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The spatial effects of transport investments in Bangladesh

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Abstract

What would be the spatial effects of reducing congestion through infrastructure investments and of building new bridges in Bangladesh? And which districts or cities will benefit from it? This paper uses a general equilibrium model to produce counterfactuals on the spatial and welfare effects of transport projects across districts in Bangladesh. We employ a quantitative economic geography model alongside spatially detailed information on the location of people, economic activity, and transport costs along the domestic transport network to develop counterfactual scenarios to identify which places are likely to gain and which places are likely to lose from several potential infrastructure projects.

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Keywords: economic corridors; regional economic development; GIS

1. Introduction

Economic integration with the rest of the world is an important driver of economic development, it raises income through specialization, and provides access to cheaper and higher-quality imported goods. Transport infrastructures and logistics are important factors that determine transport costs and affect the degree of integration with the rest of the world.

However, geographic and economic heterogeneity within countries will have economic integration across districts lead to differential effects across locations. Some districts will experience larger reductions in transport costs than others while improving connectivity to the main port of Chittagong could mostly produce economic benefits for the districts that produce traded goods such as textile. Better connectivity will boost the productivity of some sectors, that will benefit from increase in wages and therefore attract more workers. Lower transport costs will also reduce the costs of importing goods, and therefore increase real wages and consumption levels. The domestic transport network is one channel through which different transport costs to reach global markets both for imports and exports will have trade opening affect differently locations in the country.

Investing in transport infrastructure and policies can either reinforce the actual distribution of population and economic activities or help to spread the benefits of trade opening across the country and have more districts benefit from cheaper imports and more opportunities to produce tradable goods. It is therefore important to understand the spatial effects of several potential transport investments.

In this paper we use a general-equilibrium model to produce counterfactuals on changes in population, economic

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activities, and welfare across districts in Bangladesh for several scenarios. The model is described in detail in Lall & Lebrand (*forthcoming*). Results are compared for three scenarios: reducing congestion on the main national roads, building new bridges to fill infrastructure gaps and connect the Western part, and the combination of the two. Potential complimentary policies regarding population mobility and policies to support secondary cities are discussed.

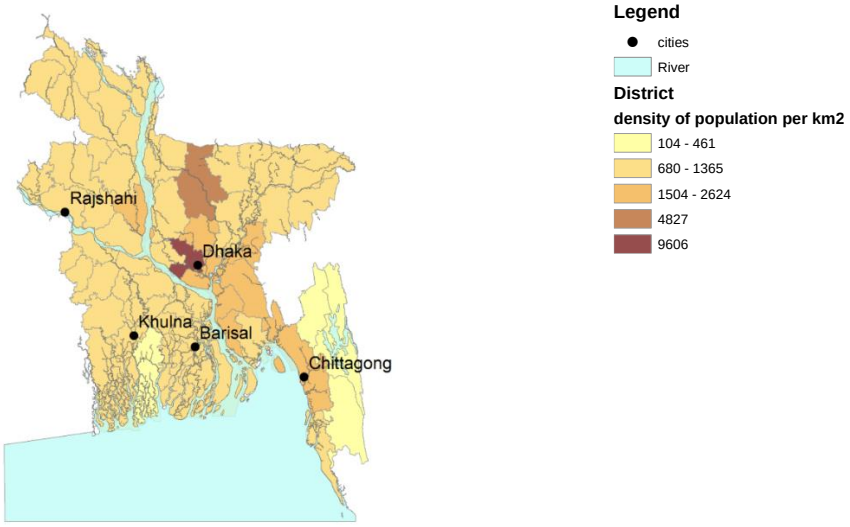
2. A high concentration both in population and economic activities

The distribution of population and economic activities is uneven across districts in Bangladesh. As one example, the Great Dhaka is one of the most densely populated areas in the world, with a density of 23,234 people per square kilometre within a total area of 300 square kilometres. Most manufacturing activities are concentrated in a few districts (Dhaka, Chittagong, Gazipur), and exports are concentrated in one sector, Ready-Made Garment (RMG). While concentration of people and economic activities can be beneficial through agglomeration benefits, negative effects such as congestion and pollution can appear for a too high level of concentration and lower productivity and reduce the attractivity of very populated areas.

2.1. *A concentration of population in a few districts*

Population is concentrated in a few districts that are very dense, and mostly locate along the Chittagong-Dhaka corridor. The overall country is one of the densest countries in the works, with a population density of 1265 people per square kilometre, which ranks 11th in the world in 2017, only after locations such as Macao, Singapore, Bahrain or Malta*. In comparison, the world average is 58 people per square kilometre. The density of population also varies across districts. More than 9% of the total population lives in the Dhaka district, which is also the densest district in terms of population per square kilometres (Figure 1 and Figure 2). Mymensingh is the second densest district of the country. It is worth noticing that other densely populated districts are situated around Dhaka and along the corridor between Dhaka and Chittagong. In terms of share of total population, after Dhaka, the districts of Chittagong, Comilla, and Gazipur, all districts along the corridor Dhaka-Chittagong, gather the largest parts of the total population (Figure 2).

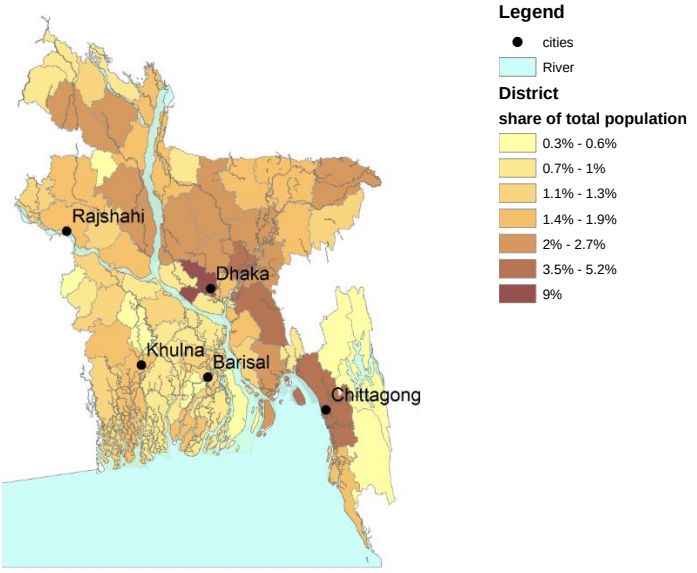
Figure 1: Density of population per district (2015)



Source: Average population density per unit of analysis (2015). Population density (UN Adjusted values) from Gridded Population of the World v4.

* Source: World Bank population density database for 2017.

Figure 2: Share of total population per district (2015)



Source: Population (UN Adjusted values) from Gridded Population of the World v4.

2.2. An even higher concentration of manufacturing and tradable activities

Manufacturing activities, tradable goods production, are even more concentrated than population. Districts are specialized in their production, with some districts producing mostly agriculture and others specialized in manufacturing. While a large part of the population in most districts remains employed in agriculture and rural services, a few districts have specialized in manufacturing production. Dhaka, Gazipur, Chittagong, and Narayanganj are districts in which more or about 40 % of the employed population works in manufacturing, mostly in RMG production (Figure 3 and Figure 4). After China, Bangladesh is the second largest exporters of RMG products, and more than 80% of export earnings come from the RMG sector. Most firms producing RMG goods, which requires a good and fast access to the port of Chittagong, have located along the Dhaka-Chittagong corridor. The decision of where to locate for such firms depend on the location along the transport network and the comparative advantages that a district can offer in terms of labor supply, tax systems, livability, services, and ICT infrastructure among other factors. Given the importance of having timely shipments along the global textile value chains, most firms have chosen to locate along the Dhaka-Chittagong corridor, which allows relatively fast shipments compared to other districts in more isolated parts of the country.

Figure 3: RMG employment share

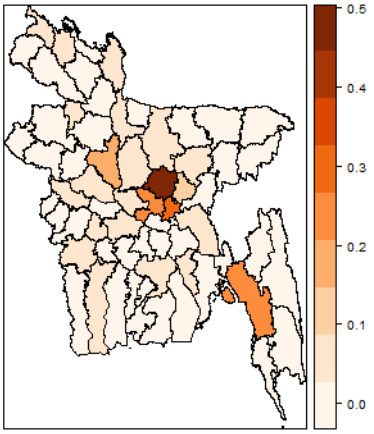


Figure 4: Total manufacturing employment share

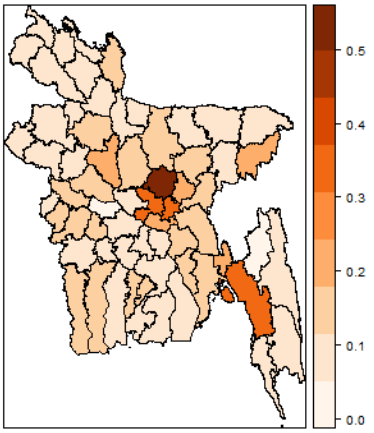
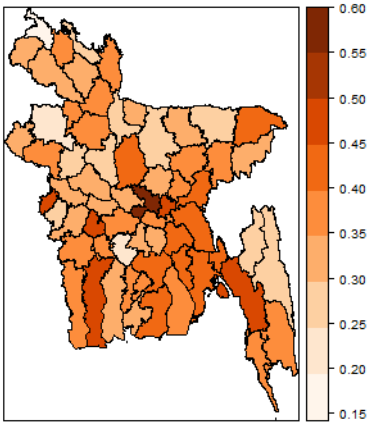


Figure 5: Services employment share



Note: Data come from the LFS 2013 survey for Bangladesh.

3. Using a model to evaluate the spatial impacts of transport investments

Spatial distribution of population and economic activities is influenced by locational advantages, the ways in which economic agents interact across space, the domestic transport network, and the location of gateways to connect to global markets. Identifying which districts will benefit from external integration with global markets and evaluate how transport investments to reduce transport costs will impact the location of people and economic activities depends on the balance between cheap inputs like labor and land, and a good access to the main port. Better connected districts will attract more workers, while a high concentration of people and activities will lead to a high price of land versus wage, which reduces the attractivity of such locations. In order to quantify and predict the impact of such forces, it is important to develop simulation tools that gather all economic forces at stake.

Research in in quantitative spatial economics mimics the behaviour of firms and workers in deciding what to produce and where to do it. Their decisions are reconciled through general equilibrium models that can be calibrated based on the observed level of variables such as population density and economic activity in each location. Because of their meaningful connection with regional data, these models can be used to assess the consequences of different transport development options of interest to policy makers. A critical advantage of quantitative spatial economics is its ability to generate predictions of the spatial distribution of economic activity.

This chapter looks at the differentiated spatial impacts of potential transport or logistics improvements across districts. Which districts will win the most or relatively lose from transport reforms? It focuses on the impact of better connectivity to reach the main gateway for trade, which is currently the port of Chittagong. It relies on a model of general equilibrium to look at the impact of lower transport costs from different transport scenarios on district connectivity and to produce counterfactuals on the allocation of workers, and economic activities across locations.

3.1. Geography, firms and workers

The spatial general equilibrium model of Bangladesh developed for this chapter relies on previous work done for Argentina (Fajgelbaum et co. 2014) and for the Belt and Road Initiative in Central Asia (Lall and Lebrand, forthcoming). It has three main building blocks.

The first one is geography. The model allows for spatial granularity at the district level and considers 64 districts for Bangladesh. Each district is characterized by its location, size and economic structure. Interactions within this geography are captured by a description of the transport network and a quantification of transportation costs. For

example, exporters from the Dhaka area ship goods between their place of production and the main port to access world demand for textile. Their costs depend on transportation mode, distance and type of road. Similarly, goods can be imported from the rest of the world to various districts of the country.

The second building block of the model is a description of economic activity. Production is undertaken by firms that choose how much to produce and how much labor, and land to use in the process. Firms are classified into three sectors: agriculture, manufacturing, and non-tradable production which includes most services and local manufacturing. Tradable services can also be incorporated in the latest category as changes in transport costs to access Chittagong port are unlikely to affect their production patterns.

The third building block is workers. Workers choose in which sector to work and where to live. All workers derive their income mainly from employment and spend it on goods and services produced in the city or imported from the rest of the world Their decisions on where to live and where to work depend on rents, wages, the amenity across locations and restrictions over mobility across regions.

The three blocks of the model are connected by final prices, land rents and wages that prevail in each district. Consistent with the idea of a "general equilibrium," prices adjust to balance supply and demand at the level of each district.

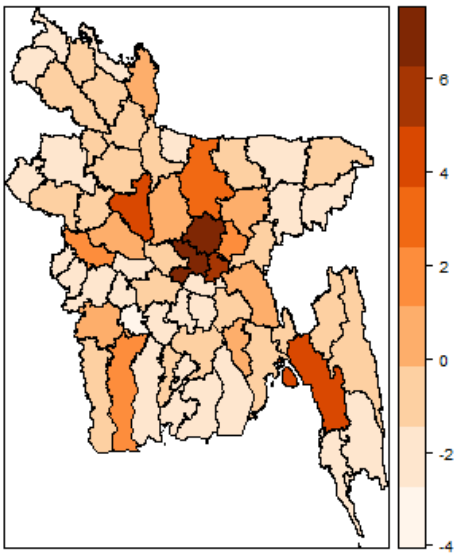
3.2. Calibrating the model

The information needed to calibrate the spatial general equilibrium model for Bangladesh is taken from traditional data sources such as surveys as well as from geo-coded information on transport networks.

The calibration process relies on observed variables (size of land, employment per sector, population density) to induce some key parameters that will encompass the unobserved characteristics of each district. Although productivity and livability scores at the district level are not observed, the model is used to infer these scores based on the observed levels of the size and composition of land, employment per sector, and population density. Productivity scores reflect the potential of firms to produce using labor and land inputs. While workers and land are similar across districts, the capacity of firms to produce differ across locations. Livability scores reflect the potential of a district in terms of amenity and affect the residential choice of workers. Workers tend to move towards districts that offer higher real wages and higher amenity levels. The districts of Dhaka, Gazipur, Narayanganj, Chittagong, and Sirajganj have the highest livability scores (Figure 6).

Data that are used to calibrate are land areas (ESA land categories from the Aiddata database), the current distribution of population per district, and employment categories from the 2013 LFS survey. Survey data are used at the district level to provide estimates of employment per industry, with four sectors of interest: agriculture, manufacturing without RMG, RMG, and services.

Figure 6: The calibration of the model generates livability scores by location (in log)

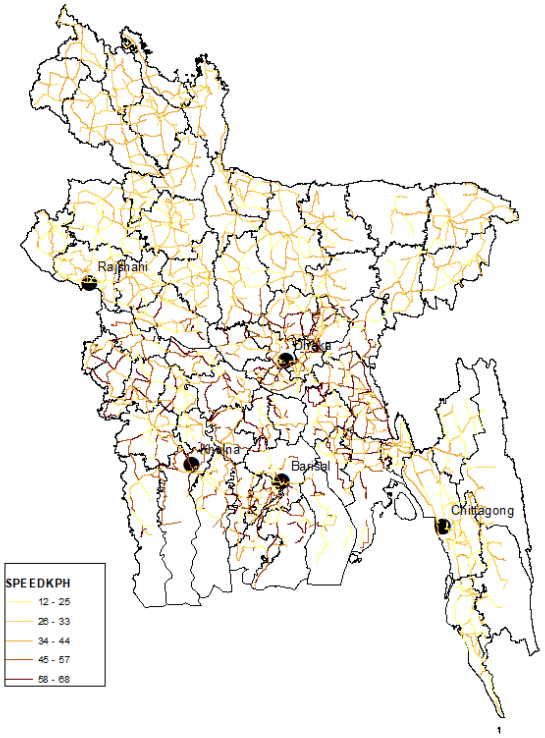


In order to measure the change in connectivity for each district, the impact of different transport infrastructure investments on the time and costs to reach a main transport gateway using the transport network has to be quantified. Transport costs are measured as a function of the optimal time to reach Chittagong port, which is measured by using GIS network techniques to minimize travel time given all the possible routes in the network. Each district is proxied by its centroid on the map, and the minimum-time path on the existing road network is calculated. The road network that is used to measure the optimal path is based on actual measured speed, rather than ex-ante assumed speed. Such distribution of speed reflects the impact of congestion and poor quality of the roads on the actual traffic conditions (Figure 7).

Several methods have been used to parametrize iceberg costs used to calibrate the model. Trade costs between locations o and d are modelled according to an iceberg assumption: for one unit of a good to arrive at its destination d, $\tau_{\{od\}} > 1$ units must be shipped from origin o. All assume that the trade cost incurred along the connection between o and d is a function of the time it takes to travel from o to d. Following Allen and Arkolakis (2016), we assume an exponential functional form, that has been used extensively in the economic geography literature and ensures that infrastructure costs are always equal or greater than one.[†]

[†] Iceberg costs are measured by $\tau_{\{od\}} = \exp(\kappa \times \text{time}_{\{od\}}^{\alpha})$ With $\alpha = 0.9$ and $\kappa = 0.03$†.

Figure 7: Road transport network with actual measured speeds



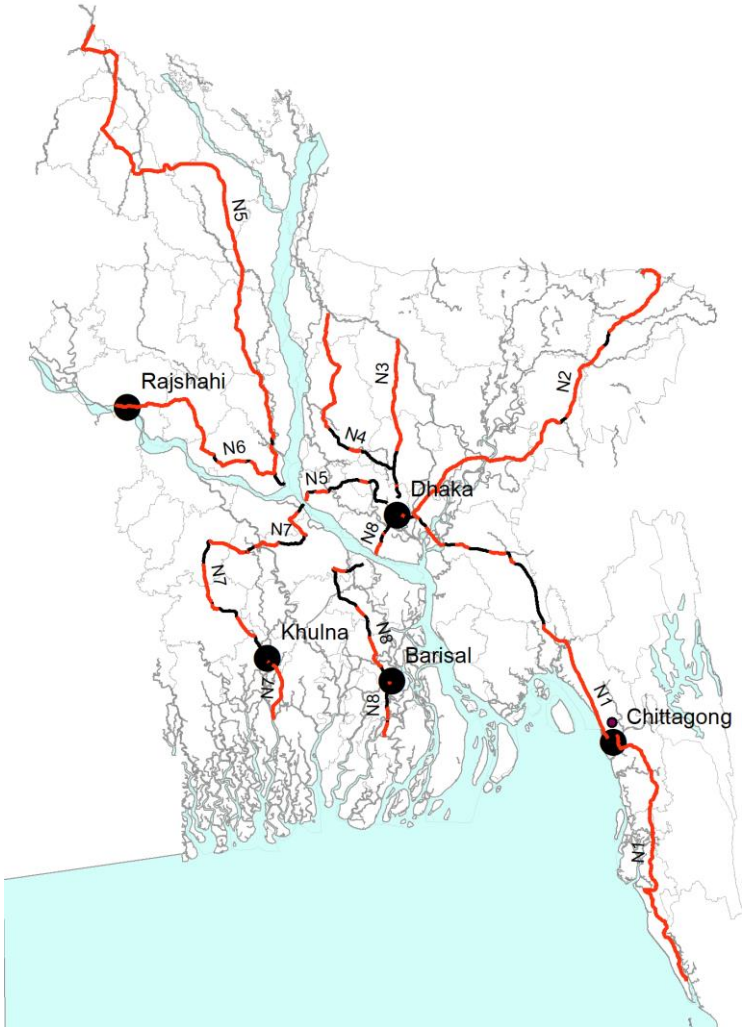
3.3. Constructing the four scenarios

The model is used to simulate three transport development scenarios for Bangladesh. This is accomplished by changing the values of transport costs defined in the domestic transport network in ways that reflect the impacts of the two key interventions considered would have on regional dynamics. These interventions are introduced sequentially in order to identify the additional impact of each of them.

Two types of transport interventions are considered: investment to reduce congestion on existing roads and constructions of new bridges across the main river.

- Intervention 1 - Transport/Logistics investments on main national roads: the first scenario considers investments to reduce congestion and therefore improve traffic on all main national roads (roads N1-N8). Improving the quality of the roads, constructing new lanes, improving other modes of transportation such as rail or water modes to decrease freight traffic on the roads are all examples of investments to reduce congestion. Lower congestion and better infrastructure are assumed to allow trucks to be faster, especially on the segments where congestion is such that the observed speed of traffic is very low. In order to evaluate this counterfactual, congestion is assumed to be reduced, which translates into the real speed of trucks on all route segments to be assumed to be at least 40km/h (Figure 8). On the segments with a speed higher than 40kmph, the speed is assumed to remain the same.

Figure 8: all National roads N1-N8



Note: the portions of national roads in red are the segments whose observed speed is below 40 km/h. The portions in black have an observed speed higher than 40km/h

- Intervention 2: New bridges In addition to improving the quality of freight traffic and reduce congestion, the construction of new bridges would create new routes and help shippers going to or coming from the Western regions to have a better access to the main port of Chittagong. In addition to the Jamuna bridge, four other bridges are considered in this scenario to cross the Padma river. Two other bridges are considered to improve the connections with Khulna and Jessore, both in the South-Western part of the country, whose connections to the main port of Chittagong and therefore to global markets are presently limited. These bridges are also major segments along the main national roads N5, N6 and N8 going from Dhaka to the Western part of the country.

Figure 9: Map of the new bridges

While previous investments in improving road traffic only would slightly decrease the time to reach Chittagong port for most regions, building new ports will have much larger effects (Figure 9 and Figure 10). The construction of new bridges will dramatically improve connectivity to global markets for certain regions that are currently isolated. Locations in the South West of the country with previously high transport costs will experience large decrease in transport costs to reach the main port of Chittagong (Figure 10).

Figure 9: Time to reach the main port for investments in roads only

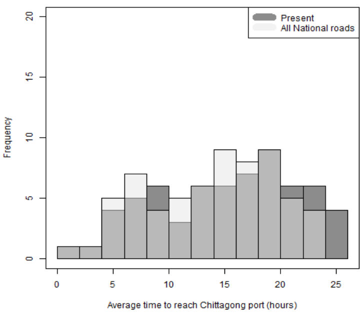


Figure 10: Time to reach the main port for investments in bridges only

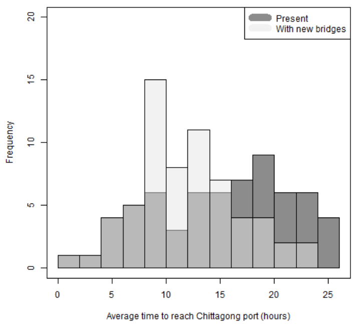
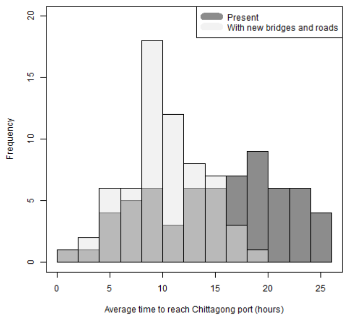


Figure 11 Time to reach the main port for investments in roads and bridges



Source: each diagram shows the distribution of time in different scenarios across districts in Bangladesh.

- <u>Intervention 3: combining road investment with new bridges</u>

Both improving traffic on the main national roads and building new bridges when considered together have the largest effect to improve connectivity to reach the main port towards global markets. The third counterfactual of interest combines both interventions to evaluate the relative gains across locations. Combining both investments would lead transport time to reach the Chittagong port to drastically decrease for all districts (Figure 11).

4. Which benefits from transport investments?

Better integration with the rest of the world will differently impact Bangladeshi regions depending on their locations, the structure of their economy, their comparative advantage, and other factors such as education and productivity. Several factors affect the interregional dynamics: (i) the presence of agglomeration benefits and negative externalities like pollution and congestion, and (ii) the domestic integration through the transport network for regions to be well connected to the main global markets. Bangladesh 's population and economic activities tends to be highly concentrated in very few locations (Figure 2 and Figure 3). Regions that are isolated struggle to attract firms and workers in manufacturing and export markets, while attractive areas suffer from congestion and pollution due to a very high concentration of activities in a very small number of locations such as Dhaka. The presence of agglomeration benefits is one factor to explain such uneven distribution. Agglomeration benefits from having suppliers and buyers close to each other while firms can have access to a large pool of workers partly explain that high level of concentration around a few cities. However, the high level of congestion and pollution in these cities as well as a decreasing attractivity for workers to live there tend to push firms away from these high concentrated locations. The quality of the transport network is the second factor that explains that most export activities are located in or around Dhaka and Chittagong.

Several countries have developed ambitious plans to invest in their domestic transport network, both to improve their infrastructure and their logistics services. These plans often aim at developing regions that have not benefited from the country's opening to global markets. For example, China has invested a lot in building major highways and railways to integrate the Central and Western parts of the country that were previously isolated and have not benefited from trade opening as much as coastal locations. Improving domestic connectivity is one among other interventions to integrate better all regions with external trade. However, these effects will differ across locations, some regions might win while others might relatively lose. Which regions will benefit or relatively lose from improving domestic connectivity? The answer to this question depends on the type of transport interventions. The model developed and calibrated for Bangladesh can be used to simulate outcomes from several scenarios: improving traffic on national roads and building new bridges.

4.1. An uneven improvement in connectivity across districts

A key difference among the three scenarios is the identity of the main beneficiaries in terms of reduction in transport costs to reach global markets as well as the extent of these reductions. In the first scenario, reducing congestion on the slowest segments of national roads will mostly benefit the locations that are further away from Chittagong, especially in the North and South Western parts (Figure 12). In the second scenario, new bridges will only benefit the South western regions which will experience dramatic reductions in transport costs to reach Chittagong port (Figure 13). In the third scenario, the combination of reduction in congestion and new bridges will end up in most regions benefiting from lower transport costs, with the largest reductions in the South Western part of the country (Figure 14).

Figure 12: Change in transport costs in Intervention 1 (in %)

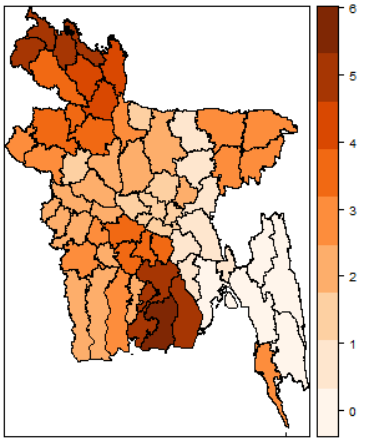


Figure 13: Change in transport costs in Intervention 2 (in %)

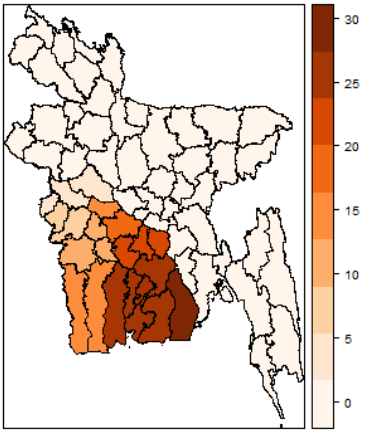
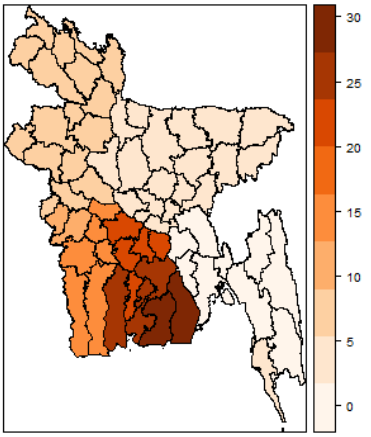


Figure 14: Change in transport costs in Intervention 3 (in %)



4.2. Spatial distribution of population gains: towards more or less concentration?

Such reductions on transport prices will first affect prices of goods and then wages and land rents, which are the drivers of economic decisions. Decisions for economic activities to move in a certain location rather than in others and for workers to move to certain locations depend on prices. Lower transport costs decrease the price of imported goods for consumers and increase the price of exported goods at which local producers can sell their goods while remaining competitive with foreign producers.[‡] Workers in the tradable sectors will benefit from higher production prices and higher returns through increases in wages. Land which is a fixed factor will also become more expensive in areas that will benefit from lower transport costs. However, such effects in sectors where traded goods are produced will also impact the rest of the economy. Workers in regions that will benefit from wage increases will also benefit from wage increases, and prices of non-tradable goods will automatically increase too.[§] Such wage increases will attract more workers from other regions, and such mobility by increasing the work supply will end up limiting the wage increases. All these effects are captured in the general equilibrium model of Bangladesh.

Each intervention will differently reduce transport costs across regions. In the future, some regions will attract more workers than others and therefore grow more. Overall the total population is assumed to grow by 10%, but some regions will grow more while others will grow less than 10%. When only reducing congestion on the main national roads, the regions that will grow the most are Dhaka, Sirajganj and Gazipur districts (Intervention 1 in Figure 15). When building new bridges, the regions that will grow the most are those in the South-Western part of the country (Intervention 2 in Figure 16). New bridges will remarkably reduce transport costs to reach the main port of Chittagong for these regions, while other locations will not benefit from this intervention. When combining both interventions, both the regions around Dhaka and those in the South-Western part of the country will grow the most (Intervention 3 in Figure 17). The Northern and Eastern locations will relatively benefit much less in terms of population growth than the rest of the country.

[‡] The local price of imported goods ("IMP") in district l depend on the international price P^*_{IMP} and is given by $P_{IMP}(l) = \delta(l)\, P^*_{IMP}$. Lower transport costs, i.e. lower $\delta(l)$, imply lower domestic prices in location l. For exported goods in location l, the local price is given by $P_{EXP}(l) = \frac{P^*_{EXP}}{\delta(l)}$ with P^*_{EXP} the international price. Lower transport costs increase the price of the domestic good, i.e. increases the returns on producing exported goods for local producers.

[§] Given our assumption of perfect mobility across sectors within districts, wages are equalized across sectors. Therefore, changes in connectivity does not only affect wages and land prices in the tradable sectors but also changes incentives in non-tradable sectors. Thus, higher prices for the exported goods tend to increase wages and land prices and therefore non-tradable prices.

Figure 15: Population growth (Intervention 1)

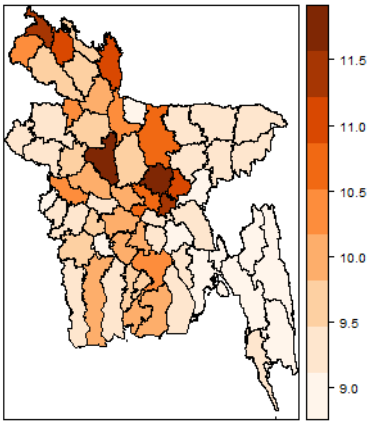


Figure 16: Population growth (Intervention 2)

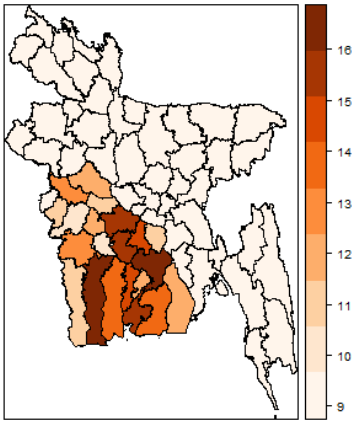
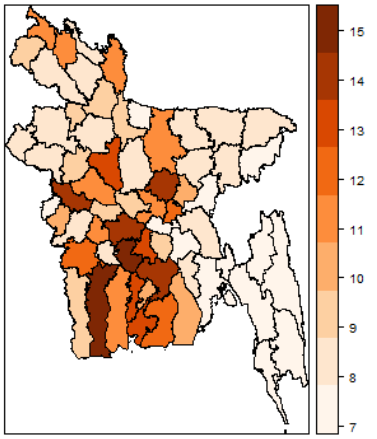


Figure 17: Population growth (Intervention 3)



However, the current concentration of individuals and economic activities in a few locations, such as the district of Dhaka, means that it might be more important to look at the number of additional workers rather than its growth rate. Indeed, for all interventions most additional workers will be concentrated in the district of Dhaka, Gazipur, and Chittagong (Figure 18,Figure 19 and Figure 20). Other districts such as Gazipur, Sirajganj in intervention 1 or Barisal and Khulna in intervention 2 will grow more than Dhaka or Chittagong districts but most of the additional workers will concentrate in Dhaka district.

Figure 18: Additional employed workers per district (Intervention 1)

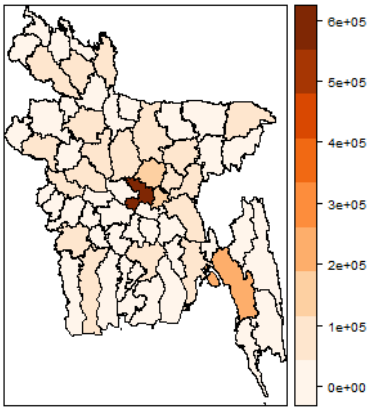


Figure 19: Additional employed workers per district (Intervention 2)

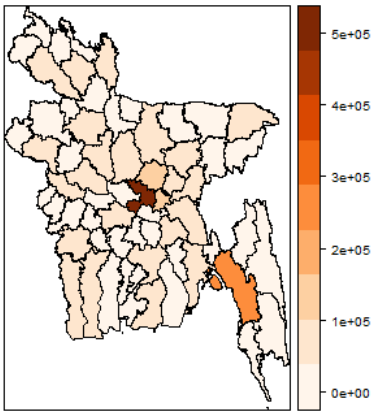
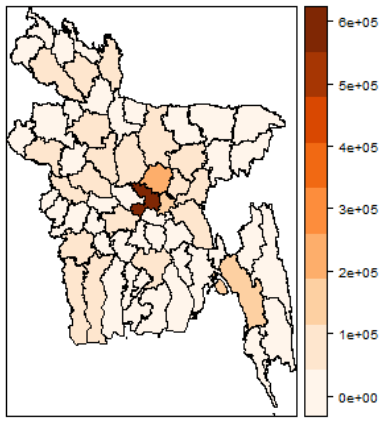


Figure 20: Additional employed workers per district (Intervention 3)



Note: Agriculture is no included in the analysis. Additional employed workers per location here include workers either in manufatcuring or services.

Reductions in transport costs only partly explain the effects of the intervention on population growth. Following intervention 1, the regions in the North and South will experience the largest reduction in transport costs

while most population growth will be concentrated around Dhaka. Overall higher population growth will be observed in regions that experience large reductions in transport costs (Figure 21), have a comparative advantage in producing exportable goods (Figure 22), and are attractive locations (Figure 23). Looking at the population gains from intervention 3, there are two types of winners: (1) the regions with a high comparative advantage in producing exportable goods (RMG manufacturing) and a high level of attractivity such as Dhaka, and (2) the regions in the South Western parts that will experience very large reductions in transport costs thanks to the construction of new bridges.

Figure 21: Transport costs and population growth (Intervention 3)

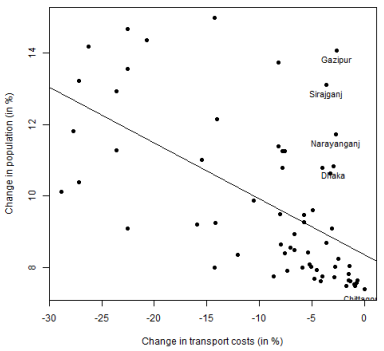


Figure 22: Initial RMG employment shares and population growth (Intervention 3)

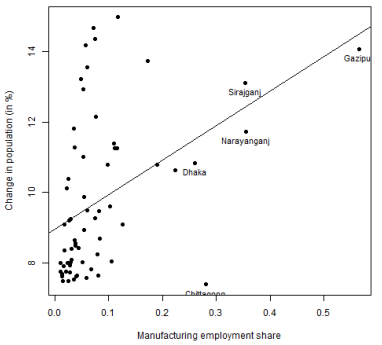
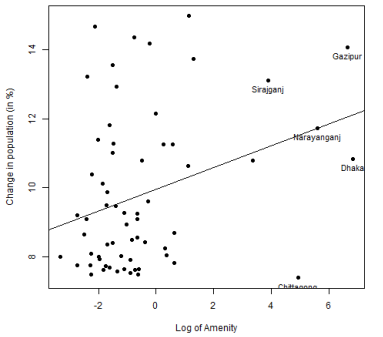


Figure 23: Amenity and population growth (Intervention 3)



4.3. Spatial distribution of welfare gains: who wins, who loses?

Some regions will benefit more than others in terms of welfare gains, measured as the growth of real wage which represents the consumption level. Having assumed a large growth of the population without any further productivity improvement, wages fall in the model for almost all scenarios. The spatial impacts of connectivity improvements across locations should therefore be evaluated by the relative welfare gains. Connectivity improvements impact both wages and consumption prices. In intervention 1, the regions that will benefit the most are the regions around Dhaka and in the North of the country (Figure 24). Following intervention 2, only the South-Western regions relatively benefit from the construction of new bridges that lower import prices and increase local producer prices (Figure 25). Overall, when considering both reduction in congestion on national roads and the construction of new bridges, both the South-Western regions and the locations around Dhaka will relatively benefit in terms of welfare (Figure 26)

Figure 24: Real-wage growth (Intervention 1)

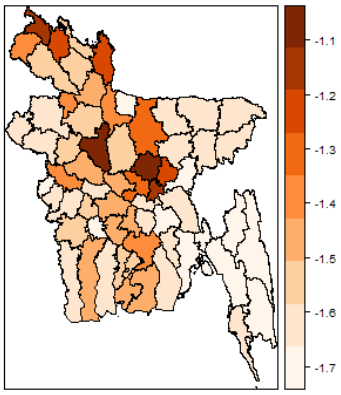


Figure 25: Real-wage growth (Intervention 2)

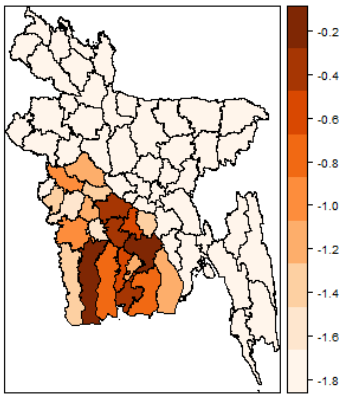
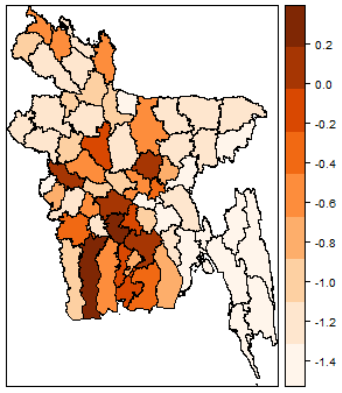


Figure 26: Real-wage growth (Intervention 3)



Regions that benefit in terms of welfare tend to experience larger reduction in transport costs (Figure 27), have a large comparative advantage in RMG manufacturing (Figure 28) and are more attractive (Figure 29). While Gazipur, Sirajganj, Narayanganj and Dhaka do not experience the largest reduction in transport costs, they still benefit a lot from the combined interventions because they are the regions with the highest share in RMG employment and are attractive places both for workers and for firms. On the contrary, the regions in the South-Western part of the country will attract workers and become more competitive given the large reduction in transport costs that the construction of new bridges will bring, despise their current lack of production of export goods and their lower attractivity.

Figure 27: Transport costs and welfare gains (Intervention 3)

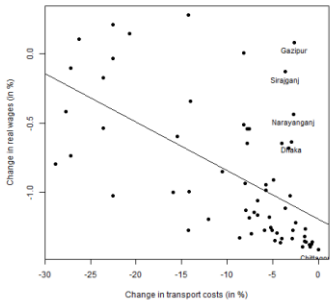


Figure 28: Initial RMG employment shares and welfare gains (Intervention 3)

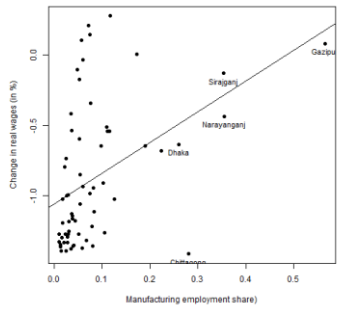
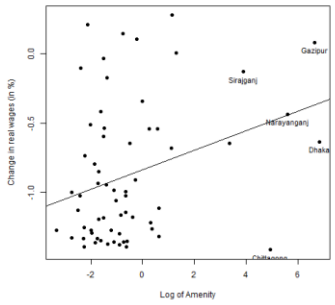


Figure 29: Amenity and welfare gains (Intervention 3)



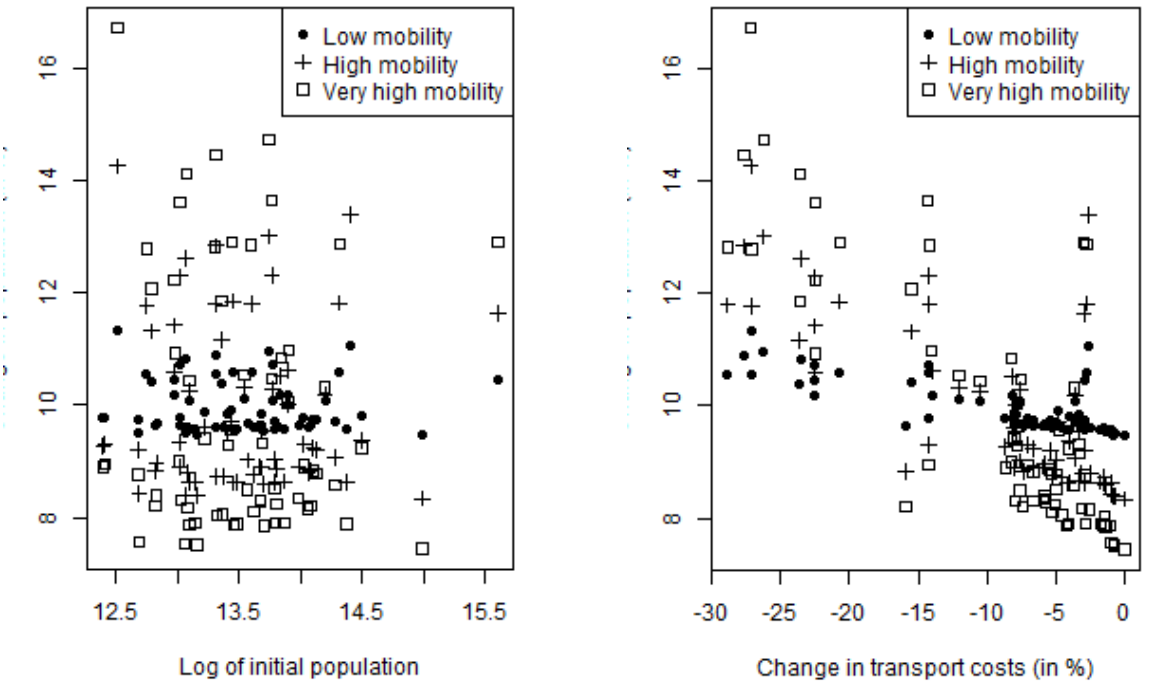
4.4. Complementary interventions: labor mobility restrictions

Restrictions on labor mobility reduce the movement of workers towards districts with higher economic opportunities. Mobility restrictions are modeled through the exogenous elasticity of labor mobility to real wages that determines to which extent workers react to increases in economic opportunities in other locations. A lower elasticity

indicates a lower propensity to move, which suggests higher barriers to mobility. In the case of a low propensity of workers to move, all districts grow at the same rate and little reallocation of workers towards the districts that benefited from better connectivity happens (Figure 30). In the case of very high mobility, districts that benefit from large decrease in transport costs will attract a lot of workers and grow more than districts that will experience little change in connectivity (Figure 30).

Figure 30 Mobility and population growth for Intervention 3

(a) With respect to initial population (b) With respect to transport costs



Note: Low mobility corresponds to a Fréchet parameter $\theta = 1$*, high mobility to* $\theta = 4$*, and very high mobility to* $\theta = 8$*. Previous simulations show results for a level of mobility.*

Lower mobility restrictions will benefit the country through a better allocation of workers where the economic opportunities are increasing. Policies can be used to increase the attractivity of some areas, but mobility restrictions could lead to higher wage inequality with relatively few workers in well-connected areas that experience a high increase in wages, whereas a higher mobility would bring more workers in more attractive places that will also benefit from economic opportunities. In addition, a better matching of skills between employees and employers tends to increase productivity and growth. However negative externalities appear from a high population density that will reduce productivity and makes such regions as well as the country less attractive for multinational firms to develop value chains in Bangladesh. It might therefore be also interesting to complement transport investments with regional plans to develop secondary cities too.

4.5. Complementary interventions: towards more attractive secondary cities

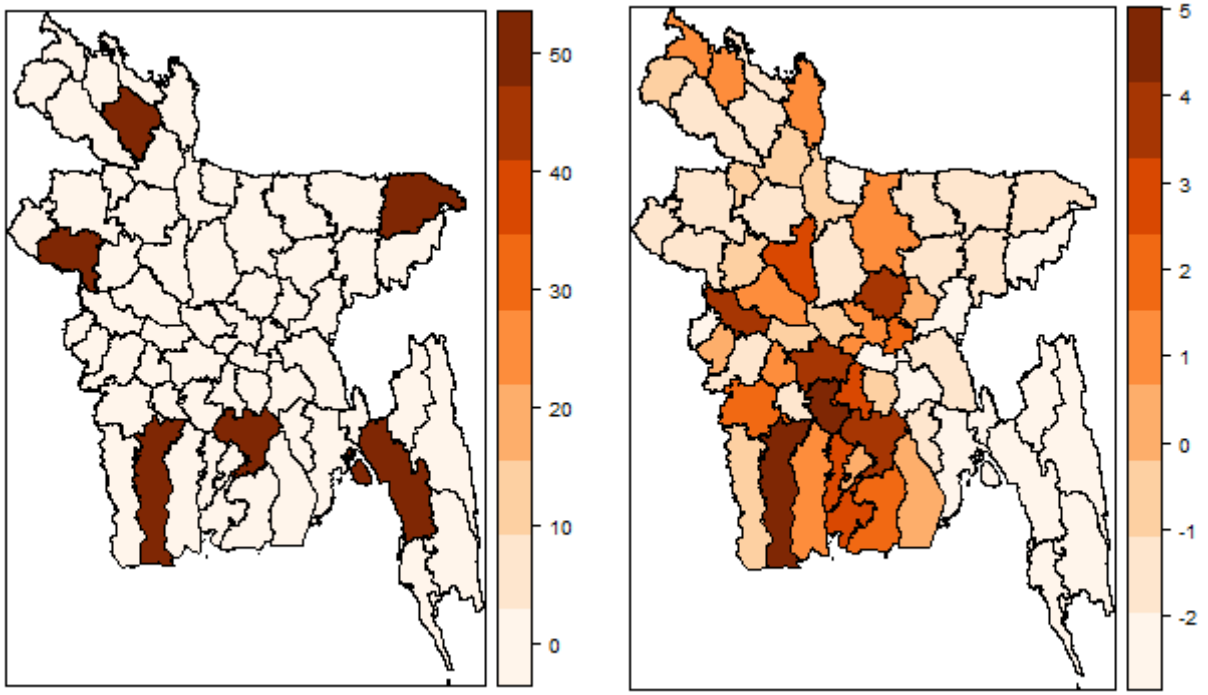
Given the high concentration of population and economic activities in a few locations, improving transport infrastructure can complement policies that promote secondary cities. This last section presents the results for a scenario in which the livability of some secondary cities is increased by 50% (Figure 31). The district with the

secondary cities that are improved are: Barisal, Chittagong, Khulna, Rajshahi, Rangpur, and Sylhet. Results in terms of population growth in this scenario with and without infrastructure investments, i.e. investments along the national roads and in new bridges (intervention 3), are compared. Among the six secondary cities whose livability index increases, only Barisal and Khulna, both located in the South West of the country, benefit from the transport investments. All four others have lower population growth when investing in renovating the national roads and building new bridges in addition of improving the attractivity of secondary cities.

Figure 31 Livability and population growth for Intervention 3

(a) Growth of livability index of 50% in selected districts

(b) Change in population growth from Intervention 3 and new livability levels compared with the baseline case of no transport intervention (in %)



Understanding the effects of transport investments on each district in complement to other policies will help policy makers to prioritize which areas might benefit the most from a combined set of investments in both transport and urban attractivity. Some districts, like Gazipur and Sirajganj, will benefit from transport investments even if no complementary urban plans are implemented. Choices remain to be made to whether the priorities should go to locations that will benefit from transport investments to maximize the economic gains or to locations that will instead relatively lose from these transport investments.

5. **Conclusion**

This paper uses a general-equilibrium model to produce counterfactuals on the spatial effects of large transport investments in Bangladesh in terms of population, economic activities and welfare. Reducing transport congestion on the national roads or building new bridges will affect differently regions across Bangladesh.