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Bridging Bangladesh and India

Cross-Border Trade and the Motor Vehicles Agreement

Matías Herrera Dappe
Mathilde Lebrand
Diana Van Patten

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Abstract

This paper studies the effects of removing transport and trade barriers between Bangladesh and India on aggregate real income and the distribution of population and real income within both countries. The paper uses a spatial general equilibrium model calibrated to these two economies, along with road network travel time calculated using GPS data, to measure changes in economic outcomes given changes in trade costs across regions. The paper focuses on the Motor Vehicles Agreement between Bangladesh, Bhutan, India, and Nepal and full transport and trade integration between Bangladesh and India. The counterfactual exercises show that decreasing transport and trade barriers between Bangladesh and India can lead to up to a 7.6 percent increase in national real income for India and a 16.6 percent increase for Bangladesh.

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Bridging Bangladesh and India: Cross-Border Trade and the Motor Vehicles Agreement*

Matías Herrera Dappe† World Bank

Mathilde Lebrand‡ World Bank

Diana Van Patten§ Princeton University

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†mdappe@worldbank.org.

‡mlebrand@worldbank.org.

§vanpatten@princeton.edu.

1 Introduction

The Bangladesh-India border is the fifth-longest border in the world. It is so thick that it is more costly for Bangladesh and India to trade with each other than for either of them to trade with Germany. As a result of the thick border, bilateral trade represents only about 10 percent of Bangladesh's trade and 1 percent of India's trade. These figures compare poorly with East Asian and Sub-Saharan African economies, where intraregional trade accounts for 50 percent and 22 percent of total trade, respectively.

Lack of transport integration is an important contributor to the thickness of the border. Because trucks are not allowed to cross borders, cargo must be transloaded, adding to transport and trade costs. On average, crossing the border at Petrapole-Benapole, the most important border post between the two countries, takes 138 hours, including 28 hours spent transloading cargo. In contrast, the time to cross borders handling similar volumes of traffic in other regions of the world, including East Africa, is less than six hours.

Lack of transport integration between Bangladesh and India also means that Indian trucks are not allowed to transit through Bangladesh. As a result, India's northeast states are connected with the rest of India only through the Siliguri corridor, a 27-kilometer wide tract of land commonly known as the "chicken's neck." The transit restriction leads to long and costly routes between northeast India and the rest of India and the world. Goods from Agartala, for example, travel 1,600 kilometers through the Siliguri corridor to reach Kolkata Port instead of 450 kilometers through Bangladesh.

The Motor Vehicles Agreement (MVA) between Bangladesh, Bhutan, India, and Nepal (known as the BBIN countries), signed in 2015 but not yet implemented, seeks to facilitate the unrestricted cross-border movement of cargo, passenger, and personal vehicles between BBIN countries. Under the agreement, trucks carrying export-import or transit cargo can move inside the territories of other countries without transshipping to local trucks at border land ports.

This paper explores the aggregate and regional effects of changing current transport and trade barriers between Bangladesh and India on aggregate real income and on the distribution of population and real income across regions within both countries. It uses a spatial general equilibrium model calibrated to these two economies, along with road network travel time calculated using GPS data, to measure changes in economic outcomes given changes in trade costs across regions.

The paper examines three scenarios. The counterfactuals explore the potential benefits for two neighboring economies of relaxing transport and trade barriers, based on policies currently being considered. The analysis focuses on the aggregate impact of increasing market access and the extent to which it affects not only border regions but locations far away from the countries' borders.

The model developed allows for multiple regions (districts and states) that trade differentiated products while facing bilateral trade costs. As in Allen and Arkolakis (2014), the trade costs are proportional to the least-cost route connecting any pair of locations, given the countries' road networks. Workers who consume traded and nontraded goods are imperfectly mobile across regions. Along the lines of Krugman (1991), each region features free entry of firms, each with increasing returns, and thus positive agglomeration externalities.

The quantitative exercises are based on data on economic activity (employment and wages) across districts in Bangladesh and states in India, along with GIS data on the road network of each country. The GIS data allow changes in trade costs to be estimated more precisely than they could be using standard distance-based measures, given the heterogeneous conditions of roads in these countries. Using these data, we recover trade flows across locations and calibrate the rest of the parameters to different moments. We use standard values from the literature for the elasticities in the model.

By reducing transport and trade costs, the MVA would reduce the prices of final goods and intermediate inputs. These reductions would lead to increases in national real income of up to 7.6 percent in India and 16.6 percent in Bangladesh. Increasing the competitiveness of some states and districts more than others would increase economic activity in some areas, where firms would have to pay higher wages to attract enough workers to take advantage of the improved competitiveness and access to markets. The relocation of economic activity would lead to reductions in spatial wage inequality in India and a marginal increase in Bangladesh.

This paper is related to several strands of research. It contributes to the international trade literature on economic geography, including the work of Cosar and Fajgelbaum (2016), Allen and Arkolakis (2019), Redding (2016), Fajgelbaum and Schaal (2020), Caliendo et al. (2018), Fajgelbaum and Redding (2014). Much of this literature focuses on trade liberalization and the role of internal geography. In contrast, we explore the role of transport integration as a main factor in reducing the thickness of the border.

The paper also contributes to work on transport infrastructure and the spatial distribution of economic activity. A growing body of literature (including Redding and Turner (2015), Allen and Arkolakis (2019), Donaldson and Hornbeck (2016), Donaldson (2018), and Balboni (2019)) uses quantitative spatial models to evaluate the general equilibrium impacts of transport infrastructure investments. This paper highlights the role of transport integration for trade in both final and intermediate goods. Including trade in intermediate goods magnifies the gains from better integration.

The rest of the paper is structured as follows. Section 2 introduces our quantitative model, which incorporates a role for trade in both intermediate and final goods. Section 3 presents the data and the calibration. Section 4 describes the counterfactuals we assess. Section 5 presents the main results of the simulation. Section 6 shows how these results vary when assumptions about labor mobility and agglomeration externalities change. Section 7 summarizes the paper's main conclusions.

2 Model

This section presents a quantitative model that incorporates both trade in final and intermediate goods, which we apply to the economies of Bangladesh and India. The model allows for multiple regions in each country—districts in Bangladesh and states in India—that trade differentiated products while facing bilateral trade costs. Exporting regions are indexed by i and importing regions by n (where there are two subscripts, the first one refers to the importer). Table 2 in appendix A summarizes the notation for all the variables used in the paper.

Regions are connected by the road network, which can be used to ship goods subject to symmetric iceberg trade costs, such that $\tau_{ni} = \tau_{in} > 1$ units must be shipped from region i in order for one unit to arrive in region n (or vice versa). The model follows Allen and Arkolakis (2014) in having the trade costs proportional to the least-cost route connecting any pair of locations given the road networks of both countries. Trade costs depend on distance and the quality of infrastructure linking the two locations. In particular, we assume that τ_{ni} is a function of distance d:

$$\tau_{ni} = \phi_{ni} d^{\omega}$$

and calibrate ϕ_{ni} using data on speed on the road network.

Each region is endowed with an exogenous amount of effective land, H_n, which is used in productive activities or for housing, and a number of workers, where each worker has one unit of labor that is supplied inelastically with zero disutility. Workers are imperfectly mobile across regions. Regions also differ by their level of amenities, U_n, and productivity in the tradable sector. Amenities represent exogenous characteristics that are valued by individuals, such as good weather.

There are two types of agents in the economy, mobile workers and owners of immobile capital (land). Workers earn a wage w_n in location n; landowners in n receive the total returns to land in the region where they live, $R_n H_n$. The model is static; workers and capital owners therefore spend all income in the region in which they live.

2.1 Production

Final Good Each region produces a final good that can be either consumed, used as an intermediate input by other firms, or transferred to owners of private capital used in the production of traded goods who live in other countries, in the form of net exports to the rest of the world. The quantity of the final good produced in region n is:

$$Q_n = \left(\sum_i M_i q_{ni}^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}}, \tag{1}$$

where M_i is the number of firms in region i and q_{ni} is the quantity that each firm located in i sells to n. As the good Q_n is priced competitively, its price is:

$$P_n = \left(\sum_i M_i p_{ni}^{1-\sigma} \right)^{\frac{1}{1-\sigma}}, \tag{2}$$

where p_{ni} is the price set in region n by each firm from region i.

Tradable Goods Firms in region i produce differentiated tradable goods. To produce a variety, a firm must incur a fixed cost of F_i units of an intermediate bundle X_i and then produces output one-to-one from the bundle of intermediate inputs X_i.

The output q_i of each firm in region i is sold in all regions n subject to transport costs τ_{ni}, hence:

$$q_i = \sum_n \tau_{ni} q_{ni}. \tag{3}$$

Assuming that firms are monopolistically competitive, they set prices equal to:

$$p_{ni} = \tau_{ni} p_{ii}, \tag{4}$$

where p_{ii} is the domestic price equal to $p_{ii} = \frac{\sigma}{\sigma-1} p_i^X$ with p_i^X the cost of the bundle of factors and intermediate inputs used in production.

Constant markups and zero profits imply that all firms in i have the same size ensuring zero profits.

$$q_i = (\sigma - 1) F_i. \tag{5}$$

As a result, given total production X_i of the bundle of intermediate inputs used by firms, the number of firms consistent with free entry is pinned down. In particular, using the share of wages in local production from the relation (16) in appendix B, the number of firms in i is:

$$M_i = \frac{1}{\beta_L \sigma F_i} \frac{w_i L_i}{p_i^X}. \tag{6}$$

Intermediate Bundle The intermediate bundle X_i used by the M_i monopolistic firms is produced by local perfectly competitive firms using labor L_i, perfectly mobile private capital K_n, and tradable intermediate inputs I_n from domestic and foreign firms through the following Cobb-Douglas production function:

$$X_i = A_i (L_i) L_i^{\beta_L} K_i^{\beta_K} I_i^{1-\beta_L-\beta_K}. \tag{7}$$

The productivity shifter of each location A_i may be endogenous through an agglomeration externality,

$$A_i (L_i) = A_i^0 L_i^{\gamma}, \tag{8}$$

where γ is the aggregate total factor productivity (TFP) elasticity of the economy. The bundle of intermediate inputs is supplied under perfect competition, implying that the price of the bundle in region i equals the marginal cost:

$$p_i^X = \frac{w_i^{\beta_L} P_i^{1-\beta_L-\beta_K}}{Z_i (L_i)}, \tag{9}$$

where $Z_i (L_i)$ takes the form

$$Z_i \equiv Z_i^0 L_i^{\gamma}, \tag{10}$$

where $Z_i^0 \equiv \frac{A_i^0 G_i^X}{(r^X)^{\beta_K}}$ captures the fundamental component of productivity A_i^0 and the cost of private capital r^X.

2.2 Consumer Preferences

Workers are imperfectly mobile across locations within a country and choose the location that maximizes their utility. Their preferences are defined over consumption of final goods and residential land use. The utility of each individual worker l in region n is given by the product of a common component, v_n^W, from living and working in location n and an idiosyncratic shock, e_n^l, defining the preference of individual l to be in that location, $v_n = v_n^W e_n^l$.

The common component depends on amenities from location n, U_n and consumption of final goods (c_n^W) and housing (h_n^W):

$$v_n^W = U_n \left(c_n^W\right)^{\alpha_C^W} \left(h_n^W\right)^{1-\alpha_C^W}. \tag{11}$$

Optimizing consumers over $\left(c_n^W, h_n^W\right)$ subject to the budget constraint, $P_n c_n^W + R_n h_n^W = w_n$, with P_n, the aggregate price of the final good in location n, R_n, the land rent, and w_n the wage in location n yields

$$v_n^W = U_n \frac{w_n}{(P_n/\alpha_C^W)^{\alpha_C^W} \, (R_n/1-\alpha_C^W)^{1-\alpha_C^W}}.$$

Using equilibrium prices in housing market derived in (20) yields:

$$v_n^W = V_n \left(\frac{w_n}{P_n}\right)^{\alpha_C^W} L_n^{-\left(1-\alpha_C^W\right)}, \tag{12}$$

where $V_n = U_n \left(\alpha_C^W\right)^{\alpha_C^W} \left(\alpha_C^K H_n\right)^{1-\alpha_C^W}$.

The random component e_n^l is assumed to follow a Frechet distribution and be independent and identically distributed, $\Pr\left(e_n^l < x\right) = e^{-x^{-\varepsilon_W}}$. As a result, the fraction of workers that choose to live in region n is:

$$\frac{L_n}{L} = \left(\frac{v_n^W}{v^W}\right)^{\varepsilon_W}, \tag{13}$$

where v^W is the workers welfare in the country, set such that the national labor-market clears.

2.3 Landowners

Landowners have similar preferences to workers, although they may spend a different fraction of income on housing:

$$v_n^K = U_n \left(c_n^K\right)^{\alpha_C^K} \left(h_n^K\right)^{1-\alpha_C^K}, \tag{14}$$

with a budget constraint of $P_n c_n^K + R_n h_n^K = R_n$. Because we assume homothetic preferences, when we aggregate the model it does not matter how many landowners there are. We therefore assume that all landowners own one unit of land. After optimization, the aggregate utility of all landowners is:

$$v_n^K = U_n \frac{R_n}{P_n^{\alpha_C^K} R_n^{1-\alpha_C^K}}. \tag{15}$$

2.4 Equilibrium in Relative Changes

The equilibrium is defined in changes by comparing the counterfactuals with the baseline. The counterfactuals consider shocks to trade costs $\hat{\tau}_{ni}$, where $\hat{x}$ denotes the value of variable x in the counterfactual equilibrium relative to the initial equilibrium.[1] As shown in the appendix B, following standard steps as in Redding and Rossi-Hansberg (2017), the equilibrium in changes is defined for employment, price indexes and wages $\left\{\hat{L}_n, \hat{P}_n, \hat{w}_n\right\}$, and the welfare of workers $\hat{v}^W$ as a function of calibrated parameters and data.

Solving the system requires information on the parameters $\left\{\sigma, \gamma, \beta_L, \beta_K, \varepsilon_W, \alpha_C^W\right\}$ and data on import shares, export shares, and employment. Having computed $\left\{\hat{L}_n, \hat{P}_n, \hat{w}_n\right\}$ in the counterfactuals, we can then compute all the outcomes in each region.

3 Spatial Data and Calibration

The information needed to calibrate the model comes from traditional data sources, such as surveys and geo-coded information on the transport network. It includes state- and district-level data on transport costs, land size, labor force, and wages.

The labor force includes the working-age population (people 15 and older). All wages are monthly and expressed in dollars. Data on labor force and wages in India come from the 2011 Periodic Labor Force Survey; data on Bangladesh come from the 2010 Labor Force Survey.

[1] That is, $\hat{x} = \frac{x'}{x}$, where x' is the counterfactual value and x is the initial value of variable x.

Transport costs are measured as a function of the travel time to reach other regions from the most populated district (upazila) in each Indian state (Bangladeshi district). Travel time, calculated using GIS network techniques, is the shortest time given all possible routes in the primary and secondary road network. Travel times in Bangladesh are based on actual speeds collected from more than 200 intercity road segments across the country and random speed assignment to the remaining segments based on the distribution of speeds in nearby segments. Travel times in India come from Krishna and Leemput (2018), based on GPS data from Blackbuk, an Indian logistics company that provides an online marketplace platform for freight shipments.

The elasticity of substitution between traded varieties is assumed to be $\sigma = 5$, as in Head and Mayer (2014). For robustness, we also consider 4 and 6 as alternative values of this elasticity. The aggregate TFP elasticity, γ, is calibrated to 0.05, following Ciccone and Hall (1996). The Cobb-Douglas share of labor, β_L, is set to 0.39, and the share of private capital, β_K, to 0.49, using data from KLEMS for India, and to 0.46 and 0.26, respectively, for Bangladesh, using to data from the World Integrated Trade Solution database (WITS). The share of housing expenditure $1 - \alpha_C^W$ is set to 0.35 for Bangladesh and 0.44 for India, using the share of household consumption expenditures in total expenditures from UN data. Following Fajgelbaum et al. (2015), we set the calibrated shape parameter of the random component of utility, ε_W, at 1.5. For robustness, we considered other values for ε_W, to study how the results vary with workers' mobility.

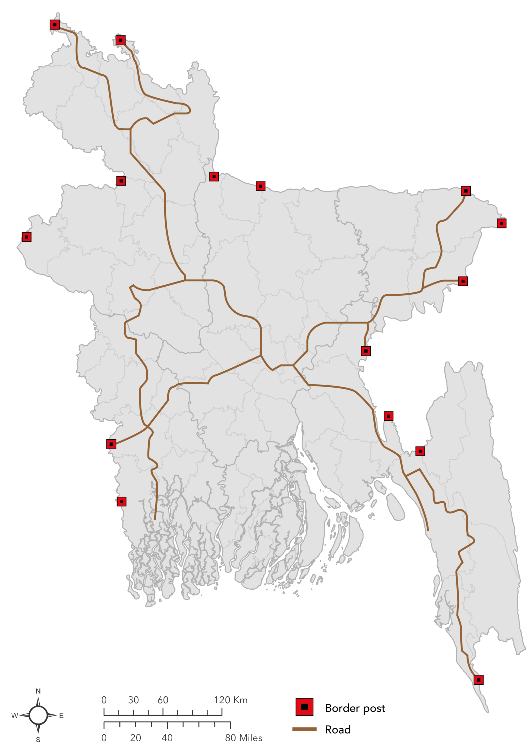
4 Counterfactual Scenarios

In the baseline, Indian trucks are not allowed to use Bangladeshi routes and must bypass Bangladesh through the Siliguri corridor to reach the northeast, and Bangladeshi trucks are not allowed in India. It takes an average 138 hours for cargo to cross the border between Bangladesh and India at Benapole-Petrapole, including 28 hours spent transloading cargo to and from Bangladeshi and Indian trucks.

Three scenarios were considered to assess the trade and welfare impacts of allowing Indian trucks to ply Bangladeshi roads and Bangladeshi trucks to ply Indian roads. In all of them, we assume that labor is mobile within countries and immobile across countries.

Inefficient MVA. The first scenario considers the opening of new corridors through Bangladesh for Indian trucks transporting cargo to and from northeast India and Indian exports to and imports from Bangladesh (Figure 1).[2] It also allows Bangladeshi trucks to enter India to deliver exports and pick up imports using the same corridors.

FIGURE 1: Land ports and road corridors in Bangladesh



This scenario assumes that transloading is no longer required, although it is an option (some shippers might still prefer to transload cargo), and that some other border frictions are removed, leading to a border crossing time of 55 hours at any of the six border posts. In the remaining border posts, cargo can cross the border, but it has to be transloaded; the total crossing time remains 138 hours, as in the baseline. Removing frictions at the border, including the need to transload cargo, reduces the transport costs for bilateral trade between some regions. The new transit routes reduce travel times and transport costs for freight moving between the northeast states and some other states in India, particularly states in the center and south of the country.

Efficient MVA. The second scenario is similar to the first, except that it assumes that additional frictions at the border are removed, so that Indian trucks transiting through Bangladesh do not need to stop at the border and trucks carrying bilateral trade spend only 10 hours at the border. If Indian trucks transiting through Bangladesh use electronic locks, as in the trial runs done so far, the border times would be similar to times at the most

[2] The selection of corridors and border posts is based on Road Transport and Highways Division (2016).

efficient border crossing points outside a customs union, which tend to be up to three hours. Given the cumbersome customs clearance process currently in place, this scenario assumes that not all frictions will be removed for bilateral trade and that the border crossing time would be slightly more than three times that in the most efficient border crossing points outside a customs union.

Full integration. The third scenario assumes complete integration of Bangladesh and India, with no restrictions on foreign truck movements. This scenario assumes that trucks do not need to stop at the border between Bangladesh and India and that trucks can use all border posts and roads in both countries. Transport costs in this scenario are the lowest of the three scenarios.

5 Simulation Results

5.1 Gains from the Motor Vehicles Agreement

This subsection presents the results of the model for both MVA scenarios. It starts with the aggregate results for each country and then discusses the spatial effects.

The opening of new transit routes for Indian trucks travelling to and from northeast India through Bangladesh and the removal of border frictions for bilateral trade would bring significant economic benefits to Bangladesh and India. Under the inefficient MVA scenario, income is estimated to increase by 3.4 percent in Bangladesh and 1.4 percent in India; under the efficient MVA scenario, income is estimated to increase by 11.3 percent in Bangladesh and 5.6 percent in India (Table 1). The MVA would lead to reductions in travel time and transport costs for freight, with their extent varying between the inefficient and efficient MVA scenarios, which explains the differences in income gains between the two scenarios. The reduction in transport times and costs reduces the prices of intermediate and final goods.

Table 1: Predicted percentage changes in income in Bangladesh and India as a result of the Motor Vehicles Agreement

Scenarios	Bangladesh	India
Inefficient MVA	3.5	1.4
Efficient MVA	11.3	5.6

Notes: The table shows the percentage change in worker's welfare at the country-level. We consider transit from India-Bangladesh only through the entry points outlined in the MVA.

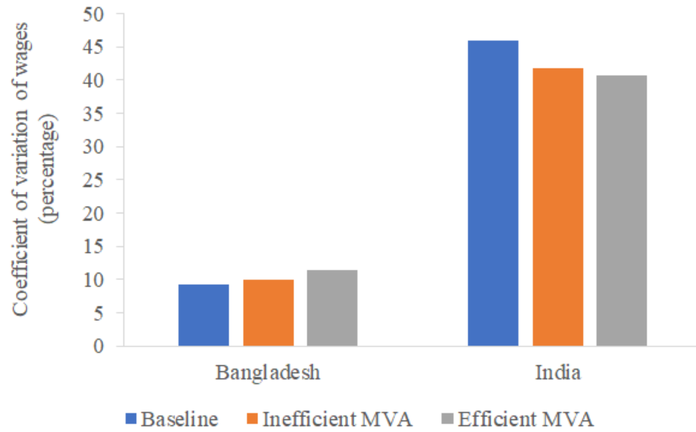
Lower prices of final goods increase the purchasing power of consumers, and cheaper input prices make producers more competitive. The locations experiencing the largest decreases in prices become more competitive, attracting more workers and increasing their economic activity. The reductions in prices, the relocation of economic activity, and potential increases in wages lead to the increase in aggregate income in Bangladesh and India.

The effects of regional integration differ between countries because of differences in the magnitude and nature of the economic shocks on Bangladesh and India. Bangladeshi districts benefit from improved access to Indian markets. Indian states experience both an improvement in access to Bangladeshi markets and a decrease in trade costs to reach other Indian markets, with the former more important than the latter.[3] The gains from regional integration are much larger for Bangladesh than for India, because Bangladeshi markets are relatively small for India and Indian markets are large for Bangladesh. Small countries tend to gain more from regional integration if they remain competitive enough to export to foreign markets.

Both new transit routes and improved connectivity for bilateral trade reduce spatial inequality across states in India and increase it across districts in Bangladesh. Improvement in the connectivity of northeast Indian states with the rest of India and the increase in competitiveness of the states close to Bangladesh leads to a relocation of economic activity across the country and therefore a reduction in wage dispersion across states (Figure 2). The MVA leads to a marginal increase in wage dispersion across Bangladeshi districts, because of the significant comparative advantage of Dhaka and Chattogram districts. The rest of this section discusses the spatial effects under the efficient MVA only; the spatial patterns under the inefficient MVA are the same, with only the magnitude of the impacts changing.

[3] A scenario with no border time for transit and a 55-hour border time for bilateral freight (that is, a scenario in between the inefficient and efficient MVA scenarios) increases income in India by 1.6 percent relative to the baseline. Even if all those gains are attributed to transit, which is unlikely, improved access to Bangladeshi markets accounts for 71 percent of the income gains under the efficient MVA scenario.

Figure 2: Spatial inequality in wages in Bangladesh and India



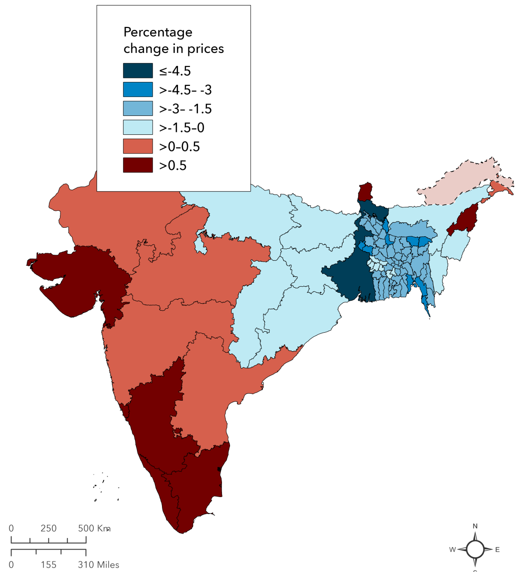
Notes: Spatial inequality is measured using the coefficient of variation (the ratio of the standard deviation to the mean).

By lowering transport and trade costs to and from the northeast Indian states and Bangladesh, the MVA increases the competitiveness of some states in India more than others. The decrease in transport and trade costs leads to reductions in the prices of goods and inputs consumed in the states, with the states closer to Bangladesh seeing the largest reductions in percentage terms; as the distance from Bangladesh increases, the reductions become smaller. The decrease in transport and trade costs also leads to increases in the price net of transport costs that firms receive for their exports (to Bangladesh and other states), which together with the lower costs of inputs leads to an increase in the competitiveness of those states.

The increase in the competitiveness of some states leads to increases in wages there, as firms in more competitive states pay more to attract workers. The increases in wages and decreases in prices across states lead to the relocation of workers and economic activity toward those states. Higher wages and the inflow of workers leads to an increase in demand for final goods and inputs in those states and therefore increases in prices. The increase in wages leads to increases in the cost and therefore price of inputs exported to other states and Bangladesh, which then leads to increases in production costs and therefore the prices of final goods and inputs in other states.

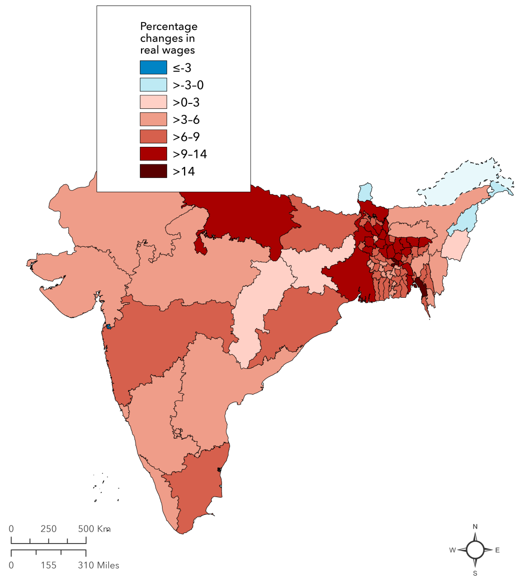
As a result of all these forces, prices decrease in the states closer to Bangladesh and increase slightly in more distant states (Figure 3). States close to Bangladesh, such as West Bengal, Odisha, Mizoram, Tripura, Meghalaya, and Assam, experience relatively large reductions in prices, because the direct effect of the reduction in transport and trade costs dominates the effect of higher demand and production costs on prices. Prices increase slightly in more distant states because the latter effect dominates.

Figure 3: Predicted percentage changes in prices in Bangladesh and India as a result of efficient Motor Vehicles Agreement



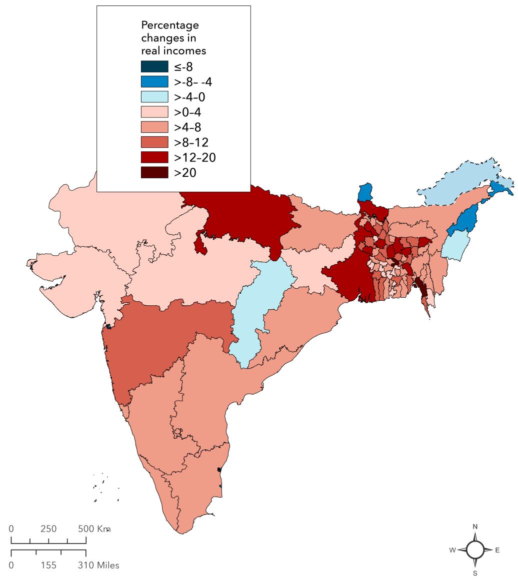
The changes in wages and prices triggered by the MVA lead to improved standards of living in almost all Indian states. Real wages increase by as much as 11 percent in most states, with a median change of 4.5 percent. Some states in the northwest and the more eastern states, such as Arunachal Pradesh and Nagaland, experience small reductions in real wages (Figure 4). West Bengal, which borders Bangladesh in the west, experiences the largest increase in real wages. In the northeast, Assam, Mizoram, and Tripura are among the top third of states in terms of real wage increases.

Figure 4: Predicted percentage changes in real wages in Bangladesh and India as a result of efficient Motor Vehicles Agreement



The overall benefit from the opening of new transit routes for Indian trucks and improved connectivity for bilateral trade is spread across the country. The changes in real wages and the relocation of people and economic activities across states lead to changes in real income (Figure 5). The states expected to see the largest increases in real income are to the west of Bangladesh, such as West Bengal, Uttar Pradesh, and Maharashtra. West Bengal benefits from its prime location. Uttar Pradesh also benefits from its proximity to Bangladesh but particularly from its large labor force and low wages. Maharashtra, the main industrial state in India, leverages its comparative advantage to enjoy significant benefits from better trade opportunities with the northeast (because of shorter routes) and Bangladesh.

Figure 5: Predicted percentage changes in real income in Bangladesh and India as a result of efficient Motor Vehicles Agreement



In northeast India, the overall benefits from integration are largest in Assam, Meghalaya, Mizoram, and Tripura. These states are among the top 11 in terms of real income gains. Assam, the largest economy in the northeast, leverages its comparative advantage to benefit from integration. Meghalaya, Mizoram, and Tripura take advantage of their location to benefit from integration. All these states attract workers and economic activity from other states, particularly from their eastern neighbors. The isolation of the northeast is a curse, but it also isolates the northeast states from competition from other Indian states and Bangladesh. After implementation of the MVA, Arunachal Pradesh, Nagaland, and Manipur, the easternmost states, lose that advantage, leading to losses in real wages, economic activity, and real income (Figure 5).

As a result of the reductions in transport and trade costs to India, all districts in Bangladesh benefit in the efficient MVA scenario. All Bangladeshi districts experience reductions in the prices of final goods and intermediate inputs (see Figure 3), which make them more competitive. Integration with India improves access to Indian markets for Bangladeshi exports and to cheaper imports from India. Access to cheaper inputs from India and higher prices (net of transport costs) for their exports increase profit margins for producers, who can then offer higher wages to attract workers; they also boost economic activities.

Increased trade opportunities lead to higher standards of living and economic activity across the entire country. Districts on the southeast-northwest axis, particularly Dhaka and Chattogram, enjoy the largest gains in real wages, where real wages increase by as much as 24 percent (see Figure 4). These districts benefit most because of their comparative advantage, which leads workers in the southwest and southeast to migrate to Dhaka, Chattogram, and other districts on the southeast-northwest axis, further concentrating employment and economic activity. Real income increases by as much as 40 percent in Dhaka and 28 percent in Chattogram, with a median increase of 8 percent (see Figure 5).

5.2 Gains from Full Integration

Removing all border frictions to the movement of trucks between Bangladesh and India would reduce trade costs between Bangladesh and India further and yield greater benefits to both countries. Full transport integration between both countries would allow Indian trucks to transit through Bangladesh and to deliver exports and pick up imports anywhere in Bangladesh and Bangladeshi trucks to deliver exports and pick up imports anywhere in India using any border post. India's national real income would increase 7.6 percent over the baseline case-43 percent more than in the efficient MVA scenario. National real income in Bangladesh would rise by 16.6 percent-47 percent higher than in the efficient MVA scenario. The additional gains would be driven by the fact that trucks transporting bilateral trade would not need to stop at the border and would be able to use any road and border post allowing them to use the lowest-cost routes.

Further reduction in transport costs under full integration intensifies the spatial patterns observed under the efficient MVA scenario, particularly in Bangladesh. In all districts in Bangladesh, the percentage gains in real income is greater under full integration than under the MVA (Figures 6 and 7). The districts along the northwest-southeast axis and those in the northeast enjoy larger gains in real incomes, because of further improvements in their competitiveness and the relocation of workers from the southwest and southeast (except Chattogram) to the rest of the country. Under both full integration and the MVA, Dhaka district enjoys the largest gains in real income, followed by Chattogram district. Under the efficient MVA, real income gains are 67 percent of the gains under full integration in Dhaka and 59 percent in Chattogram. In India, all states that enjoy gains in real income under the efficient MVA also gain under full integration, and they tend to gain more (Figures 6 and 7). For example, gains in real income in West Bengal and Meghalaya under full integration are about two-thirds larger than under the efficient MVA; in Assam, Mizoram, Nagaland, and Tripura they are 22-43 percent larger.

FIGURE 6: Predicted percentage changes in real income in Bangladesh and India under full regional integration

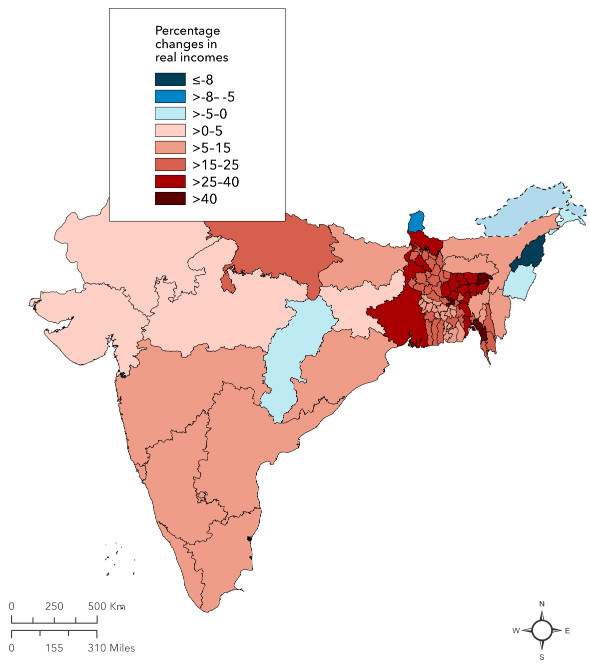
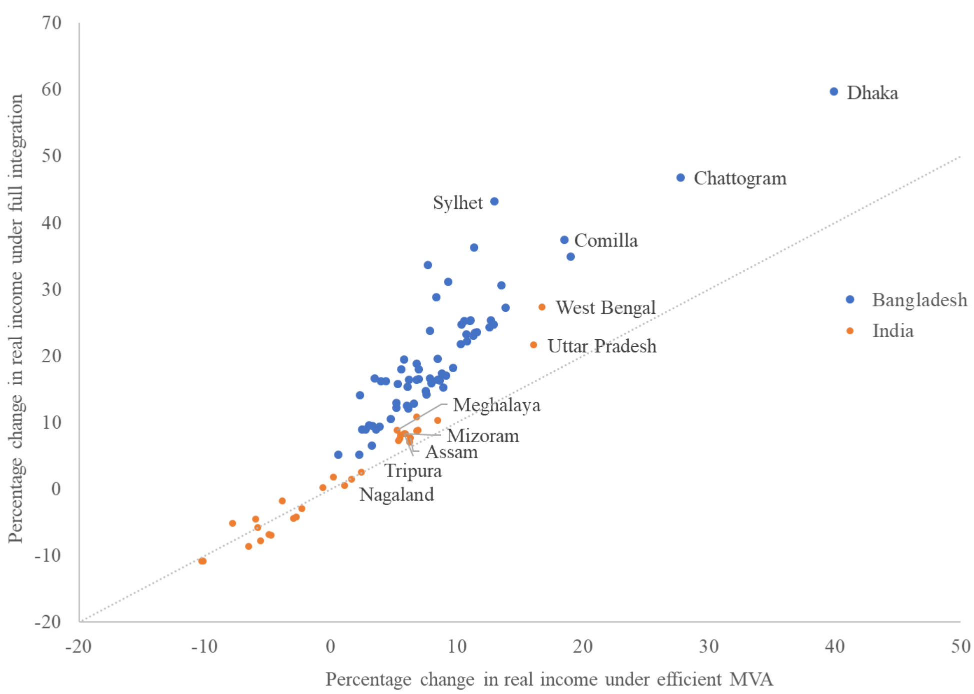
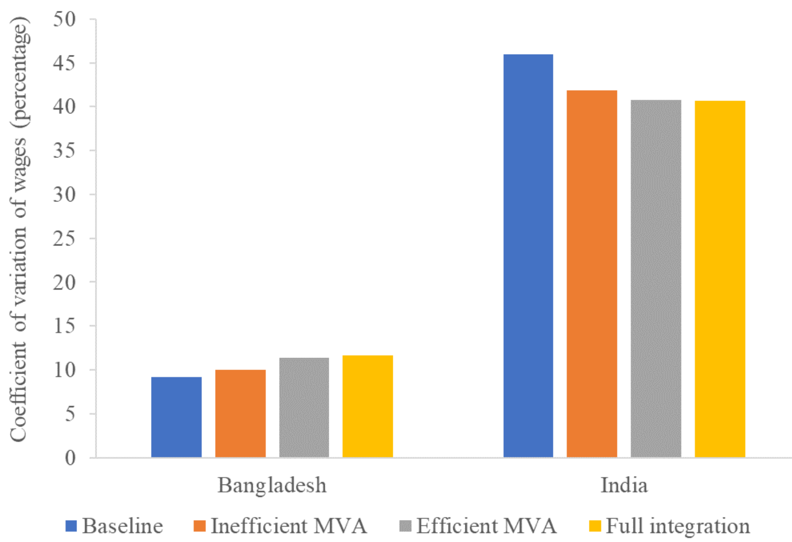


FIGURE 7: Correlation between real income gains in Bangladesh and India under full integration and efficient MVA, by district and state



Full integration leads to larger increases in economic activity across both countries, with a higher concentration of economic activity in the leading districts in Bangladesh. The changes in economic activity are driven partly by internal migration in response to changes in wages across districts and states. In both countries, wage dispersion under full integration is almost the same as under the efficient MVA scenario (Figure 8), which means spatial inequality under full regional integration marginally increases in Bangladesh and decreases in India compared with the baseline.

FIGURE 8: Spatial inequality in wages in Bangladesh and India



Notes: Spatial inequality is measured using the coefficient of variation (the ratio of the standard deviation to the mean).

6 Robustness

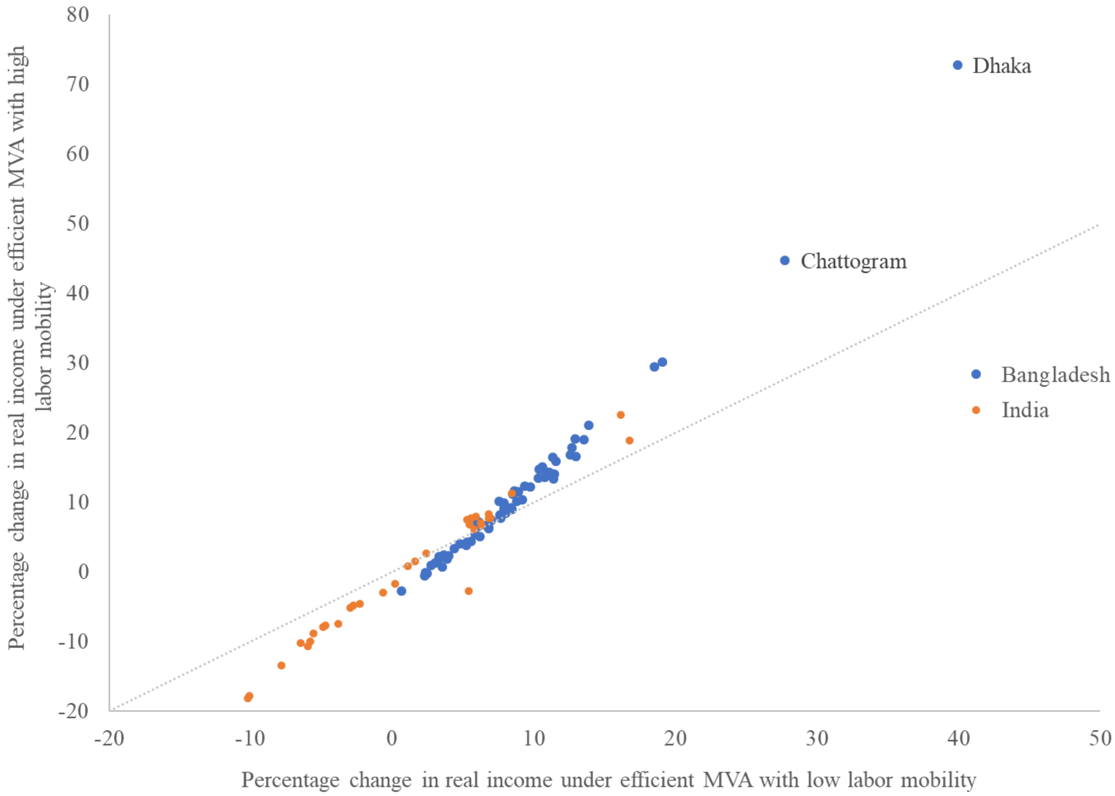
6.1 Labor Mobility

The gains from regional integration depend on workers being able to relocate within their countries; barriers to domestic mobility can prevent these gains from being realized. Housing prices that are too high can deter workers from moving. Regulations or informal labor market barriers can limit the ability of migrating workers to quickly find jobs and be integrated in a new location. Lack of good education and health services-and a low level of overall livability-can also create barriers to domestic mobility. In addition to reducing national income, high barriers can increase inequality if workers are forced to remain in poorer areas that do not benefit from increase in competitiveness through better connectivity and trade opportunities.

The findings presented so far were estimated assuming low labor mobility in Bangladesh and India. Historically, the United States has been a country with high labor mobility, although it fell markedly between 1850 and 2000, from 8.5 to 4.5 (Allen and Donaldson, 2018). The migration elasticities estimated by Allen and Donaldson are much higher than the 1.5 migration elasticity we used to calibrate our model, which better represents the level of labor mobility in Bangladesh and India.

Complementary policies that increase labor mobility in Bangladesh and India would increase the aggregate gains from regional integration. The efficient MVA scenario was simulated assuming a migration elasticity of 4.5, the same as in the United States in 2000. Using this elasticity, national real income would increase 6.2 percent relative to the baseline in India (11 percent more than in the efficient MVA scenario with low labor mobility) and 14.5 percent in Bangladesh (28 percent more). Higher labor mobility also increases the spatial impacts (Figure 9). Regions that enjoy the largest gains (losses) in real income with low labor mobility enjoy even larger gains (losses) with higher labor mobility. For example, Bangladeshi districts such as Dhaka and Chattogram and Indian states such as West Bengal enjoy larger gains in real income.

Figure 9: Predicted percentage changes in real income under efficient MVA with low and high labor mobility



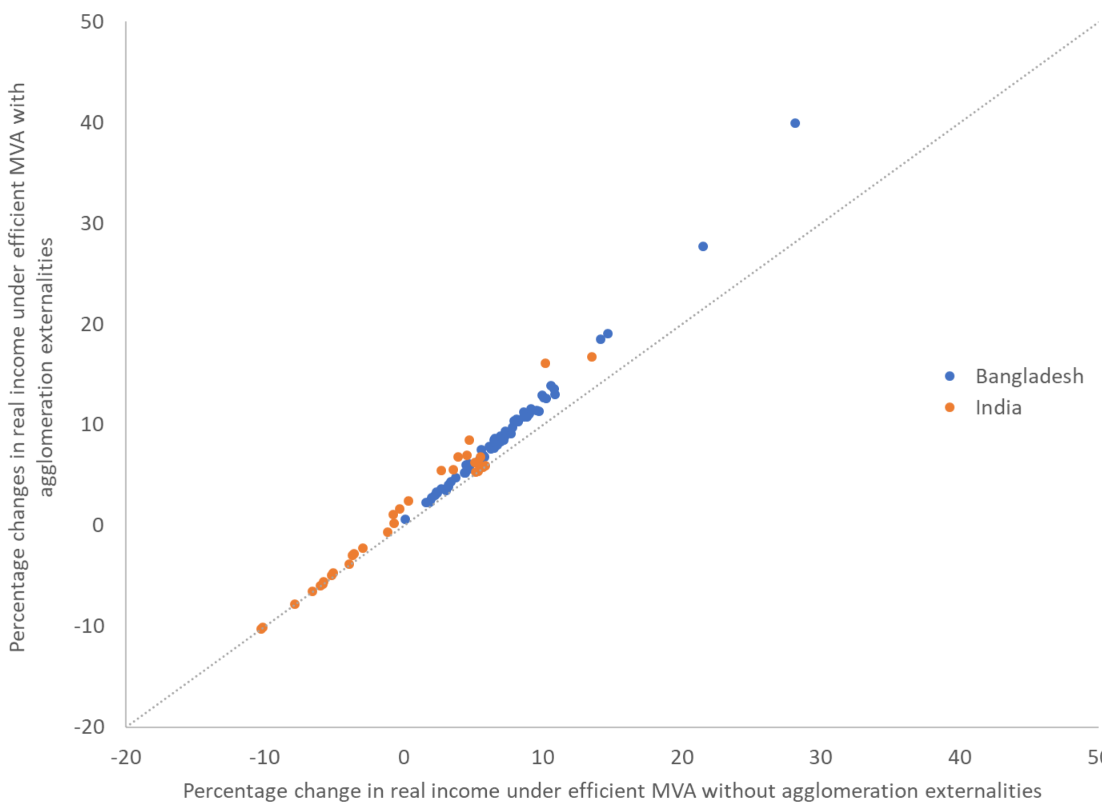
The gains under the efficient MVA with higher labor mobility are smaller than the gains under full integration and low labor mobility, highlighting the significant potential of full integration. If trucks are allowed to cross the border at certain border posts and most border frictions are removed, going the extra mile by allowing trucks to use any border post and removing all border frictions should be easier to implement than an array of policies to increase labor mobility. It should also deliver greater benefits.

6.2 Agglomeration Externality

We used Indian states (29) rather than districts (593) as the unit of analysis to avoid a dimensionality problem. To analyze the impact of the difference in size between Bangladeshi and Indian regions, we present the results of the efficient MVA counterfactual under the assumption that γ=0 in the model, meaning there is no agglomeration externality.

Figure 10 presents the changes in real income under the efficient MVA scenario with and without agglomeration externalities. It shows minor differences between these results and the results presented in Section 5.2. The effects come not from the difference in sizes between Indian states and Bangladeshi districts but from the decrease in productivity resulting from a lower γ. In our model in changes, outlined in appendix B, the only variable in levels coming from the data is the population share L_i/L in Equation (36), included to ensure that the size of the total population does not change. As these shares are consistent within countries, and the population changes in each country must sum to 1, the results in this section are very close to those in Section 5.2.

FIGURE 10: Predicted percentage changes in real income in Bangladesh and India under efficient MVA with and without agglomeration externality



7 Conclusion

The Motor Vehicles Agreement would reduce the cost of transport and trade between Bangladesh and India. By reducing the prices of final goods and intermediate inputs, it would increase income in both countries. By increasing the competitiveness of some states and districts more than others, it would increase economic activity in some areas, where firms would have to pay higher wages to attract enough workers to take advantage of their improved competitiveness and access to markets. The relocation of economic activity would lead to reductions in spatial wage inequality in India and a marginal increase in Bangladesh.

An important limitation of the analysis is that the elasticities used to calibrate the model are standard values from the empirical literature that estimates these coefficients for other countries. Some researchers (such as Baum-Snow et al. (2020)) prefer an approach based on reduced-form modeling, which first estimates a reduced-form relationship and then uses that relationship to conduct simulations. An empirical strategy would not be useful in predicting the impact of transport integration between Bangladesh and India, because no similar event has happened in the past. Once Bangladesh and India integrate and the benefits of integration are realized, an ex post empirical analysis could shed light on the mechanisms at play.

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Appendix A. Notation

Table 2: Notation

Notation	Variable
A_n	Productivity of the traded sector in location n
F_n	Entry cost in location n
U_n	Fundamental amenities in location n
H_n	Housing in location n
X_n	Non-traded bundle in location n
L_n	Labor in location n
K_n	Private capital in location n
Q_n	Final good in location n
q_{ni}	Quantity exported by each firm from i to n
q_n	Quantity produced by each firm in n
α_C^K	Consumption share in capital owner's utility
α_C^W	Consumption share in workers' utility
β_K	Share of private capital
β_L	Share of labor
C_n	Consumption in location n
I_n	Intermediate input in location n
λ_{ni}	Share of imports from i to n
s_{ni}	Share of exports from i to n
τ_{ni}	Trade cost from $i$to n
R_n	Price of housing in location n
p_n^X	Price of non-traded bundle in n
w_n	Wage in location n
r^X	Cost of private capital
P_n	Price of final good in location n
p_{ni}	Price of exports from i to n
M_n	Number of firms in location n
ε_W	Shape parameter of utility's random component
γ	Aggregate TFP elasticity
σ	Elasticity of substitution
v^W	Utility of workers
v_n^K	Utility of capital owners in n

Appendix B. System of Equilibrium in Relative Changes

Additional Derivations

Factor Demands From the optimization of producers of X_n, aggregate demand for each factor in n is:

$$w_n L_n = \beta_L p_n^X X_n, \tag{16}$$

$$r^X K_n = \beta_K p_n^X X_n, \tag{17}$$

$$P_n I_n = (1 - \beta_L - \beta_K)\, p_n^X X_n. \tag{18}$$

For future use, it is convenient to express intermediate expenditures as function of the wage:

$$P_n I_n = \left(\frac{1 - \beta_L - \beta_K}{\beta_L}\right) w_n L_n. \tag{19}$$

Housing Market Clearing From the aggregation of workers and landowners, the condition that supply equal demand of housing is:

$$R_n H_n = \left(1 - \alpha_C^W\right)(w_n L_n) + \left(1 - \alpha_C^K\right)(R_n H_n),$$

implying a rent-to-wage ratio of:

$$\frac{R_n}{w_n} = \left(\frac{1 - \alpha_C^W}{\alpha_C^K}\right)\left(\frac{L_n}{H_n}\right). \tag{20}$$

Aggregate Goods Demand From the aggregation of workers and landowners, total demand for traded commodities is $P_n C_n = \alpha_C^W (w_n L_n) + \alpha_C^K (R_n H_n)$. Using (20), we find that aggregate expenditures in final consumer goods equals wage income:

$$P_n C_n = w_n L_n. \tag{21}$$

As a result, the fact that $Q_n = C_n + I_n + NX_n$ together with (19) and (21), allows us to express the aggregate expenditures in tradable goods as:

$$P_n Q_n = \frac{1 - \beta_K}{\beta_L} w_n L_n + P_n NX_n. \tag{22}$$

We assume that $r^X K_n$, the income of owners of capital used in n, is spent entirely on goods produced in n. Then, using (16) and (17), $P_n N X_n = \frac{\beta_K}{\beta_L} w_n L_n$. Combining it with (22) yields:

$$P_n Q_n = \frac{1}{\beta_L} w_n L_n. \tag{23}$$

Import Shares Total exports from i to n are:

$$M_i p_{ni} q_{ni} = (P_n Q_n)\, \lambda_{ni}, \tag{24}$$

where λ_{ni} is defined as the share of n's expenditures going to i:

$$\begin{aligned} \lambda_{ni} &= M_i \left(\frac{p_{ni}}{P_n}\right)^{1-\sigma}, \\ &= Z_{ni} w_i^{1-\sigma\beta_L} L_i^{1+\gamma\sigma} \frac{P_n^{\sigma-1}}{P_i^{\sigma(1-\beta_L-\beta_K)}}, \end{aligned} \tag{25}$$

where

$$Z_{ni} \equiv \frac{(Z_i^0)^\sigma}{\beta_L \sigma F_i} \left(\frac{\sigma}{\sigma-1}\tau_{ni}\right)^{1-\sigma}, \tag{26}$$

where the first condition follows from optimization of producers of Q_n and the second follows from using the expression determining the number of firms in i (6), the pricing equations (4) and (2.1), and the cost of the intermediate bundle (9).

Export Shares Using goods market clearing and bilateral pricing decisions, total sales of tradable products are $M_i p_i q_i$:

$$M_i p_i q_i = \sum_n M_i p_{ni} q_{ni}.$$

Using (24),

$$M_i p_i q_i = \sum_n \lambda_{ni} (P_n Q_n).$$

Using the pricing equation $p_{ii} = \frac{\sigma}{\sigma-1} p_i^X$, and the free-entry conditions (5) and (6), the value of total sales is:

$$M_i p_i q_i = \frac{w_i L_i}{\beta_L}. \tag{27}$$

Therefore, using (24) and (27), the share of exports from i that go to n is:

$$s_{ni} = \frac{w_n L_n}{w_i L_i} \lambda_{ni}. \tag{28}$$

System in Relative Changes

Main System Suppose we have shocks $\{\hat{Z}_{ni}, \hat{V}_n,$ and $\hat{L}_n\}$ to the system of equilibrium equations in levels. These shocks capture shocks to all the fundamentals. In particular:

$$\hat{Z}_{ni} = \left(\hat{A}_i^0 \left(\hat{r}^X\right)^{-\beta_K}\right)^{\sigma} \frac{\hat{\tau}_{ni}^{1-\sigma}}{\hat{F}_i}, \tag{29}$$

$$\hat{V}_n = \hat{U}_n \hat{H}_n^{1-\alpha_C^W}. \tag{30}$$

Then, in changes, the system of equilibrium conditions is given by:

$$1 = \sum_i \lambda_{ni} \hat{\lambda}_{ni} \text{ for all } n, \tag{31}$$

$$1 = \sum_n s_{ni} \hat{s}_{ni} \text{ for all } i. \tag{32}$$

Using (25) and (28), the changes in import and export shares are

$$\hat{\lambda}_{ni} = \hat{Z}_{ni} \hat{w}_i^{1-\sigma\beta_L} \hat{L}_i^{1+\gamma\sigma} \frac{\hat{P}_n^{\sigma-1}}{\hat{P}_i^{\sigma(1-\beta_L-\beta_K)}}, \tag{33}$$

$$\hat{s}_{ni} = \frac{\hat{w}_n \hat{L}_n}{\hat{w}_i \hat{L}_i} \hat{\lambda}_{ni}. \tag{34}$$

Using (13), the change in the employment share is:

$$\hat{L}_n = \left(\frac{\hat{V}_n}{\hat{v}^W} \left(\frac{\hat{w}_n}{\hat{P}_n}\right)^{\alpha_C^W}\right)^{\frac{\varepsilon_W}{1+\varepsilon_W\left(1-\alpha_C^W\right)}} \hat{L}^{\frac{1}{1+\varepsilon_W\left(1-\alpha_C^W\right)}}. \tag{35}$$

where $\hat{v}^W$ is pinned down by labor market clearing, which must clear independently for each country, because we assume no international migration. Modifying the notation slightly for clarity yields:

$$\hat{L}_{Ban} = \sum_{i \in Ban} \frac{L_i}{L} \hat{L}_i \qquad \hat{L}_{Ind} = \sum_{i \in Ind} \frac{L_i}{L} \hat{L}_i. \tag{36}$$

Replacing the import and export shares in the market-clearing condition, we end up with a system in 3N+1 equations ((31), (32), (35) and (36)) in equal number of unknowns, $\left\{\hat{L}_n, \hat{P}_n, \hat{w}_n, \hat{v}^W\right\}$.

More Compact System From (35) we have:

$$\hat{P}_n = \hat{w}_n \left(\frac{\hat{L}_n^{\frac{1}{\varepsilon_W}+\left(1-\alpha_C^W\right)}}{\hat{L}^{\frac{1}{\varepsilon_W}}} \frac{\hat{v}^W}{\hat{V}_n} \right)^{-\frac{1}{\alpha_C^W}}. \tag{37}$$

Replacing into (33) yields:

$$\hat{\lambda}_{ni} = \hat{A}_{ni} \hat{w}_i^{1-\kappa_1} \hat{L}_i^{1-\kappa_2} \hat{w}_n^{\sigma-1} \hat{L}_n^{-\kappa_3} \left(\frac{\hat{v}^W}{\hat{L}^{\frac{1}{\varepsilon_W}}} \right)^{\frac{1-\sigma(\beta_L+\beta_K)}{\alpha_C^W}}, \tag{38}$$

where

$$\kappa_1 = \sigma \left(1 - \beta_K\right), \tag{39}$$

$$\kappa_2 = -\sigma \left[\gamma + \frac{1 - \beta_L - \beta_K}{\alpha_C} \left(\frac{1}{\varepsilon_W} + 1 - \alpha_C^W \right) \right], \tag{40}$$

$$\kappa_3 = \frac{\sigma - 1}{\alpha_C} \left(\frac{1}{\varepsilon_W} + 1 - \alpha_C^W \right). \tag{41}$$

The shock is summarized by:

$$\hat{A_{ni}} \equiv \hat{Z_{ni}} \frac{\hat{V_n}^{\frac{\sigma-1}{\alpha_C^W}}}{\hat{V_i}^{\frac{\sigma(1-\beta_L-\beta_K)}{\alpha_C^W}}}. \tag{42}$$

Combining (34) and (38) with (31) and (32) and letting

$$\hat{V^W} \equiv \left(\frac{\hat{v^W}}{\hat{L}^{\frac{1}{\varepsilon_W}}} \right)^{\frac{1-\sigma(\beta_L+\beta_K)}{\alpha_C^W}}, \tag{43}$$

we can write the equilibrium in changes as a system for $\left\{ \hat{L}_i, \hat{w}_i, \hat{V}^W \right\}$ such that:

$$\hat{w}_n^{1-\sigma} \hat{L}_n^{\kappa_3} = \hat{V}^W \sum_i \lambda_{ni} \hat{A}_{ni} \hat{w}_i^{1-\kappa_1} \hat{L}_i^{1-\kappa_2} \text{ for all } n, \tag{44}$$

$$\hat{w}_i^{\kappa_1} \hat{L}_i^{\kappa_2} = \hat{V}^W \sum_n s_{ni} \hat{A}_{ni} \hat{w}_n^{\sigma} \hat{L}_n^{1-\kappa_3} \text{ for all } i, \tag{45}$$

and (36) hold. Note that we care about welfare $\hat{v}^W$ but solve for the transformed variable $\hat{V}^W$ defined in (43).

Equilibrium Uniqueness

We map the conditions of the model to Allen et al. (2020). In our case,

$$X_{ni} = \left(\frac{1}{\beta_L} w_n L_n\right) Z_{ni} w_i^{1-\sigma\beta_L} L_i^{1+\gamma\sigma} \frac{P_n^{\sigma-1}}{P_i^{\sigma(1-\beta_L-\beta_K)}}. \tag{46}$$

Using (12) and (13), we can write bilateral trade flows as:

$$X_{ni} = K_{ni}\gamma_i\delta_n, \tag{47}$$

where

$$K_{ni} = \frac{L^{\frac{\sigma(\beta_L+\beta_K)-1}{\varepsilon_W \alpha_C}}}{\beta_L} Z_{ni} V_n^{\frac{\sigma-1}{\alpha_C}} V_i^{-\frac{\sigma(1-\beta_L-\beta_K)}{\alpha_C}}, \tag{48}$$

$$\gamma_i = w_i^{1-\kappa_1} L_i^{1-\kappa_2}, \tag{49}$$

$$\delta_n = \left(v^W\right)^{-\frac{\sigma(\beta_L+\beta_K)-1}{\alpha_C}} w_n^{\sigma} L_n^{1-\kappa_3}. \tag{50}$$

Conditions 1–3 from Allen et al. (2020) are therefore satisfied. In addition, using (27), total sales are:

$$\sum_n X_{ni} = \frac{w_i L_i}{\beta_L}.$$

Combining (49) and (50) yields:

$$\sum_n X_{ni} \propto \gamma_i^{\frac{\sigma-(1-\kappa_3)}{\sigma(1-\kappa_2)-(1-\kappa_3)(1-\kappa_1)}} \delta_i^{\frac{\kappa_1-\kappa_2}{\sigma(1-\kappa_2)-(1-\kappa_3)(1-\kappa_1)}}.$$

As a result, applying Corollary 2, there is a unique solution to equilibrium system of equations if

$$\frac{\sigma-(1-\kappa_3)}{\sigma(1-\kappa_2)-(1-\kappa_3)(1-\kappa_1)} > 1, \tag{51}$$

$$\frac{\kappa_1-\kappa_2}{\sigma(1-\kappa_2)-(1-\kappa_3)(1-\kappa_1)} > 1. \tag{52}$$

Both of these conditions are satisfied in our benchmark parametrization.

Appendix C. Construction of Travel Times in the Baseline and Counterfactual Scenarios

To construct the origin–destination matrix containing the shortest route between any two regions in our data, we used official GIS data on the primary and secondary road networks in Bangladesh and India. Along with the road network, we have data on speed at the road level in Bangladesh and average speed of trucks at the district level in India. Using the speeds and distances, we can compute the time to travel on each segment of the network, which allows us to compute the trade cost as a function of this weighted distance in our model.

For Bangladesh, speed data were collected for the analysis in Herrera Dappe et al. (2020). Probe vehicles were instrumented with GPS devices, which traveled along more than 200 inter-city roads at peak-hour and free-flow conditions. The GPS data collected were processed to estimate the space-mean speed of the vehicles, which is estimated as the average speed of vehicles traveling on a given segment of road. The links not covered by the GPS data were assumed to have a similar distribution as the speeds in the district. Links that are not covered in the GPS data were assigned speeds equal to a random number, uniformly distributed between the minimum and maximum speeds in the district. For India, the speed data come from Krishna and Leemput (2018), based on GPS data from Blackbuk, an Indian logistics company that provides an online marketplace platform for freight shipments.

To compute changes in traveled time, we first found the shortest route connecting any two regions (Indian states and Bangladeshi districts) in the baseline scenario. For Indian states, we used the most populated district in each state as the origin/destination in the state. For Bangladesh, we used the most populated upazila in each district as the origin/destination in the district. We created an Origin-Destination matrix of the travel time between regions, given the optimal routes on the road network between any two points. We then recomputed the matrix under each scenario in which shorter routes through Bangladesh were added and lower border waiting times are assumed. Note that to obtain the relative changes in trade cost, $\hat{\tau_{ni}} = \frac{\tau'_{ni}}{\tau_{ni}}$, we can simply take the ratio between elements of the new matrix and the initial one.

Figure 11 indicates the shortest route between two points in India through the Indian road network (in blue), and through the connected Bangladesh–India road network (in red) which is shorter.

Figure 11: Shortest route between two points when Bangladeshi and Indian roads are connected and not connected