Chapter 2 Analysis of Route and Mode Transport Choice in Eastern South Asia Following Integration Agreements

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Trade plays a central role in the economic development of countries, because accessing regional and global markets provides a broader market base for domestic natural resources and manufactured goods. Trade also benefits consumers, by offering them more affordable goods and services. Trade can be particularly beneficial for developing countries, which can use their lower-cost labor to establish labor-intensive export-focused manufacturing. The ready-made garment and textile sector in Bangladesh is one such example, contributing about 84 percent of all goods exports from Bangladesh.

Geographically contiguous countries can benefit from intraregional trade. Intraregional trade accounts for 50 percent of total trade in East Asia and Pacific and 22 percent in Sub-Saharan Africa. In contrast, it accounts for just 5 percent of total trade in South Asia (Kathuria 2018). The inadequacy of physical infrastructure and logistics services and thick borders have been the key reasons preventing the scaling up of regional trade in South Asia.

Northeast India faces severe connectivity challenges, as trade routes through Bangladesh are virtually nonexistent. Before the partition of India, in 1947, trade and commerce between northeast India and the rest of India and the outside world passed through the territory of what is now Bangladesh. Rail and river transit across the erstwhile East Pakistan continued until 1965, when all transit routes were suspended, as a result of the war between India and Pakistan. Although the governments of India and Bangladesh restored river transit in 1972, until recently no substantial progress was made on road and rail transit/transshipment (Rahmatullah 2009). As a result, cargo to and from northeast India transported by road/rail must circumvent Bangladesh, increasing transit time and cost in the region. Transporting cargo through Bangladesh would reduce the lead distance between Kolkata and Agartala by about 1,100 kilometers.

Export-import (EXIM) cargo from northeast India and Bangladesh moves through seaports in the respective countries. Indian use of the Chattogram Port in Bangladesh would dramatically reduce lead distances. Bangladeshi use of the Indian seaports at Kolkata and Haldia would yield economic benefits, through reduction in cost.

Bangladesh's inland waterway transport (IWT) network provides an alternative to the road and rail network for connecting northeast India with the rest of India. But the network is used to transport only a small volume of transit cargo mainly because of lack of adequate physical infrastructure, including the fairway and terminals. Use of the IWT network for cargo transiting to and from northeast India and cargo moving between India and Bangladesh could benefit India and Bangladesh.

Several recent bilateral and multilateral agreements aim to facilitate cross-border trade in South Asia by integrating transport and logistics services:

1. The Motor Vehicles Agreement (MVA) between Bangladesh, Bhutan, India, and Nepal (known as the BBIN countries), signed in 2015, seeks to facilitate the unrestricted cross-border movement of cargo, passenger, and personal vehicles between BBIN countries.[1] Under the agreement, trucks carrying EXIM or transit cargo can move inside the territories of other countries without the need for transshipment to local trucks at the border land ports. Currently, cargo movement to and from northeast India occurs through the Siliguri corridor (known as the "chicken's neck"). Trucks have to go around Bangladesh, increasing the distance and transit time and cost. The agreement is expected to open new and shorter routes through Bangladesh.
2. The Protocol on Inland Water Transit and Trade (PIWTT), signed by India and Bangladesh in 2009 and subsequently amended to add new routes and ports, seeks to facilitate cargo movement through Bangladesh's vast inland waterway network. It outlines new measures to facilitate inland water trade, develop infrastructure, and better integrate transport and logistics facilities in the two countries.
3. The Agreement on Coastal Shipping (ACS), signed by India and Bangladesh in 2015, seeks to facilitate the coastal movement of cargo through river-sea vessels directly from ports in India to ports in Bangladesh. Limited direct shipping between seaports in both countries is taking place primarily because of restrictions on vessel size. Both governments are planning to allow use of larger vessels in a revision of the agreement planned for 2020.
4. The Agreement for the use of Chattogram and Mongla ports (ACMP), signed by Bangladesh and India in 2018, seeks to allow the movement of goods between northeast India and the rest of India through Chattogram and Mongla ports. The agreement stipulates specific routes to connect both ports with northeast India.

The integration agreements have the potential to create new regional corridors, by opening domestic routes to regional traffic and changing the way freight moves across eastern South Asia. Effective implementation of the agreements requires the development of transport and logistics infrastructure and services, laws and regulations, and standard operating procedures to ensure hurdle-free and cost-efficient cross-border movement.

The potential traffic shift to new routes and modes from the current preferred routes and modes needs to be studied in order to facilitate proactive infrastructure capacity planning and the identification of desired service levels to enable the shift. Two key questions need answers:

- What factors or attributes of logistics service govern the route and mode choice of cargo owners and transporters in India and Bangladesh?
- What are the expected benefits in level of service from new routes and modes over existing corridors that can enable the shift of cargo?

This chapter aims to answer these questions through implementation of stated preference (SP) experiments in northeast India and Bangladesh, with a focus on the MVA, PIWTT and ACS.

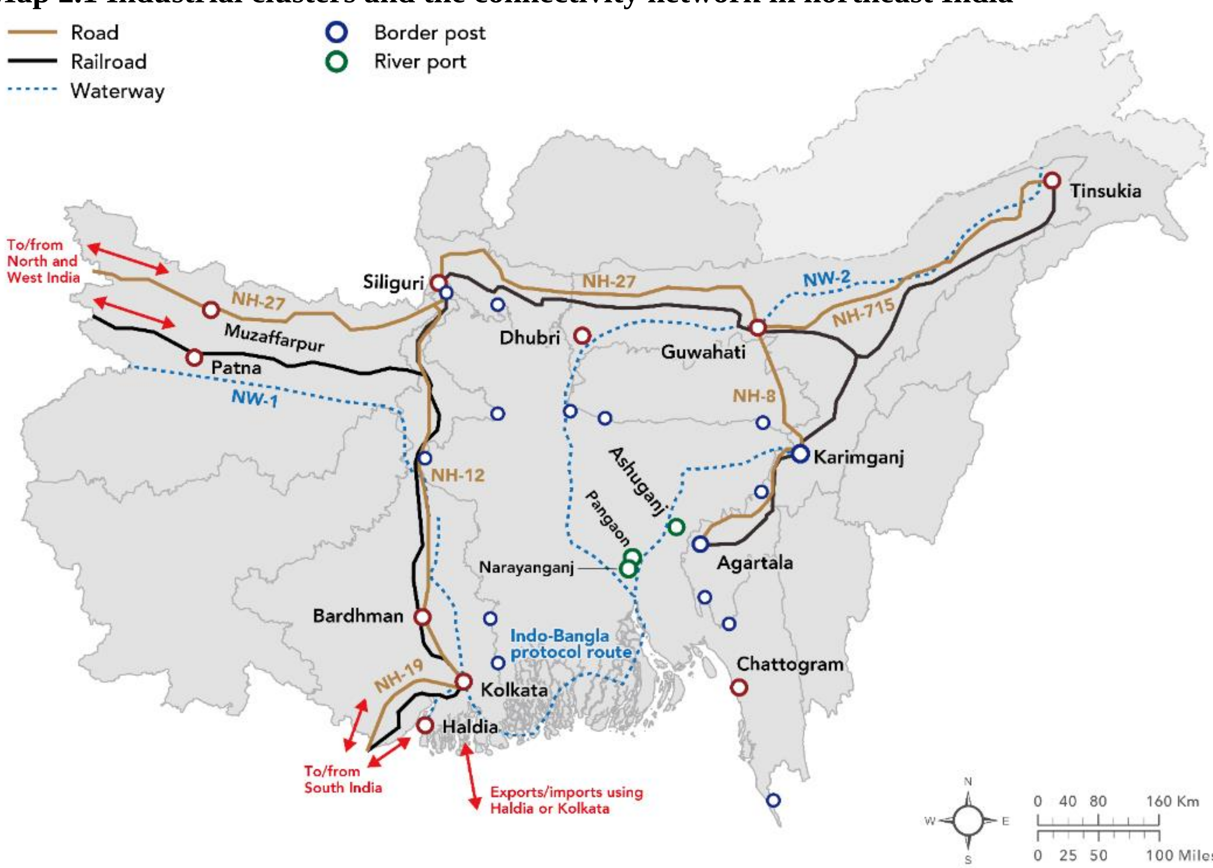
Existing Corridors, Routes, and Mode Choice

Implementation of the integration agreements between India and Bangladesh would potentially affect three types of cargo movement: domestic cargo movement between northeast India and the rest of India, EXIM cargo movement to and from northeast India, and bilateral trade between India and Bangladesh. This section describes the current routes and modes in each of these cases.

Movement of Domestic and Export-Import Cargo

Domestic and EXIM cargo movements take place through similar route and mode combinations. Northeast India is dependent on road and rail connectivity for the transport of goods to and from the rest of India. Road and rail networks pass through the Siliguri corridor. Two main routes connect northeast India with the rest of the country. The route passing through Kolkata connects the eastern and southern regions as well as the Kolkata and Haldia ports, the EXIM gateways for northeast India. The road and rail routes passing through Muzaffarpur and Patna in Bihar connect northern and western India with northeast India. Because of its good connectivity, Guwahati, in Assam, acts as a hub for trade between northeast India and the rest of India and between northeast Indian states (map 2.1).

Map 2.1 Industrial clusters and the connectivity network in northeast India



Source: Authors.

Assam is the key cargo-generating and consumption center in northeast India. Northeast India spans seven states, which collectively contribute 2.8 percent to India's GDP and about 1.5 percent of the GDP contributed by manufacturing activities. The distribution within the region is highly skewed, with Assam contributing about 61 percent of the region's GDP, followed by Tripura (9 percent) and Meghalaya (7 percent) (Central Statistics Office). Assam also contributes 75 percent of the region's manufacturing output (Indiastat). About 3.7 percent of India's population lives in northeast India, of which 69 percent live in Assam, according to the 2011 Census of India.

The key industries that produce goods for trade are natural resources–based industries, such as tea, cement, steel, and oil and gas refinery. Other industries with a sizable presence are fast-moving consumer goods (FMCG) and processed foods. The region also receives food grains, fruits and vegetables, consumer durables, fly ash, and FMCG products from the rest of India. Table 2.1 shows the movement of key commodities across existing route and mode combinations.

Table 2.1 Domestic and export-import movement of commodities in northeast India

Commodity	Route	Transport mode
Cement: Fly ash	Patna–Guwahati Kolkata–Guwahati	Rail
Cement: Finished products	Within northeast India	Road, with limited rail share
Crude oil	Patna–Guwahati	Pipeline
Petroleum, oil, and lubricant products	Within northeast India	Road, with limited rail share
Steel: Raw material	Kolkata–Guwahati	Road, with limited rail share
Steel: Products	Within northeast India	Road
Food grain	Patna–Guwahati Kolkata–Agartala	Rail, with very intermittent inland waterway movement to Agartala
Tea	Guwahati–Kolkata	Road and rail
Fast-moving consumer goods	Patna–Guwahati Kolkata–Guwahati	Road
Household goods	Patna–Guwahati Kolkata–Guwahati	Road and rail

Source: Authors.

Cement industry. The cement plants in Assam and Meghalaya region depend on the eastern states of Bihar and West Bengal for their fly ash. Limestone from Meghalaya is supplied to cement plants in the eastern states. The movement of cement is limited largely within northeast India, with very limited supply to western states. Fly ash is transported by rail; limestone is transported mainly by road. Cement is distributed within the region largely by road. In some cases where cement is moved to eastern states, plants with rail siding use the rail network.

Petroleum and natural gas industry. The industry is concentrated in Assam, with a small presence in Tripura and Mizoram. Refineries are located in Digboi, Bongaigaon, Guwahati, and Numaligarh in the state of Assam. The major consumption centers for these refineries are the northeastern states, with any surplus supplied to the state of Sikkim or exported to countries in the region. Crude oil for the refineries is procured from the Barauni refinery in Bihar through pipelines. Finished products are distributed within the region by road; supply to other regions is through road and to a lesser extent rail.

Steel industry. Steel plants are located in Meghalaya. They source their raw materials from West Bengal and Odisha. Finished products are distributed mainly within northeast India. Raw materials such as iron ore pellets and sponge iron are moved largely by truck, with a marginal share by rail. The distribution of steel products within northeast India is done by road. Trucks transport steel products to the eastern states, as lower volumes of supply make rail transport costlier. The rail network is used in the rainy season, when trucks are often unavailable.

Food grain industry. The main sources of food grain supply to northeast India are the surplus production states of Punjab, Haryana, Uttar Pradesh, and Bihar. Food grains are sent directly to the zonal distribution center at Guwahati by rail. They are then distributed to other states in the region by road. The Food Corporation of India has also used the inland waterway route to the Ashuganj river port in Bangladesh and onward by road through the Akhaura border for the supply of food grains to the Agartala region. However, this movement has been very intermittent.

Tea industry. Assam and Arunachal Pradesh are the major tea producers in the region, with most commercial tea production contributed by Assam. Processed tea from Assam is distributed to the rest of India. Both rail (containers) and road networks are used to transport tea.

FMCG industry. The FMCG industry in the region is very small, catering mainly to local demand. The deficit is met by supply from the rest of India. Goods are moved to Guwahati and then distributed to various states, mainly by truck.

*Household goods***.** Household goods, including consumer durables, are supplied from the rest of India, mainly Delhi, Maharashtra, Gujarat, Karnataka, Rajasthan, and West Bengal. They are transported by road and rail. Guwahati acts as the distribution hub in the region.

Multiple challenges cause frequent delays in the transport of cargo to and from Guwahati by road. It takes about 8–10 days for cargo to reach Guwahati from Kolkata over a road distance of about 1,000 kilometers. The key reasons for the long transit time are low average speed because of hilly terrain in the region and heavy congestion.

The roads are not suitable for transporting heavy cargo, such as project equipment, as the strength and design of the road cannot handle the weight and size of the cargo. Even in such cases, use of Inland waterway network is limited, because of low least available depth and inadequate terminal handling facilities, among other factors.

Transport along the rail network is faster, with the trip from Guwahati to Kolkata taking two to three days. However, the smaller industry size, lack of rail sidings in the region, and lack of rakes limit the use of rail as the preferred transport mode.[2] During the rainy season, road transport is hampered by landslides, making rail the preferred mode for some industries.

Movement of Bilateral Cargo

Total annual goods trade between Bangladesh and India amounted to $9 billion in 2018 (International Trade Center). The main commodities traded between India and Bangladesh are exports of cotton and fabric, automobiles, machinery and equipment, food grains, chemicals, fruits and vegetables, and steel and metal products from India and exports of fabric and yarn, and apparel from Bangladesh. Bilateral cargo movement between India and Bangladesh occurs largely through the cross-border road network, as Bangladesh is landlocked on three side by India. IWT is the second-most favored mode of transport, which caters predominantly to bulk products such as fly ash. The shares of rail and sea are very limited in bilateral trade.

Road transport moves through various land customs stations and land ports on the India–Bangladesh border. The land custom stations handling most of the bilateral cargo are Petrapole–Benapole, Ghijadanga–Bhomra, Changrabandha–Burimari, Mahadipur–Sonamasjid, Hili, Agartala–Akhaura and Golakganj–Sonahat. Petrapole–Benapole handles most industrial cargo; the commodities handled at other ports are mostly construction materials and agricultural products.

Inland water transport (IWT) has the second-largest share of bilateral trade between India and Bangladesh. Bilateral cargo is transported along inland waterways through the Indo–Bangla protocol routes. The major movement of cargo is between Kolkata/Haldia and the river ports in the Dhaka region (Dhaka, Narayanganj, and the Pangaon container terminal**)**. According to data from the Inland Waterway Authority of India (IWAI), the total cargo carried through IWT was about 3.2 million tonnes in fiscal 2019, of which about 96 percent was fly ash exported to cement companies in Bangladesh.

Bilateral cargo is also transported by sea. Sea-based trade is highly skewed toward containerized exports from India, contributing more than 95 percent of trade volumes. There is very limited direct cargo movement between India and Bangladesh through seaports. Major freight movement is on the transshipment route through the ports of Colombo or Singapore, which increases transport time and cost.

Cargo movement between India and Bangladesh by rail is very limited, because of infrastructure challenges. The commodities transported on rail are construction material (stone) and coal. Bangladesh's rail network consists mainly of meter gauge, which creates compatibility issues with the broad-gauge network of India. The load-carrying capacity of the Jamuna Bridge, which connects the western and eastern rail network of Bangladesh, is the major barrier to rail transport.

Potential Route and Mode Choices

The potential route and mode choices expected to materialize following implementation of the integration agreements between India and Bangladesh include single-mode as well as multimodal options transiting through Bangladesh. Twenty-four route and mode choices across the three movement types have been identified (table 2.2). Seven route and mode choices are currently used; the remaining 17 are potential new route and mode choices expected to materialize following implementation of the agreements (map 2.2).

Map 2.2 Potential new route and mode choices following implementation of integration agreements

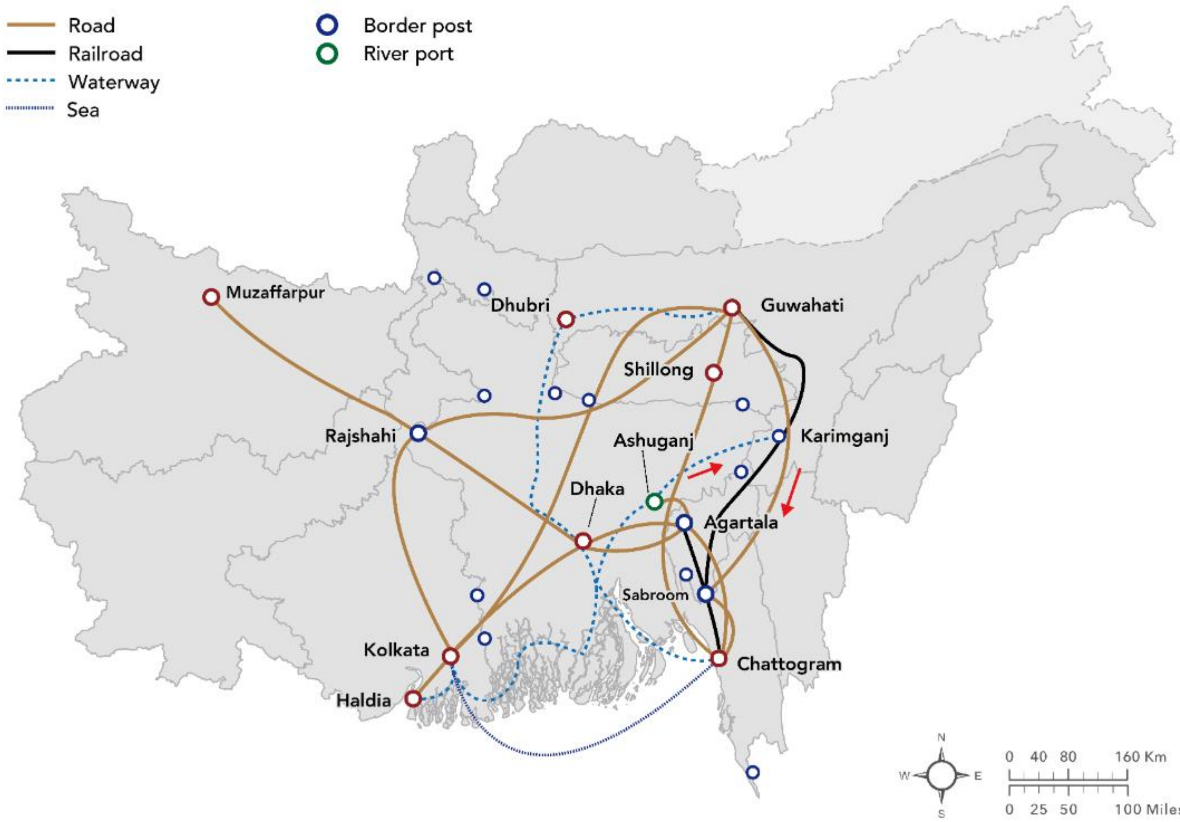


Table 2.2 Potential route and mode choices following implementation of integration agreements

Movement type	Existing routes and modes	Potential new routes and mode choices
Domestic cargo between the northeast India and the rest of the country	• Road through Siliguri corridor • Rail through Siliguri corridor	Road: • Guwahati to Kolkata via Bangladesh • Agartala to Kolkata via Bangladesh • Agartala to North India via northwest Bangladesh (Rajshahi/Rangpur region) Inland water: • Indo–Bangla protocol routes Multimodal: • Agartala to Kolkata by road (up to Ashuganj river port) and IWT protocol route

Export-import (EXIM) cargo to and from northeast India	EXIM through Haldia Port • Road through Siliguri corridor • Rail through Siliguri corridor	EXIM through Haldia Port Road: • Guwahati to Haldia via Bangladesh • Agartala to Haldia via Bangladesh Inland water: • Guwahati to Haldia via NW-2 and protocol route Multimodal: • Agartala to Haldia by road (up to Ashuganj river port) and IWT protocol route
		EXIM through Chattogram Port Road: • Guwahati/Agartala to Chattogram via Sabroom • Guwahati to Chattogram via Sylhet Rail: • Guwahati/Agartala to Chattogram via Sabroom Inland water: • Guwahati to Chattogram via NW-2 and Meghna River Multimodal: • Agartala to Chattogram by road (up to Ashuganj river port) and Inland water transport route to Chattogram • Guwahati to Chattogram by road (up to Karimganj) and Inland water transport route to Chattogram

Bilateral trade between India and Bangladesh	Road: • Movement through land custom stations/ports Sea: • Transshipment to Chattogram via Colombo/Singapore Inland water: • Protocol routes between India and Bangladesh	Rail: • Movement through the Kolkata-Ranaghat Gede–Bangabandhu-Dhaka rail Sea: • Coastal movement between Indian ports and Chattogram Port

Methodological Approach and Data

Stated-preference (SP) experiments were conducted to assess the preferences of users across route and mode choices. In such experiments, respondents are shown hypothetical alternatives that are described in terms of scores on multiple attributes of the alternatives and asked to choose between, rank, or rate the alternatives. In revealed-preference (RP) surveys, respondents are asked to record their actual choices in real choice problems. In the case of freight mode choice, for instance, an RP survey would ask shippers to provide the actual mode they use for shipments. A mode choice SP survey would present hypothetical mode choice alternatives to the shipper (road, rail, inland waterways, sea), each with specific assumptions on level-of-service attributes (for example, transport time, costs, reliability).

An advantage of an SP survey is that it allows preferences to be elicited for a situation that does not yet exist, such as a situation with considerably less border restrictions between India and Bangladesh and with a better-integrated transport infrastructure for freight transport. It is important to aim for realism in SP experiments, by using the current situation as a point of reference. For this reason, the SP survey was conducted for this study was set up in the context of current shipments of the interviewed firms, modifying the attribute levels of these observed shipments. This kind of SP is called a customized SP, or pivot design.

A pilot survey of about 20 percent of the target population was conducted to gain a clear idea of the model coefficients or priors to be defined for the main SP experiment. Annex 2A describes the pilot survey. Box 2.1 presents the set-up and implementation methodology of the SP experiments. Annex 2A describes the recruitment and survey method.

<<Start Box>>

Box 2.1 Stated-preference experiments

The survey consisted of three SP experiments, including one unlabelled (abstract) experiment and two labelled experiments. (See Louviere, Hensher, and Swait 2000 for a general introduction to SP experiments and de Jong 2008 and Tavasszy and de Jong 2014 for examples of SP experiments in freight transport.) In the unlabelled experiments, alternatives were presented as generic names (Route 1, Route 2). These unlabelled route choices ensured unbiased responses and yielded a deeper understanding of the attributes that determine which route a respondent wants to use.

SP1 was an unlabelled or abstract experiment administered to both shippers/third-party logistics service providers (3PLs) and carriers (road haulage). SP2 and SP3 were labelled experiments; SP2 was conducted for carriers and SP3 for shippers/3PL players. In these labelled experiments, the names of the routes or modes were shown. SP2 assessed the route choices of the respondents; SP3 assessed the overall choice influencing route, mode, and port choice of respondents. Each respondent participated in two experiments: shippers and 3PL players in SP1 and SP3 and road carriers in SP1 and SP2.

SP1 consisted of 10 choice screens, one of which was a dominant question (to check whether the respondent was paying attention and making rational choices). SP2 and SP3 contained 12 choice screens for each experiment. Each respondent was thus asked to make 22 choices.

After the efficient design (Rose and others 2008) was created, the number of blocks (design tables) for each experiment was determined based on analysis of a pilot survey. Four blocks for the design table were designed for each experiment using NGENE software (Choicemetrics 2018). For each respondent and each SP, a random draw determined which block of choice cards was presented. In the final sample of respondents, for each SP experiment, each block occurred the same number of times. Choice screens within each experiment were presented in random order. For SP2 and SP3, a random draw determined the order in which alternatives were shown to respondents. For each respondent, the order in which the alternatives were shown remained constant; the order varied only between respondents.

The number of alternatives was limited to a maximum of four, to ensure that respondents were not overburdened with choices. Too many alternatives often result in partial nonresponse and use of simplifying heuristics (such as always choosing the left-hand side alternative). SP1 and SP2 consisted of binary alternatives, as the objective was to capture choices between Route A versus Route B in SP1 and the route through the Siliguri corridor versus the route through Bangladesh in SP2. Four alternatives were used for SP3 experiments, which considered a combination of route and mode choices.

<<End Box>>

The Stated-Preference Sampling

The design framework ensured that the mode and route choices of all relevant stakeholders were captured.[3] Shippers and 3PLs were interviewed, with a focus on mode choice. Road carriers were interviewed about the route choice for road transport. Table 2.3 presents the target sample distribution, which was selected based on the cargo volumes for different movement types, and the actual sample.

Table 2.3 Sample distribution

	Shippers/third-party logistics service providers		*Carriers (road haulage)*	
Movement type	*Target*	*Actual*	*Target*	*Actual*

Domestic cargo	150	183	75	130
Export-import cargo	25	30	25	25
Bilateral trade	75	93	50	52

The three movement types were divided based on four dimensions: commodity types, geographic location, existing routes, and existing modes. Annex 2A shows the sample distribution across all dimensions.

Commodities. Commodities were selected in a way that ensured that a significant share of movement was captured. In the case of domestic and EXIM movement, the selected commodities covered about 80 percent of movement to northeast India and about 72 percent of movement from northeast India. The commodities selected for the bilateral movement represented about 73 percent of imports to and 54 percent of exports from India.

Geographic location. Respondents were divided into three categories based on their location: northeast India, the rest of India (mainly East India), and Bangladesh. These categories ensured that both shippers and carriers were selected from all three regions.

Existing routes: The existing routes for domestic cargo movement were divided into four corridors for the distribution of the respondents: Corridor A: Guwahati–Patna; Corridor B: Guwahati–Kolkata; Corridor C: Agartala–Patna; and Corridor D: Agartala- Kolkata.

- Guwahati represents origins and destinations located in Assam, Meghalaya, Manipur, Nagaland, and Arunachal Pradesh.
- Agartala represents origins and destinations located in Tripura, Mizoram.
- Kolkata represents origins and destinations located in West Bengal (including the Port of Haldia), Jharkhand, and states in southern India.
- Patna represents origins and destinations located in northern and western India.

The selected existing corridors for EXIM cargo movement were Guwahati–Kolkata (Corridor B) and Agartala–Kolkata (Corridor D). The major seaport used for EXIM of commodities used by industries and logistics services providers in northeast India is Haldia, in Kolkata. These categories were selected to survey the route and mode choices of these players.

For bilateral trade, the existing corridors selected were the road using the Petrapole–Benapole custom station, the road using other land custom stations, and the sea. Petrapole–Benapole was selected because it has the largest share of trade via road.

Existing mode. Road and rail are currently the dominant modes of transport used by industries and logistics service providers in northeast India for domestic and EXIM cargo movement. For bilateral trade, road transport is the main mode of transport, with sea the second-most preferred mode for freight movement between India and Bangladesh.

Determinants of Mode and Route Choice

The experiment assesses the choices of the routes and modes based on different attribute levels. The attributes for the experiments were selected based on the attributes recommended by the literature on SP experiments of freight transport, and the attributes that influence decisions about the mode and route choice in the region were studied.

Most of the SP surveys carried out in the freight transport sector consider transport costs and transport time. An additional reason for including these attributes is that most transport infrastructure projects and policies (for example, road pricing or trade/transport agreements) can be simulated by changing these variables in the model. Including these attribute variables greatly increases the relevance of policy in the model. The most often used attribute after transport time and cost is the probability of delay, an important determinant of hypothetical route and mode choice in freight.

Pilot surveys with the firms located or operating in the study area corridors allow factors other than transport time and costs influencing route and mode choices to be identified and ranked. The responses revealed that the selection of route and mode depends on multiple attributes, including the following:

- *Transport time*. Transport time is a key factor for most industries. It affects inventory carrying cost for shippers and the utilization of assets by carriers.
- *Transport cost*. Transport cost has a major impact on the route and mode choices by shippers and carriers.
- *Probability of delay*. The probability of delay is the most critical attribute for export-oriented industries, such as tea.
- *Frequency of operation/availability of transport*. Frequency affects the selection of some transport modes. To incorporate this attribute in the SP experiments, respondents were asked to assume that trains run at least once a day.
- *Presence of end-to-end service providers and cargo aggregators*. To use rail transport, industries are required to book a rake of 2,500 tonnes; for IWT, typical barge sizes are 800–1,000 tonnes. Shippers with smaller volumes of bulk cargo depend on cargo aggregators for rail and IWT services. This factor was incorporated into the SP experiment by asking respondents to indicate a typical shipment size and to make choices about that size of shipment, which were considered in the econometric model.
- *Number of handlings or transshipments*. Interviews with the tea industry revealed that the number of handlings is one of the key parameters for selection of route and mode. Handling increases the risk of damage and the ingress of foreign particles, resulting in rejection of the shipment, especially in the case of exports.
- *Administrative issues related to customs and other operations for the cross-border movement of cargo*. The efficiency of administrative and customs processes at the border were identified as key attributes for movement through Bangladesh. It influences door-to-door transport time and cost. Respondents were asked to assume that border issues would be resolved following implementation of the agreements and policies.
- *Impact on quality of goods*. The petrochemical and chemical shipments must meet specific quality requirements. The preference for route and mode for these types of industries may depend on the level of control the industry can exercise. For example, a chemical company can have more control over quality if its products are transported by rail than it can if they

are transported by tanker barge. Because this attribute is relevant for only some sectors, it was not included in the SP experiments.

- *Probability of damage or theft*. This attribute is not often used in the literature but was confirmed as important. It was therefore included as an attribute.

Based on the review of the literature and preliminary surveys, the following attributes for the SP experiments were selected:

- door-to-door transport time (five levels)
- total transport costs (five levels)
- number of transshipments (three levels)
- probability of a delay of more than 24 hours (three levels)
- probability of cargo damage and theft (three levels)
- border waiting time (three levels).

The values of time and cost of the chosen mode and route and the unchosen modes and routes are based on data and expert knowledge on the relative time and cost of the alternatives.

Econometric Models for Mode and Route Choice

Both mode and route are discrete variables (they can take only a limited number of values). They are also of a purely qualitative nature (a possible outcome would be “road transport” for mode choice or “Siliguri corridor” for route choice). As a result, standard regression models, which are designed to explain continuous, quantitative variables, cannot be used. Instead, a special category of models called discrete choice models should be used (Ben-Akiva and Lerman 1985; Train 2003). Tavasszy and de Jong (2014) discuss the application of these methods in freight transport modelling.

Different discrete choice models for carriers and shippers were estimated, because it is assumed that road transport carriers do not decide on mode choice but influence route choice for road transport and that mode choice (sometimes including the choice of port and route) is based on decisions by shippers. The shipper and carrier models were estimated for the three transport types: domestic transport in India, EXIM transport in India, and bilateral transport between Bangladesh and India.

The shipper models interact time and cost with firm size, containerized goods, and the value of the goods per tonne. For the carrier models, the same is true, except nonbulk goods (food and nonfood) are used instead of containerized goods. The interactions between the attributes offered in the SP and characteristics of firms and shipments are included to account for observed heterogeneity. For instance, a large firm’s response to changes in cost could be different from that of a small firm. Interactions that were not significant were dropped. Both shipper and carrier models included the logarithm of cost to capture nonlinearities. Nonlinear time specifications were tested in the shipper models, but they were not statistically significant and therefore dropped.

Shippers have the choice between multiple modes and in some cases multiple routes. To test whether there is more substitution between certain modes and routes, different multinomial nested logit model structures were tested for the three transport types. A nesting structure is preferred in the shipper models for domestic and bilateral trade, where the results show more substitution between routes than between modes. For carriers, nonnested multinomial logit models were used. All models were estimated by the maximum likelihood method using the SP data.[4]

Results of Mode and Route Choice Model Estimation

The estimated coefficients for the mode and route choice models have plausible signs and magnitudes. For domestic carriers, routes through Bangladesh have a negative constant (–0.62), which reduces the chance that carriers will select routes through Bangladesh (table 2.4). As expected, longer time and higher cost make a route less attractive, as do more frequent delays, more frequent theft and damage, and longer waiting time at the border. The coefficients for the interactions with time and cost should be regarded as influences that are added to the overall influence of time or cost. The cost coefficient for large firms in the carriers-bilateral segment is –5.50 + 3.69 = –1.81, which implies that they are less sensitive than the average-size firm. Nonbulk nonfood commodities in the carriers-bilateral segment are less sensitive to time than bulk commodities (the reference category), which can be explained by the fact that bulk products may be required in a production process for further processing.

Table 2.4 Determinants of route choice by carriers

Transport type	*Domestic*	*Export-import*	*Bilateral*
Bangladesh dummy	–0.62***	1.19***	0.16
	(–2.8)	(2.7)	(1.4)
Time (in hours)	–0.023***	–0.040***	–0.028***
	(–5.0)	(–7.3)	(–5.2)
Time for nonbulk nonfood	0.0071**		
	(2.0)		
Time for large firms		0.0060***	0.019***
		(4.6)	(3.8)
Time for goods with low value per tonne	0.0060		
	(1.3)		
Time for goods with high value per tonne	–0.042***		
	(–5.5)		
Time for goods with unknown value per tonne	–0.052***		
	(–8.4)		
Cost (in Rs)	–24.80***	–12.29***	–5.50***
	(–12.5)	(–6.0)	(–8.7)
Cost for nonbulk food		–1.06	
		(–0.6)	
Cost for large firms			3.69***
			(6.8)
Cost for containerized goods	3.66**		3.03***
	(2.3)		(5.5)
Cost for goods with low value per tonne	10.68***		
	(6.2)		

Percentage of delay (reliability)	–0.019***		–0.024***
	(–4.5)		(–4.9)
Percentage of damage and theft	–0.044***	–0.024***	–0.058***
	(–5.5)	(–2.0)	(–5.3)
Waiting time at the border (hours)	–0.037**	–0.081***	–0.038***
	(–2.6)	(–2.7)	(–5.2)
Scale coefficient SP experiment 2	1.00[a]	1.00 [a]	1.00 [a]
Scale coefficient SP experiment 1	0.47***	0.96***	1.16***
	(10.7)	(5.5)	(5.1)
Observations	2,604	525	840
Final loglikelihood	–678.1	–141.2	–445.9
Degrees of freedom	13	8	10
Rho²(0)	0.62	0.61	0.23
Rho²(c)	0.50	0.53	0.23

Source: Authors.
Notes: Figures in parentheses are *t*-statistics. a. this coefficient was fixed at 1.
Significance level: * = 95 percent, ** = 97.5 percent, *** = 99.5 percent.

In the shipper models (table 2.5), longer time, higher cost, more frequent delays, more frequent theft and damage, longer waiting time at the border, and more transshipments for a certain mode lower the probability of choosing that mode.

Table 2.5 Determinants of mode, route, and port choice by shippers

Transport type	**Domestic**	**Export-import**	**Bilateral**
Bangladesh dummy	0.98***	–0.26	0.59
	(8.9)	(–0.8)	(1.6)
Rail dummy	–0.25	–0.75**	0.20
	(–1.4)	(–2.4)	(0.5)
Inland waterways dummy	–1.01***	–0.033	0.38
	(–4.9)	(–0.1)	(1.0)
Time (hours)	–0.017***	–0.021***	–0.0047***
	(–7.6)	(–7.8)	(–8.4)
Time for large firms		0.0092***	0.0019***
		(3.8)	(3.6)
Time for containerized goods	0.0089***		
	(4.6)		
Time for goods with low value per tonne		0.011***	
		(4.0)	
Time for goods with unknown value per tonne			–0.0047***
			(–3.9)
Cost (in Rs)	–2.56***	–7.95***	–1.31***
	(–6.4)	(–10.1)	(–18.3)
Cost for large firms		2.50***	

		(2.9)	
Cost for containerized goods	0.52	–4.08***	
	(1.4)	(–3.1)	
Cost for goods with high value per tonne	–0.91***		
	(–4.2)		
Cost for goods with unknown value per tonne	–4.81***		
	(–9.9)		
Percentage of delay (reliability)	–0.0050***	–0.020***	–0.0052***
	(–3.6)	(–4.7)	(–5.0)
Percentage of damage and theft	–0.024***	–0.037***	–0.020***
	(–6.8)	(–4.5)	(–6.2)
Waiting time at the border (hours)	–0.0071**	–0.014	
	(–2.3)	(–1.5)	
Number of transshipments			–0.039
			(–1.5)
Scale coefficient of SP experiment 3	1.00[a]	1.00 [a]	1.00 [a]
Scale coefficient of SP experiment 1	2.08***	1.74***	5.97***
	(10.3)	(7.5)	(5.8)
Nesting coefficient for routes of same mode	0.72***		
	(11.1)		
Nesting coefficient for road and non-road nests			0.7848***
			(6.1)
Observations	3,938	760	1,980
Final loglikelihood	–2,876.4	–338.1	–1,598.9
Degrees of freedom	14	13	12
$Rho^2(0)$	0.32	0.56	0.25
$Rho^2(c)$	0.26	0.51	0.22

Source: Authors.
Note: Figures in parentheses are *t*-statistic.
a. Coefficient was fixed at 1.
Significance level: * = 95 percent, ** = 97.5 percent, *** = 99.5 percent.

The willingness of shippers and carriers to pay for improvements in service levels indicate the importance of each attribute. The estimated coefficients of the route and mode choice models are used to estimate the monetary value of travel and waiting at the border time, reliability, transshipment, and theft and damage for shippers and carriers.[5]

Time is not as important as cost for carriers transporting goods between northeast India and the rest of India or EXIM from/to northeast India, but it is more important than cost for carriers transporting bilateral trade between Bangladesh and India. The estimated value of time (in Indian rupees per hour per shipment) for road carriers transporting goods between northeast India and the rest of India or EXIM from/to northeast India is lower than the median transport cost per hour; it is higher than the median transport cost per hour for carriers transporting bilateral trade between Bangladesh and India (table 2.6). Time is also not as important for carriers as is usually found in

SP analyses in the Western world (where it comes close to the mean transport costs per hour, according to de Jong and others 2014).

For domestic and EXIM freight, the value of time is higher for shippers than carriers; for bilateral trade, the carriers' value of time is higher than that of shippers (see table 2.6). In the Western world, the value of time of carriers is usually higher than that of shippers (de Jong and others 2014). The fact that the analysis finds a reversal of this pattern for freight moving across India may have to do with the much longer land-based travel times in India, which makes it more difficult for shippers to ignore the interest cost on the value of goods in transit.[6]

Table 2.6 Willingness to pay by carriers and shippers (Indian rupees per shipment)

	Transport mode			
Type of trade/carrier	*Road*	*Rail*	*River*	*Sea*
Value of time (per hour)				
Domestic, carriers	88	—	—	—
Domestic, shippers	240	323	248	
Export-import, carriers	143	—	—	—
EXIM, shippers	372	313	377	—
Bilateral, carriers	495	—	—	—
Bilateral, shippers	211	291	370	393
Value of reliability (per 1 percentage point increase in probability of delay)				
Domestic, carriers	83	—	—	—
Domestic, shippers	132	177	136	
Export-import, carriers	—	—	—	—
Export-import, shippers	193	163	195	—
Bilateral, carriers	618	—	—	—
Bilateral, shippers	290	401	509	541
Value of theft/damage (per 1 percentage point increase in probability of theft/damage)				
Domestic, carriers	189	—	—	—
Domestic, shippers	633	850	653	
Export-import, carriers	92	—	—	—
Export-import, shippers	1,425	1,200	1,442	—
Bilateral, carriers	1,528	—	—	—
Bilateral, shippers	1,112	1,537	1,951	2,074
Value of transshipments (per transshipment)				
Domestic, carriers	—	—	—	—
Domestic, shippers	—	—	—	—
Export-import, carriers	—	—	—	—
Export-import, shippers	—	—	—	—
Bilateral, carriers	—	—	—	—
Bilateral, shippers	2,153	2,976	3,777	4,016

Value of border waiting time (per hour)				
Domestic, carriers	159	—	—	—
Domestic, shippers	186	250	192	
Export-import, carriers	309	—	—	—
Export-import, shippers	552	464	558	—
Bilateral, carriers	1,002	—	—	—
Bilateral, shippers	—	—	—	—

Source: Authors.
Note: — = Not applicable.

The values of reliability average about Rs 300 per shipment, with a large variance (see table 2.6). A value of Rs 300 means that a 1 percentage point reduction in the probability of delays of more than 24 hours (for example, from 10 percent to 9 percent) is valued at Rs 300. The result implies that on average, a 1 percent change in the frequency of delay is worth about the same as 1 hour of transport time. Carriers and shippers involved in bilateral trade between Bangladesh and India place the highest value on reliability; carriers and shippers involved in domestic freight movements between northeast India and the rest of India place the lowest value on it.

The value placed on avoiding theft and damage varies widely across movement types, probably reflecting differences in the values of the goods shipped. The mean value of about Rs 1,100 means that a 1 percentage point reduction in the probability of damage or theft (for example, from 10 percent to 9 percent) is valued at Rs 1,100 per shipment. This figure is three to four times the average value of time per hour. High values are found for bilateral trade and EXIM (shippers) to and from northeast India for all modes. These values also depend on the shipment size. Per tonne, road values will therefore be highest.

Transshipment is more onerous for modes with larger shipment sizes. Reducing the number of transshipments by one is worth about 10 hours of travel time. Shippers engaged in bilateral trade are willing to pay about Rs 2,100 to reduce the number of transshipments in road transport by one, about Rs 3,000 in the case of rail, and about Rs 4,000 in the case of river and sea transport.

A reduction of an hour of waiting time at the border is worth more for carriers and shippers involved in bilateral movements than for carriers and shippers involved in domestic movements between northeast India and the rest of India and trade between northeast India and the rest of the world. Bilateral movements have to cross the border; other movements have alternatives, which can explain the difference in willingness to pay. The average value for an hour of waiting time at the border is about the same as the average value of an hour in general. A reduction of an hour of waiting time at the border is worth less than the transport costs per hour for domestic movements between northeast India and the rest of India, but it could be worth as much, or even more than, the transport costs per hour of bilateral trade and trade between northeast India and the rest of the world.

For the most part, decision makers are inelastic with respect to changes in price and time. For road transport, the price elasticity of the number of tonnes are –0.51 for domestic, –0.13 for EXIM, and –0.25 for bilateral freight. For rail transport, the price elasticity of the number of tonnes are –1.00

for domestic, –2.44 for EXIM, and –1.14 for bilateral freight. These estimates are within the range typically found in the literature, except for the elasticities for EXIM freight, which are higher (in absolute value), indicating strong price sensitivity in northeast India. The time elasticities for both modes are a bit lower (in absolute values) than the price elasticities.

The success of the integration agreements in triggering changes to more efficient routes and modes across eastern South Asia requires improving infrastructure and service delivery in an integrated manner. Elasticity estimates vary greatly across commodity groups and origin–destination pairs. They also depend strongly on the availability of port and rail infrastructure. This heterogeneity suggests that the reduction of border delays or travel time (through implementation of cross-border integration agreements) or pure pricing instruments (such as road pricing for trucks) will have limited mode/route substitution impacts unless they are complemented with policies that improve infrastructure for rail, river transport, and coastal shipping. The high willingness to pay estimates for travel and wait time savings; reliability; and lower chances of theft, damage, and border delays call for tackling both hard and soft infrastructure deficiencies to ensure that trade and transport facilitation bottlenecks at borders do not erode improvements in road, rail, and river connectivity.

Simulation Results for the Analysis of Mode and Route Choice

This section examines the potential for modal and route shifts that the integration agreements and a set of complementary policies may induce.

Simulation Method

Mode and route choice models were used to predict the potential mode and route shift of a series of policy measures that facilitate cross-border trade between India and Bangladesh in a number of corridors. The simulations use the database of all carriers and shippers that participated in the SP survey, weighted by their reported annual transported volume. The following corridors are considered:

- domestic transport: Guwahati–Kolkata, Agartala–Patna, Agartala–Kolkata
- EXIM transport: Guwahati–Kolkata, Agartala–Kolkata
- bilateral transport: India–Bangladesh, Bangladesh–India.

Most of these corridors offer road, rail, inland waterway, and sea transport alternatives. In each corridor (and separately for domestic, EXIM, and bilateral transport), the choice is modelled in two steps:

- *Route choice modelling.* For road transport, the distribution over routes in each corridor is predicted by simulating the route choice of all carriers with the estimated carrier (route choice) models. The estimated carrier models apply to road transport and are therefore not applicable to model the choice between rail, inland waterways, and sea routes. These route choices are therefore simulated by a deterministic model that assigns the entire volume to the fastest route.
- *Mode choice modelling*. Based on the predicted route shares, weighted-average level-of-service attributes are calculated for each available mode in each corridor. Thereafter, the

mode choice is predicted by simulating the mode choice of all shippers with the estimated shipper (mode choice) models.

The estimated mode and route choice models are first applied to model the mode and route choice of all respondents in the SP data (separately for domestic, EXIM, and bilateral transport) in the base year (2019). The mode-specific constants for road, rail, inland waterways, and sea are then recalibrated for each corridor to match the current mode shares in that corridor (annex 2B presents the costs and time elasticities after calibration). Thereafter, the recalibrated model is applied for two scenarios for the same year (2025). In the first scenario (the reference case for 2025), no policy measures are adopted. Assumptions are made about the overall growth in transport by commodity type between 2019 and 2025,[7] keeping the mode and route shares unchanged. In the second scenario, policy measures are adopted. When they are implemented, the attractiveness of most alternatives improves, and new travel alternatives (routes) through Bangladesh become available.

Simulated Policy Measures

The policy measure scenario assumes that the three agreements (MVA, PIWTT, and ACS) and some infrastructure intervention recommendations are implemented to improve the level of service in some corridors (table 2.7). Expansion of the effective capacity of roads to key land ports and along regional corridors will reduce travel time and costs. It can be increased through a mix of infrastructure investments, policies to increase containerization, cargo aggregation, and reductions in the share of empty running trucks and overall congestion on the roads. One of the potential road routes through Bangladesh that ensures the lowest travel time in Bangladesh connects Kolkata and Guwahati through the Hili and Mahendraganj/Dhanu-Kamalpur land ports and crosses the Jamuna River in Rangpur division, where there is currently no bridge. It is assumed that a new bridge over the Jamuna River and approach roads in Rangpur division will be built and existing bridges will be rehabilitated.

Table 2.7 Measures to facilitate shift to new mode and route alternatives

Measure	Impact on level-of-service attributes
Expansion of effective capacity of roads to key land ports and along regional corridors	• Reduces travel time and cost
Construction of a new bridge over the Jamuna River in Rangpur division and approach roads and the rehabilitation of existing bridges	• Reduces travel time and cost
Construction of dedicated lanes at land ports and berths at Chattogram Port for transit cargo	• Reduces border waiting time • Reduces probability of delay, theft, and damage
Increase in the effective capacity of evacuation infrastructure at Chattogram Port	• Reduces probability of delay, theft, and damage • Reduces travel time
Improvement of land port facilities	• Reduces border waiting time

Deployment of modern information technology infrastructure at relevant land ports and seaports	• Reduces border waiting time and probability of delay
Development of off-border custom clearance facilities in Bangladesh and India	• Reduces border waiting time • Reduces number of transshipments
Improved collaboration between customs authorities of Bangladesh and India through adoption of standard operating procedures for cross-country transport	• Reduces border waiting time
Standardization of policies and regulations, such as vehicle and road design standards, following implementation of the integration agreements	• Reduces border waiting time • Reduces number of transshipments

Policy measures that reduce border times and number of transshipments are key to ensure the implementation of the integration agreements lead to a shift of freight traffic to optimal routes and modes. Construction of dedicated lanes at land ports and berths at Chattogram Port for transit cargo, improvement of land port facilities, In the model simulation, each transport alternative (mode and route) is described by the following level-of-service attributes: travel time (hours); travel costs (Rs/tonne); probability of delay more than 24 hours (percent); chance of theft or damage (percent); number of transshipments; border waiting time (hours). Annex 2C presents the level-of-service attributes for the mode and route alternatives available after implementation of the integration agreements.

Some of these alternatives lead to large reductions in distance and consequently transport cost and time. A truck traveling from Guwahati to Kolkata via the Siliguri corridor takes on average 164 hours and pay Rs 3,129 per tonne. In the scenario in which the policy measures are implemented, the truck can use the route through the Petrapole/Benapole land port, which will take on average 126 hours plus 8 hours waiting time at the border and cost Rs 2,479 per tonne, reducing the time by 18 percent and the cost by 21 percent. The differences are even more pronounced for a truck traveling from Agartala to Kolkata. Via the Siliguri corridor, it takes 250 hours and costs Rs 4,940 per tonne; through Petrapole/Benapole, it will take 80 hours plus 8 hours waiting time at the border and cost Rs 1,597 per tonne—a 65 percent reduction in time and a 68 percent reduction in cost. For a truck traveling between Agartala and Patna, it takes 237 hours and costs Rs 4,614 per tonne through the Siliguri corridor. Using the route through Hili will take 122 hours plus 8 hours at the border and cost Rs 3,177 per tonne—a 45 percent reduction in time and a 31 percent reduction in cost.

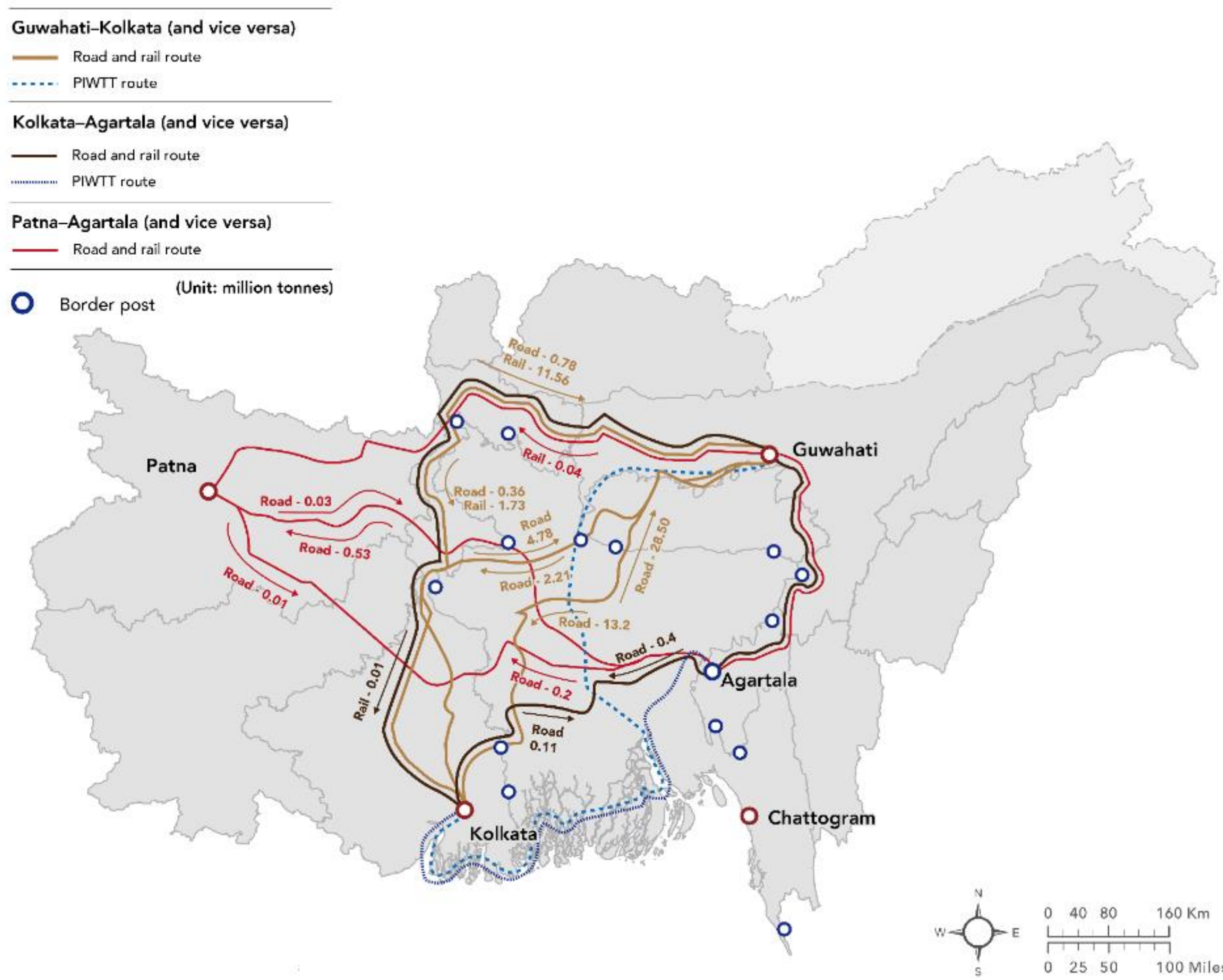
For the probability of delay and theft or damage, it is difficult to determine the effect of the policies. For current routes, the average of the base-year values and European reference values is used. For new routes that become available after policy implementation, the average values of current routes are taken. The assumption is made that there is no systematic difference between routes in India and Bangladesh in terms of delays, theft, or damage. Should any of these assumptions not be realized, the predicted mode and route shift would be different. It is assumed by 2025, all policies will have been implemented, though not necessarily at the same time.

Predicted Mode and Route Shares

For the domestic movement of cargo through Kolkata to northeast India, after implementation of the agreements the choice of route and mode will be highly skewed toward road transport via the Petrapole/Benapole border (map 2.3 and table 2.8). The Hili border will be the preferred route for movement to Agartala through Patna. Rail transport through the Siliguri corridor will be used for movement to Guwahati through Kolkata and to Agartala through Patna.

There will be a decline in the share of rail transport, however, from 18 percent to 10 percent for Guwahati–Kolkata and from 39 percent to 25 percent for Kolkata–Guwahati, as a result the new attractive road alternative. An even larger reduction in the rail share is predicted for Agartala–Kolkata (from 17 percent to 6 percent), Kolkata–Agartala (from 27 percent to 2 percent), Patna–Agartala (from 29 percent to 11 percent) and Agartala–Patna (from 28 percent to 2 percent). For Guwahati–Kolkata and Kolkata–Guwahati, interventions that lead to a 25 percent reduction in rail costs and times would be sufficient to maintain the original base-year market shares (of about 18 and 39 percent, respectively) in 2025 with implementation of the agreements. For the other domestic corridors, even with 25 percent time and cost reductions, the rail shares would still be below those of the base year; additional cost and time reductions would be necessary to maintain the base-year share.

Map 2.3 Predicted freight traffic between northeast India and rest of India in 2025 if agreements are implemented



The share of inland waterways, which had a 7 percent market share on the Kolkata–Agartala corridor in the base year (it only amounted to 10,000 tonnes) drops to 0. To regain this market share of 7 percent for IWT, even a 50 percent reduction in time and cost would not be sufficient (such reductions lead to a market share for IWT of just 3 percent after implementation of the agreements). This finding implies that substantial reductions are needed in reliability, theft or damage of cargo, and border delays along IWT routes to remain competitive alternatives.

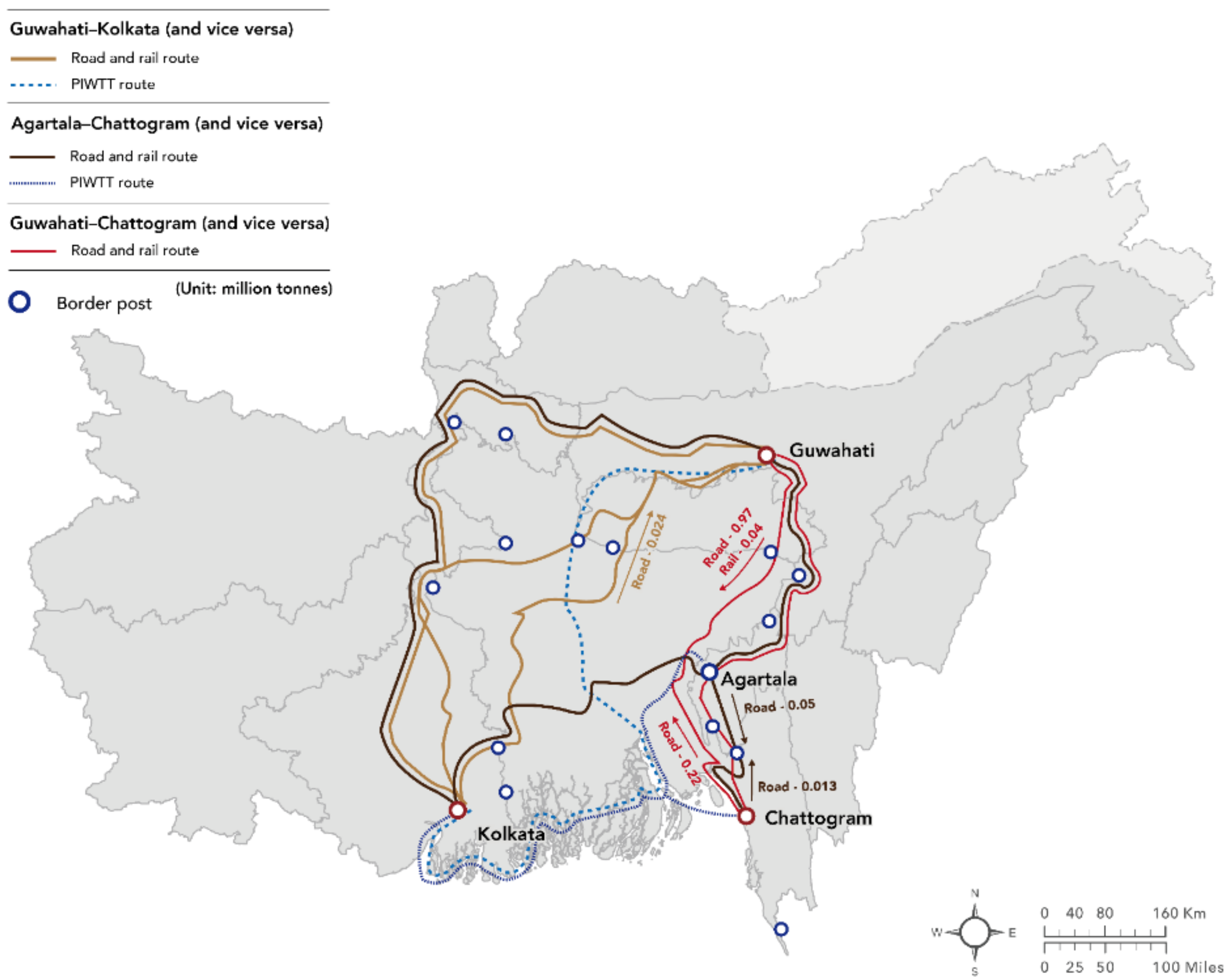
Table 2.8 Predicted freight traffic between northeast India and rest of India in 2025 if agreements are implemented, by route and mode

Origin–destination	*Route*	*Mode*	*Route share*	*Annual traffic in 2025 (million tonnes)*
Guwahati–Kolkata	Via Gobarakura/Gasuapara and Petrapole/Benapole land ports	Road	75 (0)	13.2 (0)
	Via Dhanu/Mahendraganj and Hili land ports	Road	13 (0)	2.2 (0)
	Via Siliguri corridor	Road	2 (82)	0.4 (9.3)
	Via inland waterways	Inland waterways	0 (0)	0 (0)

	Via Siliguri corridor	Rail	10 (18)	1.7 (2.0)
Kolkata–Guwahati	Via Petrapole/Benapole and Gobarakura/Gasuapara land ports	Road	62 (0)	28.5 (0)
	Via Siliguri corridor	Road	2 (61)	0.8 (15.7)
	Via Siliguri corridor	Rail	25 (39)	11.6 (10.1)
	Via Inland waterways	Inland waterways	0 (0)	0 (0)
	Via Hili and Dhanu/ Mahendraganj land ports	Road	10 (0)	4.8 (0)
Agartala–Kolkata	Via Agartala/Akhaura and Petrapole/Benapole land ports	Road	98 (0)	0.4 (0)
	Via Siliguri corridor	Road	0 (72)	0 (0.18)
	Via Siliguri corridor	Rail	2 (28)	0.01 (0.07)
	Via inland waterways	Inland waterways	0 (0)	0 (0)
Kolkata–Agartala	Via Petrapole/Benapole and Akhaura/Agartala land port	Road	98 (0)	0.11 (0)
	Via Siliguri corridor	Road	0 (66)	0 (0.05)
	Via Siliguri corridor	Rail	2 (27)	0 (0.02)
	Via inland waterways	Inland waterways	0 (7)	0 (0.01)
Agartala–Patna	Via Agartala/Akhaura and Hili land ports	Road	69 (0)	0.53 (0)
	Via Agartala/Akhaura and Darshana land ports	Road	25 (0)	0.19 (0)
	Via Siliguri corridor	Road	0 (83)	0 (0.34)
	Via Siliguri corridor	Rail	6 (17)	0.04 (0.07)
	Inland waterways	Inland waterways	0 (0)	0 (0)
Patna–Agartala	Via Hili and Akhaura/Agartala land ports	Road	65 (0)	0.03 (0)
	Via Darshana and Agartala/Akhaura land ports	Road	23 (0)	0.01 (0)
	Via Siliguri corridor	Road	0 (71)	0 (0.02)
	Via Siliguri corridor	Rail	11 (29)	0 (0.01)
	Via inland waterways	IWT	0 (0)	0 (0)

Source: Authors.
Note: Figures in parentheses are base-year figures.

Map 2.4 Predicted freight traffic of exports from and imports to northeast India in 2025 if agreements are implemented



Almost all trade between northeast India and the rest of the world is transported to and from seaports by road, both with and without the policy measures (map 2.4 and table 2.9). However, after the agreements are implemented, shippers in northeast India clearly prefer the Chattogram Port over the Kolkata and Haldia ports, leading to an almost complete shift of flows from Kolkata/Haldia to Chattogram. This result seems to be intuitive, as the Chattogram Port is closer, reducing the transport time and costs for EXIM (other attribute values of the alternatives are similar in this scenario). The Sylhet (Dawki–Tamabil) and Sabroom–Ramgarh land ports are the key land ports expected to facilitate the movement of EXIM to and from Guwahati and Agartala, respectively.

For EXIM to and from Guwahati, IWT retains its small share and rail loses its market share when the agreements are implemented. Rail also loses market share in the movement of exports from Agartala. Interventions leading to a 25 percent reduction in rail costs and times for Guwahati will maintain the base-year market share of 5 percent for rail (the rail share becomes 9 percent). For the rail link connecting Agartala, additional time and cost reductions would be needed.

Table 2.9 Predicted freight traffic of exports from and imports to northeast India in 2025 if agreements are implemented, by route and mode

Origin–destination	Route	Mode	Route share (percent)	Annual traffic in 2025 (million tonnes)
Guwahati–abroad	Via Sylhet to Chattogram	Road	93 (0)	0.97 (0)
	Via Sylhet to Chattogram	Rail	4 (0)	0.04 (0)
	Via Siliguri corridor to Kolkata	Road	0 (95)	0 (0.71)
	Via other routes to Kolkata or Chattogram	Road	3 (0)	0.03 (0)
	Via Siliguri corridor to Kolkata	Rail	0 (5)	0 (0.04)
	Via inland waterways to Kolkata	Inland waterways	0 (0)	0 (0)
Abroad–Guwahati	From Chattogram via Sylhet	Road	95 (0)	0.22 (0)
	From Chattogram via Sylhet	Rail	0 (0)	0 (0)
	From Kolkata via Siliguri corridor	Road	0 (98)	0 (0.13)
	From Kolkata or Chattogram via other routes	Road	3 (0)	0.007 (0)
	From Kolkata via Siliguri corridor	Rail	0 (0)	0 (0)
	From Kolkata via inland waterways	Inland waterways	2 (2)	0.004 (0.003)
Agartala–abroad	Via the Sabroom/Ramgarh land port to Chattogram	Road	99 (0)	0.05 (0)
	Via the Sabroom/Ramgarh land port to Chattogram	Rail	1 (0)	0.001 (0)
	Via the Siliguri corridor to Kolkata	Road	0 (95)	0 (0.04)
	Via the Siliguri corridor to Kolkata	Rail	0 (5)	0 (0.002)
	Via inland waterways	Inland waterways	0 (0)	0 (0)
Abroad–Agartala	From Chattogram via the Ramgarh/Sabroom land port	Road	100 (0)	0.01 (0)
	From Chattogram via the Sabroom/Ramgarh land port	Rail	0 (0)	0 (0)
	From Kolkata via the Siliguri corridor	Road	0 (100)	0 (0.01)
	From Kolkata via the Siliguri corridor	Rail	0 (0)	0 (0)

	Via inland waterways	Inland waterways	0 (0)	0 (0)

Source: Authors.
Note: Figures in parentheses are base-year figures.

Once the integration agreements are in place, coastal shipping will become more prominent in bilateral trade between Bangladesh and India (map 2.5 and table 2.10). Currently, the road route through Petrapole-Benapole plays a key role in their bilateral trade, with a share of 76–97 percent, depending on the direction. IWT is the second most used mode for exports from India (18 percent), but not for exports from Bangladesh. When the agreements are in place, the route through the Petrapole-Benapole land port (road transport) will remain the key route facilitating bilateral freight movement, with a mode share of 86–95 percent depending on the direction. However, the share of costal shipping will raise to 5–11 percent, depending on the direction.

Rail and inland waterways will see declines in their market shares for bilateral transport after implementation of the agreements. Interventions leading to a 50 percent reduction in rail costs and times would reduce the market share of rail to 1 percent instead of 0. Similarly, interventions leading to a 50 percent reduction in IWT costs and time would reduce the market share of IWT from India to Bangladesh from 18 to 11 percent instead of 3 percent.

Map 2.5 Predicted bilateral freight traffic in 2025 if agreements are implemented

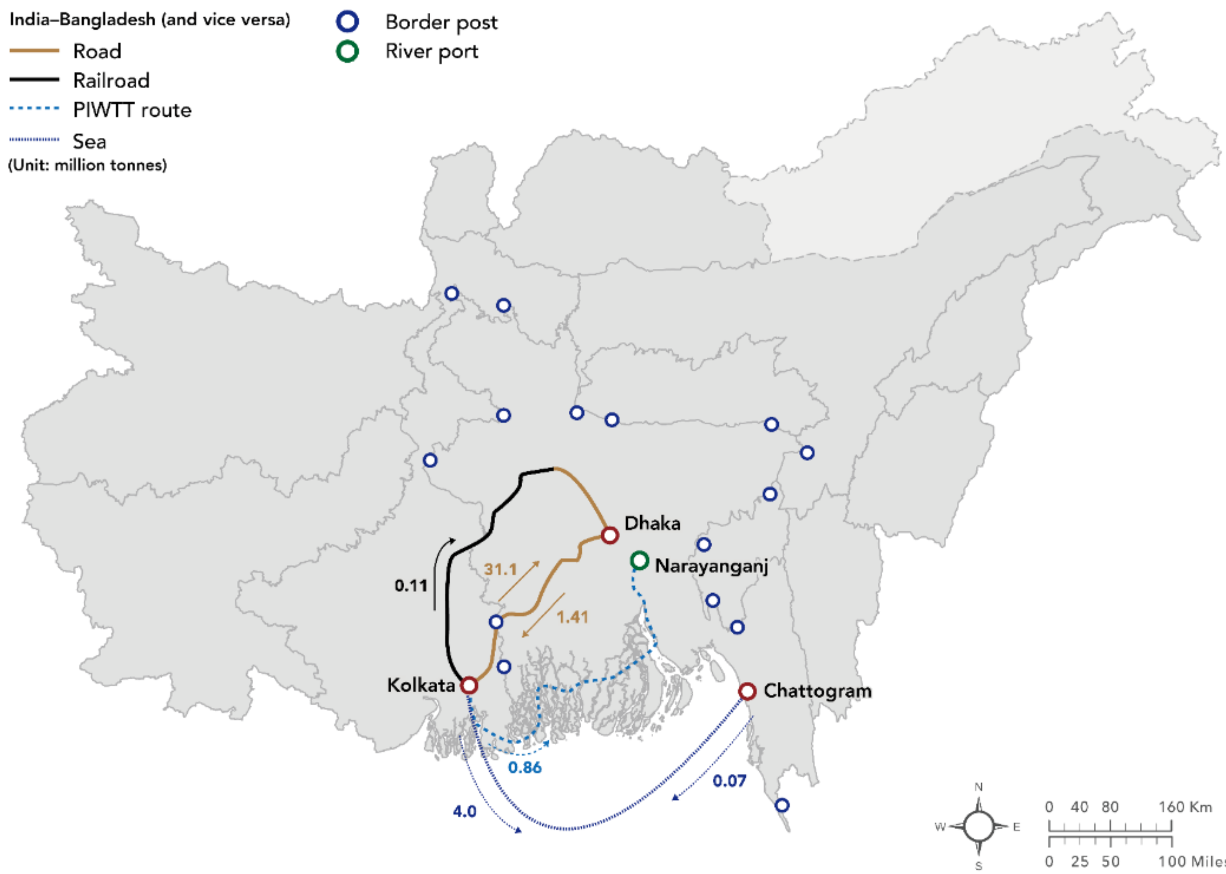


Table 2.10 Predicted bilateral freight traffic in 2025 if agreements are implemented, by route and mode

Origin–destination	Routes	Mode	Route share (percent)	Annual traffic in 2025 (million tonnes)
India–Bangladesh	Via Petrapole/Benapole	Road	86 (76)	31.1 (13.4)
	Via coastal movement from Haldia to Chattogram Port	Coastal shipping	11 (4)	4.0 (0.75)
	Via Gede (partly by road)	Rail	0 (2)	0.11 (0.34)
	Via inland waterways	Inland waterways	3 (18)	0.86 (3.16)
Bangladesh–India	Via Benapole/Petrapole	Road	95 (97)	1.41(0.78)
	Via coastal movement from Chattogram to Haldia Port	Coastal shipping	5 (3)	0.07 (0.02)
	Via Gede (partly by road)	Rail	0 (0)	0 (0)
	Via inland waterways	Inland waterways	0 (0)	0 (0)

Source: Authors.
Note: Figures in parentheses are base-year figures.

The results show that shippers and carriers react strongly to the time and cost advantages offered by the new alternatives through Bangladesh, especially for road transport. If, of course, reliability declined (because of unpredictable delays caused by congestion, for example); damage and theft increased; or waiting times at the border were longer than expected, the shift to road transport routes through Bangladesh would be more modest.

Such situations can be simulated using the model presented in this chapter, by testing different assumptions about these factors by mode and route. For instance, if the roads in Bangladesh have twice as many delays, theft and damage, and border waiting times as assumed earlier, the Siliguri road would have a 4 percent share on the Guwahati–Kolkata route after implementation of the agreements, rather than the 2 percent shown in table 2.8.

The importance of reliability, damage and theft, and waiting times at the border can also be assessed using the model presented in this chapter to help policy makers prioritize interventions. Using the routes through Petrapole/Benapole and Hili land ports for domestic freight traffic from Guwahati to Kolkata, the analysis shows changes in each of the level-of-service attributes have similar and small effects on the shares of both routes. For instance, reducing the probability of delays or the probability of theft from the levels assumed in table 2.8 to zero have similar effect on the shares of the Petrapole/Benapole and Hili routes (table 2.11).

Table 2.11 Predicted domestic freight traffic from Guwahati to Kolkata in 2025 if agreements are implemented, under alternative level-of-service attributes

Level-of-service variants	Share of Petrapole/Benapole route (percent)	Share of Hili route (percent)
Probability of delays of more than 24 hours (percent)		
0	76	13
9 (as assumed in table 2.8)	75	13
18	75	13
40	73	12
Probability of theft and damage (percent)		
0	76	13
4 (as assumed in table 2.8)	75	13
10	74	12
Border waiting time in hours		
0	77	13
8 (as assumed in table 2.8)	75	13
20	74	12

Summary and Concluding Remarks

Recent agreements in the region, particularly the MVA, the PIWTT, and the ACS, aim to open new corridors to facilitate the movement of freight and trade in India and Bangladesh. The results of SP experiments and an econometric model indicate a very high preference for shifting to the new routes and mode choices for freight moving between northeast India and the rest of India and between northeast India and the rest of the world. For bilateral movement between India and Bangladesh, the road route would still be preferred, although there would be a significant shift toward coastal areas.

The predicted shifts in routes and modes of freight transport are based on the assumptions that complementary policies and interventions are implemented together with the agreements to significantly improve the level of service attributes for potential choices. Improvement in the level-of-service attributes assumed in the experiments need to be realized to achieve the predicted route and mode shift.

Ideally, countries should not prescribe the routes and modes to be used for freight transport, leaving that decision to shippers and carriers unless there are important safety, security, or environmental reasons to limit the volume of traffic along certain areas. If countries do prescribe the routes and border posts to be used—which is the case under the MVA—the selection should be based on shippers' and carriers' preferences. If it is not, the integration agreements could have limited or no effect on transport costs, patterns, and volumes. BBIN countries should consider removing the restrictions on specific routes.

The shorter routes through Bangladesh and the elimination of transshipment at border points would reduce travel times and costs. However, upgrading and development of connectivity infrastructure, handling infrastructure at land ports, and automation of cross-border processes need to occur to ensure that the time savings are not offset. It will be important to ensure that no additional costs, such as facilitation payments or accident costs, are incurred on the new routes through Bangladesh.

Reducing manual interventions and checks through automation and IT-based solutions may be required.

Unpredictable border crossing times and congestion along the new routes could potentially increase the probability of delays. Process definition and standardization at the borders and upgrading of infrastructure to eliminate congestion will be needed to reduce the probability of delays. Proper sealing of trucks and security surveillance along the corridors will be required to reduce the chances of theft and damage.

Harmonization and standardization of regulations and integration of custom processes will be needed to ensure seamless integration. Implementation of the MVA will mean that mandatory transshipment at land ports will no longer be necessary. It will be important to ensure that no additional transshipments are required because of differences in axle-load limits or gauges between the two countries. Infrastructure constraints and custom process delays at the borders would increase congestion, increasing border waiting time. Integrating cross-border IT infrastructure, facilitating off-border custom clearances, and upgrading land port connectivity will be required to eliminate the infrastructure constraints and process delays.

The strength of the analysis presented in this chapter is that it is based on interviews with actual shippers and carriers in the relevant corridors on their behavior when it comes to deciding which modes and routes to take. These behavioral data were used in discrete choice models that account for differences in the characteristics of the shipments and the firms (observed heterogeneity) as well as different substitution patterns between modes (nested logit), where shifts between rail, IWT, and sea transport are more likely than between any of these modes and road transport. This approach is not common at all in freight transport analysis, where most models are based on aggregate data.

A disadvantage of the methodology is that the data collected are stated preferences of decision makers in an experimental context, because the context of the implementation of the agreements does not yet exist. Actual behavior of shippers and carriers when the agreements are implemented could differ from the behavior stated in the SP survey (hypothetical bias). To minimize such effects, the experiments were conducted in the contexts of actual shipments and the models were calibrated to observed market shares.

Annex 2A Survey

Pilot Survey

A pilot survey of about 20 percent of the target population (85 respondents) was conducted to gain a clear idea of the model coefficients or priors to be defined for the main SP experiment. Initially, the value of the coefficients for the pilot surveys was based on the relevant literature. From the analysis of the choices made by respondents during the pilot survey, the prior values were refined. The refined prior values were then used for the statistical design and the most relevant levels of attributes for SP experiments. The questionnaires and Android application were also adapted based on the requirements discovered in the pilot stage.

The analysis of pilot-stage data yielded results with the expected signs on the coefficients. In the logit models for the SP1 shippers group, the coefficients for time, cost, delay, and theft had the right signs and were significant (at the 95 percent level). Only the number of transshipments attribute was not significant, although for shippers' EXIM and bilateral segments it had the right sign. Seventy-one interviews from the pilot stage could be used for econometric modelling and shift estimations.

Recruitment and Survey Method

In the sample plan, a master list of industries and logistics service providers by commodities and geographies was prepared. The recruitment and survey of respondents was done in two steps:

- Step 1: Telephone interviews of the screening questionnaire. Representatives of industry and logistics service providers were contacted by phone to determine whether their cargo movement type was relevant for the study and whether they used at least one route or mode tested in the study. Only relevant respondents were considered. An appointment for a face-to-face interview was scheduled during the phone interview.
- *Step 2: Face-to-face interview through Computer Assisted Personal Interview (CAPI)*. The SP experiments were modelled in an Android-based application. All SP experiments were conducted face to face on android devices (tablets and smartphones) carried by enumerators. The data were autotransmitted to a central server from the devices upon completion of the experiment.

CAPI methodology was adopted for this study, given the limited understanding of SP experiments among target respondents in northeast India and Bangladesh. Enumerators spent considerable time explaining the experiment methodology and hypothetical situations. They also guided respondents for correct data responses to the questionnaire, based on which the SP experiments were generated in the application. Only respondents who completed two SP experiments were considered for the data analysis.

Distribution of Sample

Table 2A.1 Distribution of respondents by commodity type

Type of cargo movement	Commodity	Number of respondents			
		Shippers/providers of third-party logistics services		Carriers (road haulage)	
		Target	Actual	Target	Actual
Domestic and export-import	Minerals, marble, stone	20–40	32	10–20	15
	Household goods	20–40	21	10–20	39
	Fruits and vegetables	20–40	19	10–20	22
	Food products, fast-moving consumer goods	20–40	27	10–20	21
	Cement, clinker, fly ash	10–20	10	8–15	12
	Petroleum, oil, lubricants, chemicals, petrochemicals	10–20	10	8–15	13
	Iron, steel	10–20	17	5–10	5
	Tea	10–20	18	5–10	8
	Food grains	1–5	4	1–5	9
	Other	20–40	55	10–20	11
	Total	175	213	100	155
Bilateral	Food grains	10–20	12	7–15	7
	Fruits, vegetables	10–20	11	7–15	7
	Apparels and textile raw materials	10–20	14	7–15	10
	Automobiles and spare parts	5–10	9	4–8	4
	Construction materials	5–10	8	4–8	6
	Fast-moving consumer goods	5–10	17	4–8	7
	Other	10–20	22	10–20	11
	Total	75	93	50	52

Table 2A.2 Distribution of respondents by geographic location

Type of cargo movement	Location	Number of respondents			
		Shippers/providers of third-party logistics services		Carriers (road haulage)	
		Target	Actual	Target	Actual
Domestic and export-import	Northeast India	50–80	94	40–60	66
	Rest of India	95–125	119	40–60	89
	Total	175	213	100	155
Bilateral	India	30–40	54	20–30	36
	Bangladesh	30–40	39	20–30	16
	Total	75	93	50	52

Table 2A.3 Distribution of respondents by existing routes

Type of cargo movement	Route	Number of respondents: Shippers/providers of third-party logistics services – Target	Actual	Carriers (road haulage) – Target	Actual
Domestic	Corridor A: Guwahati–Patna	0	0	0	0
	Corridor B: Guwahati–Kolkata	60–120	114	25–45	87
	Corridor C: Agartala–Patna	15–50	32	15–25	18
	Corridor D: Agartala–Kolkata	15–50	37	15–25	25
	Total	150	183	75	130
Export-import	Corridor B: Guwahati–Kolkata	10–15	20	10–15	15
	Corridor D: Agartala–Kolkata	10–15	10	10–15	10
	Total	25	30	25	25
Bilateral	Road using Petrapole/Benapole land customs station	20–40	44	20–30	35
	Road using other land customs station	20–40	49	20–30	17
	Total	75	93	50	52

Table 2A.4 Distribution of respondents by existing mode

Type of cargo movement	Mode of transport	Number of respondents: Shippers/providers of third-party logistics services – Target	Actual	Carriers (road haulage) – Target	Actual
Domestic and export-import	Road	125–150	144	100	155
	Rail	50–75	61, other[a] (8)		
	Total	175	213	100	155
Bilateral	Road	40–50	60		43
	Sea	20–35	22, other[a] (11)		3, others* (6)
	Total	75	93	50	52

Note: a. “Other” refers to inland waterway and/or rail modes.

Annex 2B Calibrated Elasticities

Table 2B.1 Calibrated cost and time elasticities by mode

Elasticity	Road	Rail	River	Sea
Cost elasticities				
Domestic	–0.51	–1.00	–1.44	—
EXIM	–0.13	–2.27	–2.27	—
Bilateral	–0.23	–1.14	–0.86	–1.09
Time elasticities				
Domestic	–0.32	–0.49	–2.26	—
EXIM	–0.04	–0.66	–0.61	—
Bilateral	–0.23	–0.80	–1.11	–1.82

Note: — Not applicable.

Annex 2C Level-of-Service Attributes

Table 2C.1 Level-of services attributes of domestic cargo, by route

Route	Transport time (hours)	Transport cost (Rs/tonne)	Number of transshipments	Border waiting time (hours)
Guwahati–Kolkata via Petrapole/Benapol (road)	126	2,479	1	8
Guwahati–Kolkata via Siliguri Corridor (road)	164	3,329	1	0
Guwahati–Kolkata via Siliguri Corridor (rail)	126	2,686	2	0
Guwahati–Kolkata via Hili (road)	134	2,742	1	8
Guwahati–Kolkata via PIWTT route (inland water transport)	504	2,903	2	12
Agartala–Kolkata via Siliguri Corridor (road)	250	4,940	1	0
Agartala–Kolkata via Siliguri Corridor (rail)	147	3,660	2	0
Agartala–Kolkata via Petrapole/Benapole (road)	80	1,597	1	8
Agartala–Kolkata via PIWTT route (inland water transport)	386	1,963	1	12
Agartala–Patna via Siliguri Corridor (road)	237	4,616	1	0
Agartala–Patna via Siliguri Corridor (rail)	144	3,544	2	0
Agartala–Patna via Hili (road)	122	3,177	1	8
Agartala–Patna via Gede/Darshana (road)	127	3,351	1	8

Table 2C.2 Level-of services attributes of EXIM cargo, by route

Route	Transport time (hours)	Transport cost (Rs/tonne)	Number of transshipments	Border waiting time (hours)
Guwahati–Kolkata via Petrapole/Benapole (road)	126	2,479	1	8
Guwahati–Kolkata via Siliguri Corridor (road)	164	3,329	1	0
Guwahati–Kolkata via Siliguri Corridor (rail)	126	2,686	2	0
Guwahati–Kolkata via Hili (road)	134	2,742	1	8
Guwahati–Kolkata via PIWTT route (inland water transport)	504	2,903	2	12
Guwahati–Chattogram via Sabroom/Ramgarh (road)	154	2,576	1	4
Guwahati–Chattogram via Sabroom/Ramgarh (rail)	118	2,012	2	6
Guwahati–Chattogram via Dawki/Tamabil (road)	103	2,033	1	4
Guwahati–Chattogram via Dawki/Tamabil (rail)	112	1,650	2	6
Guwahati–Chattogram via PIWTT route (inland water transport)	375	1,959	2	6
Guwahati–Chattogram via Karimganj (Multimodal)	293	2,132	2	6
Agartala–Kolkata via Siliguri Corridor (road)	250	4,940	1	0
Agartala–Kolkata via Siliguri Corridor (rail)	147	3,660	2	0
Agartala–Kolkata via Petrapole/Benapole (road)	80	1,597	1	8
Agartala–Kolkata via PIWTT route (IWT)	386	1,963	2	12
Agartala–Chattogram via Sabroom/Ramgarh (road)	72	1,031	1	4

Agartala–Chattogram via Sabroom/Ramgarh (rail)	96	982	2	6
Agartala–Chattogram via Ashuganj (Multimodal)	226	1,032	2	6

Table 2C.3 Level-of-services attributes of bilateral cargo, by route

Route	Transport time (hours)	Transport cost (Rs/tonne)	Number of transshipments	Border waiting time (hours)
Kolkata–Dhaka via Petrapole/Benapol (road)	138	1,095	0	4
Kolkata–Dhaka via Gede (road + rail)	201	1,513	2	6
Kolkata–Narayanganj via PIWTT route (inland water transport)	434	1,939	3	6
Kolkata–Dhaka via Chattogram and Colombo (sea)	610	9,837	2	—
Kolkata–Dhaka via Gede (rail)	202	1,513	2	6
Kolkata–Dhaka via Chattogram (sea)	293	2,139	2	—

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Notes

1. Bhutan signed the agreement but subsequently pulled out after its parliament failed to ratify it.
2. A rake is a line of coupled freight wagons, passenger coaches, or railcars (excluding the locomotive) that typically move together.
3. The minimum number of interviews for estimating a separate standard submodel was 25.
4. Models were also estimated using RP data collected through the surveys, but the results did not lead to better models. The estimated RP models have positive cost coefficients (domestic), do not converge (EXIM), or have very extreme time and cost coefficients (bilateral). In the models in which the SP coefficients are fixed, very unrealistic RP-scale factors are estimated for EXIM and bilateral. The models estimated on both RP and SP data do not converge and therefore cannot be used. The RP data were therefore found to be unsuitable for model estimation and were not used in the rest of this project. One possible reason for the models not converging is the spatial aggregation of the applied level of service. All combinations of origins and destinations are mapped onto one of the few distinguished corridors.

5 Shippers' willingness to pay when using different modes are different, because a logarithmic formulation for costs is used. As a result, the willingness to pay becomes dependent on the level of the

transport cost per mode in the model, which are different. The interaction variables for time and cost with the attributes of the shipments (such as the high value of the goods per tonne), and the correlations between modes and shipment attributes also affect differences in the willingness to pay between modes.

6. This study did not ask shippers to restrict themselves to the goods-related consequences of time changes, as would have been done in a value of time survey, because the study is about mode and route choice, not about disentangling the components of the value of time. Whatever factors decision makers include in mode and route choice therefore matters.

7. The projected EXIM and domestic cargo movements were calculated based on the historic growth rates of commodities in Assam and Tripura, national growth rates, and state GDP at constant 2011 prices. Bilateral cargo movement was calculated based on the average growth rate of trade between Bangladesh and India between 2016 and 2018 (about 12.6 percent a year) and the growth rate of apparel from Bangladesh (about 8.8 percent a year, according to the Export Promotion Bureau).