when all samples are included, and weakly significant for exporters in the high tier. Note that the tariff data is expressed in iceberg form (i.e., 1 + tariff). In line with expectations, home country (i) tariffs register mostly positive coefficients while destination country (j) tariffs register mostly negative coefficients. The inclusion of both i and j tariffs in the regressions would act as controls where tariffs, or reductions in tariffs, are dissimilar in magnitudes. Furthermore, as we have included bilateral tariffs for i and j in the regressions, we exclude the bilateral liberalization dummy in the regression except for the interaction term with infrastructure differences.

We describe the impact of these coefficients by comparing average effects for various tiers, using the coefficient of regression (1). With the average PCA scores in Table 1, when a middle infrastructure economy trades with a low infrastructure economy, this is associated with an improved trade balance of about 11 percent on average for the country with better infrastructure. The trade balance effect for a high infrastructure economy is larger. A high tier economy experiences an improved trade balance of 27 percent on average when it trades with low tier economies. The difference in infrastructure quality is further accentuated when country pairs engage in liberalization. For example, when a high infrastructure country and a low infrastructure country liberalize bilaterally, the country with the better infrastructure increases its trade balance by 43 percent against its low infrastructure trade partner.

Table 3: Regressions of Trade Balance and Infrastructure Quality

	All Samples	Exporter Low Importer Middle and High	Exporter Middle Importer Low and High	Exporter High Importer Low and Middle
	(1)	(2)	(3)	(4)
	Bilateral trade balance, logs			
Infrastructure quality difference	0.084***	0.086*	0.070*	0.105***

[13] Note that in the sub-sample regressions, there is no need for randomization of sample points, as there will by construct not be inclusion of mirror data points. To check if time fixed effects are needed, time dummies are included for the all sample regressions. The regressions show that dummies for all years are not significant. Also, the coefficients for all years are jointly equal to 0, indicating that no time fixed effects are needed.

	[0.028]	[0.052]	[0.039]	[0.033]
Infrastructure quality difference x Bilateral liberalization at 60% threshold	0.116**	0.093	0.120	0.118*
	[0.053]	[0.078]	[0.076]	[0.062]
Tariffs of country i, logs	0.836	2.759**	0.501	-0.564
	[0.543]	[1.192]	[0.601]	[1.135]
Tariffs of country j, logs	-0.586	-0.547	-0.577	-1.485
	[0.614]	[0.697]	[1.191]	[0.944]
Exporter resistance, logs	2.233***	3.292***	2.137***	2.048***
	[0.302]	[0.644]	[0.519]	[0.313]
Importer resistance, logs	-2.000***	-2.839***	-2.093***	-2.067***
	[0.290]	[0.464]	[0.427]	[0.448]
Constant	-1.940	-6.195	0.043	1.549
	[3.460]	[6.356]	[5.333]	[4.450]
Observations	87,142	38,480	38,779	41,481
Number of bilateral pairs	9,071	4,140	4,033	4,201
R-squared within	0.002	0.003	0.002	0.003
R-squared between	0.021	0.003	0.024	0.017
R-squared overall	0.008	0.000	0.009	0.005
F-stat [p-value]	0.0000	0.0000	0.0000	0.0000

Notes: Robust standard errors in brackets
* p<0.1, ** p<0.05, *** p<0.01

As mentioned before, the choice of tariff reduction thresholds for the liberalization indicator is a non-trivial consideration. In Table 4, we report results of the same regression specification as those in Table 3 but with different thresholds for the liberalization indicator. The main coefficient of interest—on infrastructure quality difference—is around 0.08, which is broadly in line with earlier estimates presented in Table 3. The interaction term is also positive and weakly significant (at 0.078 and 0.123 for the 50 percent and 70 percent liberalization thresholds respectively).

Table 4: Regressions of Trade Balance and Infrastructure Quality—Using 50% and 70% Liberalization Thresholds

	50% Threshold	70% Threshold
	All samples	All samples
	(5)	(6)
	Bilateral trade balance, logs	
Infrastructure quality difference	0.085***	0.084***
	[0.028]	[0.028]

Infrastructure quality difference x Bilateral liberalization	0.078*	0.123**
	[0.043]	[0.055]
Tariffs of country i, logs	0.843	0.841
	[0.543]	[0.542]
Tariffs of country j, logs	-0.595	-0.588
	[0.615]	[0.614]
Exporter resistance, logs	2.229***	2.234***
	[0.302]	[0.302]
Importer resistance, logs	-1.996***	-2.002***
	[0.290]	[0.290]
Constant	-1.937	-1.931
	[3.461]	[3.460]
Observations	87,142	87,142
Number of bilateral pairs	9,071	9,071
R-squared within	0.002	0.002
R-squared between	0.021	0.021
R-squared overall	0.008	0.008
F-stat [p-value]	0.0000	0.0000

Notes: Robust standard errors in brackets
* p<0.1, ** p<0.05, *** p<0.01

The R-square statistics for most of the regressions are low, notwithstanding the significance in the key explanatory variables. Bilateral trade balances are, on the whole, not well explained by the gravity model. We also carried out regressions using between estimators, though not reported in this paper. The R-square statistics are higher for such cross-country regressions, though such estimations are more prone to omitted variable bias.

4.1. Robustness Checks

As mentioned in the introduction, the literature is rightly concerned with infrastructure picking up the effects of omitted variables. Hence, in this paper, we are looking for the combination of two results. Firstly, the underlying variable should hold explanatory power for trade balances. Secondly, the interaction term between the underlying variable and trade liberalization should be positive. This is key to pinpointing the effects of infrastructure.

For robustness checks, we repeat the same test on other variables (i.e., essentially carrying out "placebo" tests on other variables). The results for per capita GDP (Table 9), urbanization rate (Table 10), institutions (Table 11), human capital—health and primary education (Table 12), human capital—higher education and training (Table 13) are in the Appendix 2. Mostly, the variables all have varying degrees of explanatory power, but none of them conform to the two tests as well as infrastructure does. We will further discuss the results from such placebo-tests in the later sections.

In this paper, we did not treat for endogeneity, which is also a concern typical in this trade and infrastructure literature. One could argue that economies with trade deficits provide incentives for infrastructure improvements, but the same argument can be made for economies with trade surpluses as well. Here, it is also important to emphasize that the regressions in this paper are on bilateral trade balances, not a country's aggregate trade performance. Given that a country would have many trade partners, and hence many bilateral balances, it seems unlikely that there would be reverse causation. We considered the possibility that bilateral trade balance could have affected countries' bilateral tariff setting, thereby creating endogeneity. Here, we checked for this by removing tariff regressors from the regression. Estimates are broadly similar, and our conclusions hold.

4.2. Trade Liberalization with High Tier Economies

In this subsection, we further examine the impact when developing economies (in low and middle tiers) liberalize against developed economies (high tier). Here, the infrastructure coefficients are positive and significant, at around 0.11 across regressions using different liberalization thresholds. The interaction terms are positive and significant for the 60 percent and 70 percent liberalization thresholds respectively. In short, developed economies with good infrastructure (high tier) have a significant trade advantage which contributes to more positive trade balances against developing economies. A 1-point improvement translates into over 10 percent increase in trade balance.

Table 5: Regressions of Trade Balance When Exporters Are Developing Economies (Low-Middle Tiers) and Importers are Developed Economies (High Tier)

	Exporter Low and Middle, Importer High		
	50% threshold	60% threshold	70% threshold
	(7)	(8)	(9)
	Bilateral trade balance, logs		
Infrastructure quality difference	0.106***	0.105***	0.105***
	[0.033]	[0.033]	[0.033]
Infrastructure quality difference x Bilateral liberalization	0.058	0.118*	0.148**
	[0.049]	[0.062]	[0.063]
Tariffs of country i, logs	1.562	1.485	1.473

	[0.960]	[0.944]	[0.937]
Tariffs of country j, logs	0.608	0.564	0.564
	[1.139]	[1.135]	[1.135]
Exporter resistance, logs	2.056***	2.067***	2.077***
	[0.448]	[0.448]	[0.448]
Importer resistance, logs	-2.043***	-2.048***	-2.051***
	[0.314]	[0.313]	[0.313]
Constant	-1.508	-1.549	-1.608
	[4.454]	[4.450]	[4.450]
Observations	41,481	41,481	41,481
Number of bilateral pairs	4,201	4,201	4,201
R-squared within	0.003	0.003	0.004
R-squared between	0.017	0.017	0.017
R-squared overall	0.005	0.005	0.005
F-stat [p-value]	0.0000	0.0000	0.0000

Notes: Robust standard errors in brackets
* p<0.1, ** p<0.05, *** p<0.01

5. Discussion

First, our result is consistent with the asymmetric trade cost seen in the literature [Celbis, Nijkamp & Poot (2013), Waugh (2010)]. Asymmetric trade cost is not a new subject of research. Our contribution here is to show that this asymmetry—through infrastructure quality differences—contributes to trade imbalances. For developing economies, infrastructure matters, much more so than institution quality and human capital, in contributing to trade imbalances.

Second, the result is also in line with earlier research works that show that developing economies sometimes face worsened trade balances when they liberalize. When trade is not liberalized, infrastructure quality differences between countries do not matter as much. Exporters in any bilateral trade pairs face high trade costs (e.g., tariff barriers) independent of infrastructure. Any resulting trade imbalances would be small. When trade becomes more liberalized, the asymmetry in trade costs (through infrastructure) becomes more prominent. While our research here pertains only to goods trade, it adds another layer of understanding as to why current account deficits can be persistent for many developing economies, especially post-liberalization. Blanchard & Milesi-Ferretti (2012) argue that current account imbalances matter because they reflect distortions or unfair competition, which have negative spillovers. We show that the infrastructure quality gap between developing and developed economies adds to structural trade imbalances and associated risks. This highlights the importance of infrastructure development, particularly for lower-income economies.

An alternative explanation to the regression results is that countries with poorer infrastructure import more to meet investment needs. In other words, as domestic savings are insufficient to meet investment needs for infrastructure, additional imports show up as trade deficits. Trade liberalization then allows for more imports, thereby driving the results we see in the regressions. While we cannot rule out this explanation, this is somewhat implausible. Developing economies generally do not invest sufficiently in infrastructure [Fay, Lee, Mastruzzi, Han, & Cho (2019)]. Furthermore, it is also difficult to reason that a country's investment needs, in the aggregate, will show up as a series of bilateral trade deficits that correlate with bilateral infrastructure differences.

Put in another way, even if the investment needs of a country are high, and that it is able to attract capital inflows which then show up as trade deficits, there is no reason that higher imports should be met by economies with higher infrastructure scores compared to the importing economy. Developing economies also have various non-infrastructure investment needs that would also require urgent attention (e.g., spending and investment in education etc.). Meeting these needs through higher public or private spending would also show up as savings-investments imbalances. Educational difference, however, does not show up as a significant variable in explaining bilateral trade balance, nor does the interacted term between bilateral liberalization and education pick up any effects.

Third, the difference in urbanization rate does come across as a plausible variable to explain trade imbalances. The coefficients are not as large as infrastructure quality but are nonetheless positive and significant (Table 10). However, we do not see this as a fundamental challenge to the basic conclusion of this paper. As mentioned, new economic geography insights show that improved infrastructure (i.e., lower trade costs) can lead to agglomeration economies and improve export performance. To the extent that urbanization is facilitated by and hence correlated with better infrastructure, it is not surprising that differences in urbanization can contribute to trade imbalances. We argue that the results for urbanization are consistent with our basic premise—that infrastructure quality difference can contribute to trade imbalances.

Fourth, a surprising finding that emerges from the placebo tests is the role of institutions. Institutional quality differences are not found to contribute to trade imbalances. However, the interacted term with trade liberalization is strongly positive. Economies with weaker institutions thus potentially face worsened trade deficits when there is trade liberalization.

Fifth, per capita GDP difference is interesting in that coefficients are negative. A larger difference in per capita GDP is associated with smaller trade imbalances. This could be picking up the effects of comparative advantage.

5.1. Limitations of the Study

There are also key limitations in this study that need to be articulated. First and foremost, the gravity model, while useful in the analysis of trade costs, is perhaps not completely well suited to answer questions on trade balances as it does not deal with inter-temporal consideration. The key advantage is that trade costs are easily studied in the context of the gravity model.

Another inherent limitation is with bilateral trade balances itself. Over the past few decades, global trade has been characterized by specialization in production in global value chains [World Bank (2020)]. One product, for example, may involve numerous different parts coming from multiple economies before being assembled for final production. Bilateral trade imbalances between economies may well be just reflecting the nature of specialization, with one economy importing certain intermediates from another, before exporting final goods to a third market.

In this research, we did not further analyze the composition of trade and the related impact on observed bilateral trade imbalances. We also did not analyze the role of information and communication (ICT) infrastructure, though recognizing that these might also be important for physical merchandise trade that we study here. The types of infrastructure and the sectors they affect remains an interesting area of research going forward.

6. Conclusion

In this paper, we provide a simple model—extending from the basic gravity equation—whereby asymmetric trade costs arise from infrastructure quality differences. Our contribution is to provide an empirical strategy that allows us to pinpoint the effects of infrastructure on trade with greater confidence.

While acknowledging the consensus view that aggregate trade balances reflect fundamental macroeconomic factors, we nonetheless find that infrastructure quality differences contribute towards bilateral trade imbalances, and the effects are accentuated by trade liberalization. This does not take away the macroeconomic explanations of trade balance but provides an additional layer of understanding as to why poorer developing economies seem to have persistent deficits when they open to trade, in line with findings in earlier research.

The key conclusion here is that infrastructure development needs to happen before, or at least in parallel, with trade liberalization in order to prevent negative trade impact on developing economies.

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Appendix 1: Further Details on Data

Table 6: Road and Port Infrastructure Quality of Economies in the Data Sample

Low Tier	Middle Tier	High Tier
Algeria	Albania	Australia
Angola	Argentina	Austria
Armenia	Azerbaijan	Bahrain
Bangladesh	Belize	Barbados
Benin	Bulgaria	Belgium
Bhutan	Cabo Verde	Brunei Darussalam
Bolivia	Cambodia	Canada
Bosnia and Herzegovina	Czech Republic	Chile
Brazil	Côte d'Ivoire	China
Burkina Faso	Dominican Republic	Hong Kong, China
Burundi	Ecuador	Croatia
Cameroon	Egypt	Cyprus
Chad	El Salvador	Denmark
Colombia	Ethiopia	Estonia
Costa Rica	Gambia	Finland
Dem. Rep. of the Congo	Georgia	France
Gabon	Ghana	Germany
Guinea	Greece	Iceland
Haiti	Guatemala	Ireland
Kazakhstan	Guyana	Israel
Kyrgyz Republic	Honduras	Jamaica
Lao PDR	Hungary	Japan
Libya	India	Jordan
Madagascar	Indonesia	Kuwait
Malawi	Iran	Lithuania
Mali	Italy	Malaysia
Mauritania	Kenya	Mauritius
Mongolia	Latvia	Netherlands
Mozambique	Lebanon	New Zealand
Myanmar	Liberia	Norway
Nepal	Malta	Oman
Nicaragua	Mexico	Panama
Nigeria	Montenegro	Portugal
Paraguay	Morocco	Qatar
Peru	Pakistan	Republic of Korea
Philippines	Poland	Saudi Arabia
Moldova	Russian Federation	Seychelles
Romania	Rwanda	Singapore
Serbia	Senegal	Slovenia
Sierra Leone	Slovakia	South Africa
Tajikistan	Sri Lanka	Spain
Timor-Leste	Syria	Suriname
Uganda	Macedonia	Sweden
Ukraine	Trinidad and Tobago	Switzerland
Tanzania	Tunisia	Thailand
Venezuela	Turkey	USA

Viet Nam	Uruguay	United Arab Emirates
Yemen	Zimbabwe	United Kingdom
Zambia		

Table 7: Status of Liberalization and Tariffs by Economies

Economy	Mean Tariff Rate Prior to Liberalization	Mean Tariff Rate After Liberalization	Most Popular Year of Liberalization	Number of Liberalization Episodes
Economies with tariff rates from 0% to 5% prior to liberalization				
Norway	1.15	0.41	2009	101
Austria	1.47	0.25	2006	102
Belgium	1.47	0.25	2006	102
Cyprus	1.47	0.25	2006	102
Czech Republic	1.47	0.25	2006	102
Denmark	1.47	0.25	2006	102
Estonia	1.47	0.25	2006	102
Finland	1.47	0.25	2006	102
France	1.47	0.25	2006	102
Germany	1.47	0.25	2006	102
Greece	1.47	0.25	2006	102
Hungary	1.47	0.25	2006	102
Ireland	1.47	0.25	2006	102
Italy	1.47	0.25	2006	102
Latvia	1.47	0.25	2006	102
Lithuania	1.47	0.25	2006	102
Malta	1.47	0.25	2006	102
Netherlands	1.47	0.25	2006	102
Poland	1.47	0.25	2006	102
Portugal	1.47	0.25	2006	102
Slovakia	1.47	0.25	2006	102
Slovenia	1.47	0.25	2006	102
Spain	1.47	0.25	2006	102
Sweden	1.47	0.25	2006	102
United Kingdom	1.47	0.25	2006	102
Japan	2.97	0.55	2006	91
New Zealand	3.18	1.32	2007	77
USA	3.35	0.91	2007	107
Australia	3.41	0.84	2006	85
Brunei Darussalam	3.46	0.94	2017	112
Canada	3.54	0.57	2017	114
Kyrgyz Republic	3.60	2.04	2017	42
Papua New Guinea	4.29	1.71	2007	84
Saudi Arabia	4.41	1.62	2006	58
Palau	4.41	2.36	2017	8
Myanmar	4.57	1.68	2015	37
Kuwait	4.67	1.63	2006	56
Iceland	4.67	0.65	2006	138
Ukraine	4.69	1.57	2017	114
Malaysia	4.83	1.89	2006	123
Turkey	4.92	1.78	2006	120
Bulgaria	4.97	0.41	2006	134

Economies with tariff rates above 5% and below 10% prior to liberalization				
Mongolia	5.07	2.56	2006	5
Israel	5.16	1.59	2007/2008	121
Croatia	5.21	0.89	2006	133
Chile	5.35	1.57	2015	97
United Arab Emirates	5.54	2.02	2013	40
Armenia	5.69	1.89	2006	75
Qatar	5.75	1.68	2006	48
Georgia	5.82	0.88	2007	123
Philippines	6.06	1.41	2008	27
Haiti	6.13	2.81	2012	60
Albania	6.17	2.11	2008	129
Mauritius	6.34	2.55	2006	164
Kazakhstan	6.34	2.11	2008	74
Tajikistan	6.37	3.00	2012/2013	5
Rep. of Moldova	6.41	2.45	2006	69
Montenegro	6.58	1.42	2009	107
Bahrain	6.72	1.80	2006	59
Oman	6.77	0.92	2006	44
Afghanistan	6.87	2.50	2008	1
Belarus	6.94	1.95	2016	62
Peru	7.31	1.69	2008	130
Guatemala	7.34	3.06	2007	86
Nicaragua	7.34	3.07	2007	92
Romania	7.38	0.35	2006	110
China	7.49	2.01	2015	78
Comoros	7.67	1.85	2015	27
Costa Rica	7.67	2.84	2009	109
Yemen	7.71	1.98	2009	33
El Salvador	7.73	2.82	2008	91
Bosnia and Herzegovina	7.95	2.09	2009	88
Indonesia	8.06	2.89	2010	47
Honduras	8.07	3.38	2010	71
Mexico	8.28	2.59	2010	119
Panama	8.61	2.93	2012	26
Republic of Korea	8.75	3.10	2014	113
Lebanon	8.79	2.35	2017	89
Tonga	8.92	2.71	2012/2015	28
French Polynesia	8.98	3.08	2017	23
Solomon Islands	9.23	0.13	2015	3
Russian Federation	9.24	3.48	2010	120
Serbia	9.27	2.90	2010	103
Angola	9.28	3.63	2014	51
Colombia	9.91	3.48	2012	105

Economies with tariffs above 10% before liberalization				
Aruba	10.01	1.50	2013	1
Ecuador	10.26	3.35	2009	102
Azerbaijan	10.28	1.28	2007	31
Liberia	10.29	2.50	2014	1
Viet Nam	10.49	4.13	2006/2009	88
South Africa	10.52	3.53	2006	75
Dominican Republic	10.61	3.40	2007	99
India	10.76	6.33	2006	108
Mauritania	10.85	4.69	2011	29
Lao PDR	10.89	3.54	2014	27
Paraguay	11.20	3.87	2015	54
Mozambique	11.23	4.16	2014	49
Sri Lanka	11.43	4.11	2011	90
Nigeria	11.61	4.85	2015	35
Thailand	11.69	3.85	2006	79
Seychelles	11.75	3.04	2015	86
Samoa	11.81	3.72	2014/2015	9
Uruguay	12.09	2.98	2007/2008	46
Cuba	12.15	3.20	2012	30
Jamaica	12.40	4.82	2010	35
Madagascar	12.40	3.28	2017	82
Belize	12.41	4.99	2013	29
Saint Lucia	12.59	3.63	2007	50
Argentina	12.62	3.84	2008	39
Guyana	12.76	4.22	2011	69
Fiji	12.79	4.51	2011	61
Côte d’Ivoire	12.86	3.91	2015	54
Burkina Faso	12.95	4.10	2015	47
Dem. Rep. of the Congo	13.03	6.44	2014	4
Bolivia	13.06	5.04	2006	50
Senegal	13.14	4.38	2011/2015	41
Suriname	13.20	2.28	2012	19
Pakistan	13.26	5.79	2008	64
Ghana	13.41	2.79	2016	29
Mali	13.43	3.94	2015	42
Niger	13.43	4.56	2015	48
Trinidad and Tobago	13.45	5.52	2006	46
Guinea-Bissau	13.50	4.82	2008	15
Benin	13.54	2.46	2015	33
Brazil	13.59	3.71	2006	47
Grenada	13.61	4.98	2011	21
Saint Vincent and the Grenadines	13.70	3.40	2012	41
Guinea	13.90	5.92	2008	6
Nepal	13.98	6.68	2013	32
Togo	14.21	5.17	2015	46
Venezuela	14.34	4.58	2006/2011	37
Cambodia	14.34	5.44	2014	57

Bangladesh	14.35	5.49	2009	79
Tanzania	14.39	5.45	2007	78
Sierra Leone	14.50	5.00	2006/2012	6
Jordan	14.53	4.36	2014	96
Uzbekistan	14.58	6.17	2012	6
Kenya	14.58	4.65	2006	70
Dominica	14.74	3.74	2011	25
Syria	14.82	3.66	2013	13
Zimbabwe	14.86	5.24	2015	68
Malawi	14.86	4.26	2008	63
Saint Kitts and Nevis	14.86	3.78	2008	40
Uganda	15.13	6.28	2009	83
Zambia	15.27	4.54	2008	56
Cabo Verde	15.32	6.25	2013	55
Burundi	15.62	4.44	2007	67
Antigua and Barbuda	15.75	4.40	2006	23
Gambia	16.13	4.21	2013	10
Bermuda	16.19	7.31	2013/2015	20
Morocco	16.37	4.20	2012	109
Rwanda	17.11	5.63	2010/2011	59
Algeria	17.19	5.28	2009	44
Sudan	17.38	4.47	2012	61
Vanuatu	17.47	4.60	2012	24
Equatorial Guinea	17.78	5.00	2007	1
Congo	18.05	4.90	2007	13
Chad	18.42	6.52	2011	15
Central African Rep.	18.42	5.73	2007	16
Iran	18.81	6.51	2008	3
Djibouti	19.36	6.03	2007	13
Ethiopia	19.43	7.78	2008	23
Cameroon	19.87	7.76	2007	30
Barbados	19.94	8.78	2006	58
Gabon	20.02	6.35	2010	15
Tunisia	21.23	6.95	2013	98
Maldives	21.72	7.58	2012	38
Bahamas	24.56	9.45	2013	28
Bhutan	26.44	8.62	2007	9
Egypt	31.39	4.20	2008	114

Table 8: Summary of Variables

Variable	Source	Time Period
Trade value	BACI	2006-2017
Road and port quality score	WEF	2006-2017
Tariff rate	TRAINS	2006-2017
Urban population, percent of total	WDI	2006-2017
GDP per capita	WDI	2006-2017
Institutions pillar score	WEF	2006-2017
Health & education pillar score	WEF	2006-2017
Higher education & training pillar score	WEF	2006-2017

Appendix 2: Robustness Checks ("Placebo" Tests)

Table 9: Trade Liberalization with Other Variables (per capita GDP)

	All Samples	Exporter Low Importer Middle and High	Exporter Middle Importer Low and High	Exporter High Importer Low and Middle
	(A1)	(A2)	(A3)	(A4)
	Bilateral trade balance, logs			
GDP per capita difference	-0.361***	-0.243**	-0.484***	-0.220***
	[0.068]	[0.113]	[0.109]	[0.083]
GDP per capita difference x Bilateral liberalization at 60% threshold	-0.066	-0.013	0.019	-0.104
	[0.054]	[0.082]	[0.083]	[0.067]
Tariffs of country i, logs	1.293***	3.531***	0.522	0.059
	[0.469]	[0.937]	[0.464]	[0.908]
Tariffs of country j, logs	-0.917**	-1.003*	-1.004	-1.488*
	[0.446]	[0.585]	[0.978]	[0.837]
Exporter resistance, logs	2.165***	3.145***	2.378***	2.146***
	[0.313]	[0.657]	[0.565]	[0.325]
Importer resistance, logs	-2.120***	-3.314***	-1.987***	-1.722***
	[0.301]	[0.464]	[0.467]	[0.457]
Constant	-0.387	-1.270	-2.441	-0.857
	[3.379]	[6.071]	[5.619]	[4.334]
Observations	132,423	53,224	54,550	60,475
Number of bilateral pairs	12,413	4,913	5,060	5,542
R-squared within	0.003	0.004	0.003	0.003
R-squared between	0.063	0.015	0.054	0.022
R-squared overall	0.033	0.005	0.028	0.011
F-stat [p-value]	0.0000	0.0000	0.0000	0.0000

GDP = gross domestic product
Notes: Robust standard errors in brackets
* p<0.1, ** p<0.05, *** p<0.01

Table 10: Trade Liberalization with Other Variables (Urbanization Rate)

	All Samples	Exporter Low Importer Middle and High	Exporter Middle Importer Low and High	Exporter High Importer Low and Middle
	(B1)	(B2)	(B3)	(B4)
	Bilateral trade balance, logs			
Urbanization difference	0.028***	0.044***	0.023	0.025**
	[0.009]	[0.015]	[0.015]	[0.012]
Urbanization difference x Bilateral liberalization at 60% threshold	-0.006	-0.008	0.000	-0.011**
	[0.004]	[0.006]	[0.006]	[0.005]
Tariffs of country i, logs	1.300***	3.726***	0.577	-0.260
	[0.464]	[0.918]	[0.436]	[0.896]
Tariffs of country j, logs	-0.790*	-0.737	-0.986	-1.605*
	[0.417]	[0.567]	[0.959]	[0.832]
Exporter resistance, logs	2.843***	3.995***	3.263***	2.479***
	[0.297]	[0.590]	[0.529]	[0.311]
Importer resistance, logs	-2.724***	-3.864***	-2.880***	-2.203***
	[0.290]	[0.442]	[0.447]	[0.433]
Constant	-1.014	-2.870	-1.974	-0.522
	[3.364]	[5.965]	[5.564]	[4.319]
Observations	136,081	54,326	56,167	61,806
Number of bilateral pairs	12,673	4,982	5,197	5,627
R-squared within	0.002	0.004	0.003	0.003
R-squared between	0.019	0.001	0.015	0.012
R-squared overall	0.008	0.000	0.007	0.005
F-stat [p-value]	0.0000	0.0000	0.0000	0.0000

GDP = gross domestic product
Notes: Robust standard errors in brackets
* p<0.1, ** p<0.05, *** p<0.01

Table 11: Trade Liberalization with Other Variables (Institutions)

	All Samples	Exporter Low Importer Middle and High	Exporter Middle Importer Low and High	Exporter High Importer Low a Middle
	(C1)	(C2)	(C3)	(C4)
	Bilateral trade balance, logs			
Institutions difference	-0.072	-0.104	-0.027	-0.063
	[0.046]	[0.080]	[0.067]	[0.057]
Institutions difference x Bilateral liberalization at 60% threshold	0.248***	0.269**	0.286**	0.208**
	[0.077]	[0.127]	[0.123]	[0.092]
Tariffs of country i, logs	0.831	2.631**	0.441	-0.522
	[0.543]	[1.173]	[0.599]	[1.132]
Tariffs of country j, logs	-0.577	-0.566	-0.631	-1.400
	[0.612]	[0.697]	[1.189]	[0.930]
Exporter resistance, logs	2.173***	3.069***	2.214***	1.989***
	[0.302]	[0.644]	[0.518]	[0.313]
Importer resistance, logs	-1.951***	-2.754***	-2.057***	-2.038***
	[0.291]	[0.464]	[0.424]	[0.452]
Constant	-1.847	-5.264	-0.911	2.100
	[3.467]	[6.357]	[5.324]	[4.475]
Observations	87,142	38,480	38,779	41,481
Number of bilateral pairs	9,071	4,140	4,033	4,201
R-squared within	0.002	0.004	0.002	0.003
R-squared between	0.028	0.004	0.029	0.019
R-squared overall	0.011	0.0001	0.011	0.006
F-stat [p-value]	0.0000	0.0000	0.0000	0.0000

GDP = gross domestic product

Notes: Robust standard errors in brackets

* p<0.1, ** p<0.05, *** p<0.01

Table 12: Trade Liberalization with Other Variables (Human Capital—Health and Primary Education)

	All Samples	Exporter Low Importer Middle and High	Exporter Middle Importer Low and High	Exporter High Importer Low and Middle
	(D1)	(D2)	(D3)	(D4)
	Bilateral trade balance, logs			
Health and primary education difference	-0.027	-0.034	-0.006	-0.040
	[0.054]	[0.078]	[0.083]	[0.069]
Health and primary education difference x Bilateral liberalization at 60% threshold	0.168	0.139	0.049	0.272
	[0.132]	[0.192]	[0.182]	[0.178]
Tariffs of country i, logs	0.838	2.737**	0.522	-0.554
	[0.545]	[1.192]	[0.604]	[1.140]
Tariffs of country j, logs	-0.581	-0.533	-0.604	-1.372
	[0.616]	[0.698]	[1.198]	[0.925]
Exporter resistance, logs	2.208***	3.123***	2.223***	2.015***
	[0.302]	[0.638]	[0.520]	[0.315]
Importer resistance, logs	-1.983***	-2.846***	-2.041***	-2.028***
	[0.290]	[0.464]	[0.424]	[0.449]
Constant	-1.872	-4.917	-1.118	1.758
	[3.466]	[6.295]	[5.325]	[4.460]
Observations	87,142	38,480	38,779	41,481
Number of bilateral pairs	9,071	4,140	4,033	4,201
R-squared within	0.002	0.003	0.002	0.003
R-squared between	0.028	0.004	0.029	0.020
R-squared overall	0.011	0.0001	0.011	0.006
F-stat [p-value]	0.0000	0.0000	0.0000	0.0000

Notes: Robust standard errors in brackets
* p<0.1, ** p<0.05, *** p<0.01

Table 13: Trade Liberalization with Other Variables (Human Capital—Higher Education and Training)

	All Samples	Exporter Low Importer Middle and High	Exporter Middle Importer Low and High	Exporter High Importer Low and Middle
	(E1)	(E2)	(E3)	(E4)
	Bilateral trade balance, logs			
Higher education and training difference	-0.020	-0.119	0.008	-0.052
	[0.053]	[0.088]	[0.080]	[0.063]
Higher education and training difference x Bilateral liberalization at 60% threshold	0.141*	0.123	0.128	0.158*
	[0.076]	[0.140]	[0.103]	[0.091]
Tariffs of country i, logs	0.828	2.703**	0.474	-0.592
	[0.544]	[1.192]	[0.603]	[1.138]
Tariffs of country j, logs	-0.561	-0.552	-0.575	-1.410
	[0.617]	[0.700]	[1.191]	[0.938]
Exporter resistance, logs	2.215***	3.092***	2.226***	1.992***
	[0.303]	[0.636]	[0.518]	[0.314]
Importer resistance, logs	-1.991***	-2.806***	-2.051***	-2.068***
	[0.291]	[0.465]	[0.422]	[0.450]
Constant	-1.861	-5.084	-1.058	2.322
	[3.467]	[6.312]	[5.285]	[4.477]
Observations	87,142	38,480	38,779	41,481
Number of bilateral pairs	9,071	4,140	4,033	4,201
R-squared within	0.002	0.003	0.002	0.003
R-squared between	0.027	0.005	0.028	0.021
R-squared overall	0.010	0.0003	0.011	0.006
F-stat [p-value]	0.0000	0.0000	0.0000	0.0000

Notes: Robust standard errors in brackets
* p<0.1, ** p<0.05, *** p<0.01

Appendix 3: Alternative Functional Form of Trade Cost

We present an alternative model of trade cost (with a hat) of the following functional form

Equation 10

$$\hat{T}_{ij}^{1-\sigma} = {d_{ij}}^{\delta} Z_{ij} {t_{ij}}^{1-\sigma} \left(\omega_i^{\alpha} \omega_j^{\beta}\right)^{1-\sigma}$$

In this alternative model, tariffs and infrastructure costs are log separable. This implies that the previous strategy of modelling the effects of liberalization through log differences of exports will not work. Nevertheless, there is still an empirical strategy to show the effects of infrastructure. Trade balance between two partners is given as $\theta_{ij} = X_{ij} - X_{ji}$

$$\theta_{ij} = \frac{Y_i Y_j}{Y_W} \left[\frac{\hat{T}_{ij}^{1-\sigma}}{\prod_i^{1-\sigma} P_j^{1-\sigma}} - \frac{\hat{T}_{ji}^{1-\sigma}}{\prod_j^{1-\sigma} P_i^{1-\sigma}}\right] = \frac{Y_i Y_j Z d^{\delta}}{Y_W} \left[\frac{{t_{ij}}^{1-\sigma}\left(\omega_i^{\alpha}\omega_j^{\beta}\right)^{1-\sigma}}{\prod_i^{1-\sigma} P_j^{1-\sigma}} - \frac{{t_{ji}}^{1-\sigma}\left(\omega_j^{\alpha}\omega_i^{\beta}\right)^{1-\sigma}}{\prod_j^{1-\sigma} P_i^{1-\sigma}}\right]$$

Again, note that Y_i, Y_j, Y_W, Z, d are symmetric—they affect the levels of exports, the scale but not direction of trade balance. The direction of trade balance is determined by terms within the square brackets, which include infrastructure use costs. Taking partial derivatives with respect to tariffs in home and destination economies respectively gives

$$\partial\theta_{ij} = \frac{Y_i Y_j Z d}{Y_W} (1-\sigma) \left[\frac{{t_{ij}}^{-\sigma}\left(\omega_i^{\alpha}\omega_j^{\beta}\right)^{1-\sigma}}{\prod_i^{1-\sigma} P_j^{1-\sigma}}\right] \partial t_{ij}$$

$$\partial\theta_{ij} = -\frac{Y_i Y_j Z d}{Y_W} (1-\sigma) \left[\frac{{t_{ji}}^{-\sigma}\left(\omega_j^{\alpha}\omega_i^{\beta}\right)^{1-\sigma}}{\prod_j^{1-\sigma} P_i^{1-\sigma}}\right] \partial t_{ji}$$

Summing up both of the above terms, and assuming the bilateral declines in tariffs are the same, the net impact of a symmetric reduction in tariffs would be

$$\frac{Y_i Y_j Z d}{Y_W} (1-\sigma) \left[\frac{{t_{ij}}^{-\sigma}\left(\omega_i^{\alpha}\omega_j^{\beta}\right)^{1-\sigma}}{\prod_i^{1-\sigma} P_j^{1-\sigma}} - \frac{{t_{ji}}^{-\sigma}\left(\omega_j^{\alpha}\omega_i^{\beta}\right)^{1-\sigma}}{\prod_j^{1-\sigma} P_i^{1-\sigma}}\right] \partial t$$

The directional impact on trade balance, arising from bilateral liberalization, will depend on the sign of the terms in the square brackets. If the home country has better infrastructure quality compared to the destination country, the term inside the square bracket tends toward positive, which implies an improved trade balance (given $\partial t < 0$), and vice versa. The results of this set of regressions with gross trade balance as the dependent variable, with three different levels of bilateral liberalization thresholds, are presented in Table 14.

Table 14: Alternative Model with Gross Trade Balance[14]

	50% threshold	60% threshold	70% threshold
	All Samples	All Samples	All Samples
	(F1)	(F2)	(F3)
	Bilateral trade balance		
Infrastructure quality difference	31,238**	30,883**	31,180**
	[13,807]	[13,747]	[13,695]
Infrastructure quality difference x Bilateral liberalization	36,738*	51,375*	52,546
	[22,176]	[31,096]	[34,739]
GDP per capita of country i	7.268**	7.230**	7.232**
	[3.629]	[3.636]	[3.638]
GDP per capita of country j	-3.826	-3.787	-3.806
	[5.182]	[5.182]	[5.182]
Population of country i	0.007	0.007	0.007
	[0.007]	[0.007]	[0.007]
Population of country j	-0.001	-0.001	-0.001
	[0.003]	[0.003]	[0.003]
World GDP	-0.000	-0.000	-0.000
	[0.000]	[0.000]	[0.000]
Tariffs of country i	144	138	146
	[239]	[240]	[238]
Tariffs of country j	-682	-674	-683
	[553]	[549]	[557]
Exporter resistance	231**	231**	231**
	[94.1]	[94.0]	[94.1]

[14] We also explored a model where, instead of GDP per capita and population, we included only GDP. The variable of interest, infrastructure quality difference, remains significant at the 10% level. The interaction term is significant only at the 15% level.

Importer resistance	-86.6	-86.6	-86.7
	[102]	[102]	[102]
Constant	-943,269	-943,460	-942,079
	[1013876]	[1013830]	[1014004]
Observations	86,436	86,436	86,436
Number of bilateral pairs	8,952	8,952	8,952
R-squared within	0.003	0.003	0.003
R-squared between	0.009	0.009	0.009
R-squared overall	0.010	0.010	0.010
F-stat [p-value]	0.0029	0.0027	0.0027

Robust standard errors in brackets
* p<0.1, ** p<0.05, *** p<0.01

The results show that, on average, a 1-point advantage in infrastructure PCA score is associated with an improved bilateral trade balance worth around USD31 million (using regression F2). Bilateral trade liberalization (threshold of liberalization being 60 percent) accentuates this 1-point advantage by a further USD51 million (though only weakly significant). A country with good infrastructure quality can thus see sizeable exporting advantage showing up aggregated over a number of trade partners.