Policy Research Working Paper 8806

Who Wins, Who Loses?

Understanding the Spatially Differentiated Effects of the Belt and Road Initiative

Somik V. Lall
Mathilde Lebrand

World Bank Group
Social, Urban, Rural and Resilience Global Practice
April 2019

Policy Research Working Paper 8806

Abstract

This paper examines how cities and regions within countries are likely to adjust to trade openness and improved connectivity driven by large transport investments from China's Belt and Road Initiative. The paper presents a quantitative economic geography model alongside spatially detailed information on the location of people, economic activity, and transport costs to international gateways in Central Asia to identify which places are likely to gain and which places are likely to lose. The findings are that urban hubs near border crossings will disproportionately gain while farther out regions with little comparative advantage will be relative losers. Complementary investments in domestic transport networks and trade facilitation are complementary policies and can help in spatially spreading the benefits. However, barriers to domestic labor mobility exacerbate spatial inequalities whilst dampening overall welfare.

This paper is a product of the Social, Urban, Rural and Resilience Global Practice. It is part of a larger effort by the World Bank to provide open access to its research and make a contribution to development policy discussions around the world. Policy Research Working Papers are also posted on the Web at http://www.worldbank.org/research. The authors may be contacted at mlebrand@worldbank.org and slall1@worldbank.org.

Who Wins, Who Loses? Understanding the Spatially Differentiated Effects of the Belt and Road Initiative

Somik V. Lall and Mathilde Lebrand *

Keywords: transport corridors, territorial development, labor mobility, complemen-tary policies

JEL Classification: O10, O18, R10, R11, R13

*World Bank. This paper should not be reported as representing the views of the World Bank. The views expressed in this paper are those of the authors and do not necessarily represent those of the World Bank or World Bank's policy. We thank Pablo Fajgelbaum, Baher El-Hifnawi, Caroline Freund, Michele Ruta, Indermit Gill, and Tony Venables for their advice. This paper was supported by World Bank's Global Solutions Group on Territorial Development under its program on spatial productivity, with financial contributions from UK DFID.

1 Introduction

The Belt and Road Initiative (BRI) is an effort to improve regional cooperation and connectivity on a trans-continental scale. The initiative aims to strengthen infrastructure, trade, and investment links between China and 70 other economies. It consists primarily of the Silk Road Economic Belt, linking China to Central and South Asia and onward to Europe, and the New Maritime Silk Road, linking China to the nations of South East Asia, the Gulf Countries, North Africa, and on to Europe. Trade and transport costs are envisaged to reduce through a mix of "hard" and "soft" projects, including rehabilitation of major transport corridors and building missing links in the network across Africa, Asia, Europe and the Middle East, alongside policy, institutional and governance reforms to facilitate trade. By promoting trade across countries with thick borders, especially in places that have been physically and economically distant from global markets, large transport investments can improve welfare, but it also creates internal challenges for countries participating in the projects. Because of transport costs and labor mobility frictions within countries, not all regions and workers will evenly benefit from a better integration with global markets. Workers move towards better opportunities, benefiting the regions that can offer better amenities and higher wages. Labor mobility frictions prevent workers to equally benefit from these new opportunities, with some having a better access to new economic gains than others.

In this paper, we develop a quantitative economic geography model to examine how regions within countries adjust to trade and transport shocks. Policymakers understand the salience of within country regional adjustments very well as achieving spatial equity in development outcomes is an important barometer of political success. However, insights from New Economic Geography predict that, other things equal, regions with inherently less costly access to foreign markets, such as border or port regions, stand to reap the largest gains from trade liberalization. Improvements in connectivity are likely to be associated with more spatial concentration, not dispersion of economic activity within countries.[1][2] In the absence of mechanisms to compensate places that face "net economic losses" from connectivity improvements, policymakers are likely to see considerable risks in supporting initiatives that exacerbate spatial inequalities and pose fiscal burdens as some sub-national regions may simply see trucks and rail wagons pass by whilst having to service the debt associated with infrastructure investments.

Our focus on spatial adjustment to BRI induced trade and transport effects complements other recent papers that examine how BRI related shocks affect distribution of firms and sectors

[1] See survey paper by Brulhart (2011); World Bank (2008); Hanson (1998); Fajgelbaum and Redding (2018)

[2] Standard economic analysis is based on diminishing returns, the more of an activity is undertaken, the lower is the value of doing still more. Applying this in a spatial context yields the prediction that economic activity will be smeared smoothly across space, a prediction contradicted by the existence of large cities. From a spatial perspective, this thinking needs to be revised as proximity is valuable and where economic activity clusters and is unevenly distributed across space. There are two drivers: (1) direct efficiency saving of being close together (savings in transport and communication costs, and economies of scale arise as firms and infrastructure operate at scale); and (2) agglomeration economies that are generated by close and intense economic interaction.

within countries. In particular, we examine two questions:

- First, who wins, who loses? What are the spatially differentiated economic effects of BRI investments?
- Second, what are the potential spatial efficiency equity trade-offs associated with these investments?

Our analytic work focuses on Central Asia as BRI investments have the potential to substantially spatially re-orient the economic geography of the region, due to its proximity to China, limited historical extent of regional integration, and persistence of Soviet legacy on current economic structures and trade links. This paper contributes to the nascent economics research linking the impacts of external integration on internal economic geography of countries. Until recently, much of the economic literature on international trade treats countries as 'points' with no internal spatial differentiation and much of the literature on domestic market access and economic geography does not explicitly consider the implications of international trade and connectivity. Our paper also examines the role of complementary policies such as labor and capital mobility, price pass-through, and trade facilitation reforms to maximize the gains from external integration. Until recently, much of the literature has considered perfect labor mobility within countries and no mobility across countries.

Our paper is closely related to the literature examining trade effects of infrastructure projects within and across countries (Donaldson, 2018; Duranton et al., 2014) and the resulting endogenous internal distribution of people and economic activity Allen and Arkolakis (2017), Alder (2017), Caliendo and Parro (2015), Redding (2016), and Fajgelbaum and Redding (2018). Our paper mostly builds on Fajgelbaum and Redding (2018) which, in contrast to the other papers, look at the relationship between internal and external integration, and structural transformation across sectors within countries. We use a similar framework to which we add imperfect mobility of workers to take into account domestic labor mobility restrictions in Central Asia as well as in China.

Our main findings are that urban hubs near border crossings will disproportionately gain while farther away regions with little comparative advantage will be relative losers. The determinants of the spatially-differentiated effects differ whether transport investments only take place or additional reforms improve border-crossing. Improvements in transport connectivity are often not sufficient to support economic development in less attractive locations, as local amenity and the strength of comparative advantage in the export sector are strong predictors of gains across districts.

Our main findings are the following:

1. BRI transport investments favor development around urban hubs near border crossings while farther out regions with little comparative advantage are relative losers. In Kaza-

khstan, real wages will grow 5 times more in the locations around Almaty than in the northern locations at the border with the Russian Federation.

2. Complementary investments in trade facilitation accentuate economic gains around hubs while investments in domestic transport networks help in spatially spreading the benefits.

3. Barriers to domestic labor mobility exacerbate spatial inequalities whilst dampening overall welfare.

4. Domestic policies and investments that support spatial mobility of labor and internal connectivity can mediate potential spatial efficiency equity tradeoffs within countries.

The rest of the paper is organized as follows. In Section 2, we provide details on the Belt and Road Initiative investments and the countries of interest. In Section 3, we describe our modelling strategy to develop economic geography counterfactuals of the BRI in Central Asia. We discuss results on BRI winners and losers, and discuss risks from spatial inequalities in Section 4. Section 5 concludes.

2 The Belt and Road Initiative

The Belt and Road Initiative roughly follows and expands the old Silk Road on the land side and complements it with a maritime part to build a series of economic corridors across Asia, Europe and Eastern Africa. The range of initiatives is very wide, including policy coordination, infrastructure, trade and investment, financial and people-to-people exchanges. In this paper, we focus on the consequences of transport infrastructures linked with the Belt and Road Initiative. Given that there is no official list of projects and countries in the Belt and Road Initiative, we rely on the list created by the World Bank (Figure 1, de Soyres et al. (2018)).

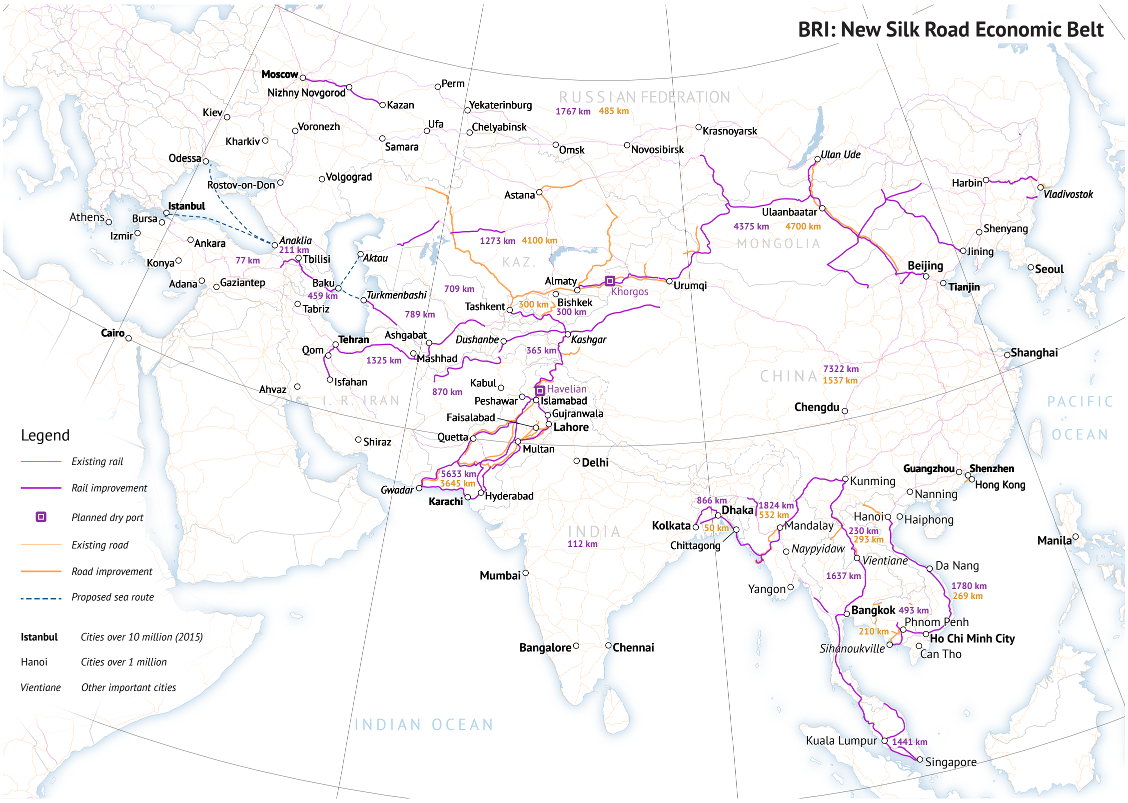
2.1 What is the Belt and Road Initiative?

Main corridors The BRI is organized around six economic corridors: (1) the China-Mongolia-Russia Economic Corridor; (2) the New Eurasian Land Bridge; (3) the China-Central Asia-West Asia Economic Corridor; (4) the China-Indochina Peninsula Economic Corridor; (5) the China-Pakistan Economic Corridor; and (6) the Bangladesh-China-India-Myanmar Economic Corridor. This paper focuses on Central Asia and the "Belt corridors" but also considers how investments outside Central Asia will improve the connectivity of these landlocked countries to international gateways. The focus on Central Asia is motivated by the fact that large reductions in transport costs can have large internal impacts for economies that are not integrated through trade linkages[3]. Three main corridors are of particular interest for Central Asia: the

[3] Figure Annex.2 shows changes in shipping times per country for the entire world

new Eurasian Land Bridge, the China-Central Asia-West Asia corridor, and the North-South corridor (China - South Asia). These policies remain more difficult to quantify and integrate in the model.

Figure 1: The map of BRI projects on the "Belt"



Source: Reed and Trubetskoy (2019)

In addition to "hard" infrastructure projects, policy, institutional and governance reforms would complement hard infrastructure projects. Reforming the transport and logistics sectors to improve transport services could do as much to reduce costs and increase trade as building new routes. Reducing trade barriers, from administrative costs to filling papers to waiting times at the border, is among the "soft" measures to be implemented along these corridors. One example is the development of the Khorgos dry port that would aim at streamlining border procedures and improving border logistics services to reduce waiting time and costs for traders between Kazakhstan and China.

Global market integration Transport prices and trade frictions define the integration of consumers and producers from different locations to global markets. The final price of traded goods depends on additional transport and trade costs to reach global markets, and these costs vary depending on the location of production or consumption and the available transport routes. Relying on the database of de Soyres et al. (2018), we assume that rail corridors are used to reach distant global markets while roads are used to go from the initial location to a main transport hub along the rail corridors. Not all locations within countries have a direct access to these corridors, shippers, therefore, have to use the road network to reach a main transport hub, change mode in order to benefit from the rail corridors. While trade frictions do not apply for transport costs within countries, they add up when using cross-continental corridors, especially for land-locked economies such as Central Asian countries[4].

2.2 Aggregate trends in Central Asia

All roads lead to Russia The Soviet period has shaped the patterns of trade and transport networks in Central Asian countries. Most current infrastructure was built during the Soviet period, and had been organized in a network centered on Russia. Production was divided across countries in the USSR according to their own comparative advantage. The whole transport network set up in the 20th century was designed to connect periphery countries to Russia.[5] While Russia remains an important trade partner, Central Asian countries are looking for diversifying their horizons given their central location. In this context, the BRI is an opportunity to open new routes, towards China, South Asia, as well as the Middle East and Africa. Central Asian countries are landlocked, hence the importance for them to be well connected.

External and internal integration The BRI will reduce transport costs through a mix of "hard" and "soft" infrastructure projects. Major infrastructure projects first aim at rehabilitating major corridors and building the missing links in the transport network in order to increase the number of routes to access ports and international gateways. These projects will affect both the absolute and relative connectivity of countries with respect to each other and the absolute and relative connectivity of provinces within countries with respect to each other. This paper focuses on the economic impacts of infrastructure projects at the district level.

Export potential for Central Asian countries In Soviet times, the Central Asian republics were interlinked within the centrally managed economic system of the USSR. Each of these republics specialized in producing a specific agricultural commodity according to its endowments. For example, Uzbekistan specialized in producing cotton, while Kazakhstan was the breadbasket of the region.[6] Central Asian agriculture is sharply differentiated by subregion. Geography

[4] More details on the BRI database and cross border times are provided in Annex B.

[5] Kazakhstan was producing and exporting commodities and wheat. During the American Civil War, it became difficult for Russia to import cotton from the United States. Uzbekistan, which had recently been absorbed into the Russian empire, was then chosen to become the main producer and supplier of cotton. The whole transport network set up in the 20th century was designed to connect periphery countries to Russia, with railway lines in Central Asia mostly connecting the capitals with Russia.

[6] After their independence in 1991, Central Asian countries were faced with a disruption of the earlier trade arrangements and economic linkages for production and distribution of farm products. In addition the quantity and quality of the production as well as the natural resources have been degrading as a result of the heavy emphasis put by the Soviet system on production instead of production efficiency. The transition in agriculture from a central command system to market-driven mechanisms has been slow.

and climate favor two major export crops, cotton in the south and wheat in the north.[7]

High trade costs and the regional economic disintegration that has reduced access to large markets for sparsely-populated countries can explain the lack of economic diversification. The geography of Central Asian countries, which are all landlocked countries with limited connectivity in all directions except North, and the poor quality of transport infrastructure and policies lead to high transport costs and poor transport connectivity (Pomfret, 2016). While high subsidies have allowed traditional crops (cotton, and wheat from northern Kazakhstan) to be exported, high trade costs especially hurt small farms and other agriculture products have been deterred from being exported. In addition to recent liberalization efforts due to new political contexts, new transport and border investments would support production diversification and trade in more profitable crops and agricultural goods.[8]

3 A model of structural change and integration

In order to quantify the consequences of reductions in transport time, we use a quantitative economic geography model of the distribution of economic activity across regions and sectors within countries. We build on Fajgelbaum and Redding (2018) enhanced with labor mobility frictions and later apply it to develop counterfactual scenarios.

The distribution of economic activity across regions and sectors is determined by productivity and relative prices, where these prices depend on both external and internal transport costs. The economy consists in three sectors: manufacturing, agriculture, and non-tradables. It consists of a set of locations $l \in \Lambda$ that differ in terms of their position and natural endowments. The transport network and border requirements defines the trade cost for each location to access a main transport hub (seaports, air ports, or dry ports) that have direct access to world markets at exogenous prices $\left\{\{P_g^*\}_{g=1}^{G}, P_M^*\right\}$ that depend on external transport costs. We assume that Central Asian economies are small enough relative to world markets for the world prices to be exogenous. Each location has a land area $L(l)$ that can be allocated among the different sectors.

In addition, individuals are assumed to be imperfectly mobile across regions. The model incorporates a large number of potentially asymmetric locations that differ in terms of their

[7]Following Russia's conquest of Uzbekistan in 1875 with the fall of Khiva and the American Civil War which created a shortage of cotton, the Tsarist regime developed the cotton sector and built railroads to transport cotton to Russia. The most productive wheat farming is in northern Kazakhstan, while other Central Asian countries expanded their wheat area after independence in a quest for greater food self-sufficiency, but their wheat is of lower quality than Kazakhstan's. The traditional livestock sector that shrank drastically after 1991 could revive as incomes increase and diets change, and niche products could also be developed.

[8]In Uzbekistan the new president has been pushing for traditional production of raw cotton and poor-quality wheat to be replaced by higher specialization in the new comparative-advantage products of horticulture. The recently-elected president is pushing for reforms to modernize the economy. At the end of 2017, the convertibility of the currency was seen as a main step to open the country, boost exports and attract potential investors.

productivity, amenity scores, and transport connectivity. Workers are mobile across locations, but have heterogenous preferences for each location. This assumption differs from Fajgelbaum and Redding (2018) which assumes perfect mobility across regions. Each location faces an upward-sloping supply curve for population such that higher real wages should be paid to attract workers with lower idiosyncratic tastes for that location[9]. Internal mobility barriers, which are relatively strong in Central Asia, might impact the extent of reallocation of workers following a connectivity shock. For example, Seitz (2017) documents the rigidities in the housing market in Kazkahstan that make cities un-affordable and prevent the emergence of a functional rental market that would facilitate labor mobility. In Uzbekistan, government regulations strongly control and restrict internal migrations between rural and urban areas as well as across regions. The capital's superior opportunities for education, employment and housing are out of reach for all of those without legal registration in the city.[10]

3.1 Households

The utility of an individual i from origin l living at destination d depends on (i) the consumption of tradable and non-tradable goods, (ii) an individual-specific preference shock, and (iii) the structure of migration costs.

Heterogenous Preferences for locations Following Redding (2016) and Morten and Oliveira (2018), individuals' heterogenous preferences for each location are added to Fajgelbaum and Redding (2018). An idiosyncratic amenity shock $b(l,i)$ for a location l and an individual i captures the idea that workers have heterogenous preferences for living in each location. These shocks are assumed ot be drawn independently across locations and individuals from a Frechet distribution:

$$G_l(b) = e^{-b(l)b^{\theta}} \tag{3.1}$$

where the scale parameter $b(l)$ determines average amenities for location l and the shape parameter θ controls the dispersion of amenities across individuals for each location.
In addition we assume migration costs that take an iceberg form, so that $\kappa_{ol} \geq 1$. We assume that it is costless to stay in the origin ($\kappa_{oo} = 1$) and that migration costs are symmetric ($\kappa_{ol} = \kappa_{lo}$). Given the specification of consumer preferences, the indirect utility function for an individual i from origin o in location l is given by

$$U_{o,l}(i) = \frac{b_l(i)}{\kappa_{ol}} C(l) \tag{3.2}$$

[9] Compared to Redding (2016), this paper does not assume inter-location trade.
[10] Such policies were initially introduced during the Soviet period to control movements of people (Turaeva, 2016). This system is similar to the Chinese hukou system of residency registration.

with $C(l)$ the consumption aggregate for location l, and κ_{ol} is the migration iceberg cost for moving from origin o to location l. Following Morten and Oliveira (2018), given that individual shocks $b_l(i)$ are drawn from a Frechet distribution, there exists a gravity equation for the total migration flow, M_{ol}, between locations o and l:

$$M_{ol} = U_l \kappa_{ol}^{-\theta} (WMA_o)^{-1} N_o \tag{3.3}$$

where $U_l = b(l)C(l)^{\theta}$ is the utility of living in location l, and $N^{pre}(o)$ is the pre-BRI number of workers in origin o. Worker market access, WMA, defined as $WMA = \sum_l U_l \kappa_{ol}^{-\theta}$, measures the outside options of workers in location o (Morten and Oliveira, 2018). WMA is higher for locations that are close to high utility (high amenity, high wages, lower prices) locations that workers can access.

Consumption Individuals can consume tradable and non-tradable goods, which are assumed to take the constant elasticity of substitution (CES) form:

$$C(l) = \left[\beta_T c_T(l)^{\frac{\sigma-1}{\sigma}} + (1-\beta_T) c_N(l)^{\frac{\sigma-1}{\sigma}}\right]$$

where $c_T(l)$ and $c_N(l)$ respectively denote consumption of the tradable and the non-tradable goods. Similar to Fajgelbaum and Redding (2018), Ngai and Pissarides (2007) and Herrendorf et al. (2013), we assume inelastic demand between tradables and non tradables ($0 < \sigma < 1$). Tradables consumption is defined over consumption of manufacturing good and agrciultural good.

Each worker is endowed with one unit of labor that is supplied inelastically with zero disutility. The labor market clearing condition is given by:

$$\sum_{l \in \Lambda} L(l) n(l) = N$$

where $L(l)$ is the land per location, $n(l)$ the population density, and N the total population.

Demands for traded and non-traded goods in location l per unit of land are:

$$\begin{aligned} c_T(l) &= \beta_T \left(\frac{E_T(l)}{E(l)}\right)^{-\sigma} \frac{y(l)}{E(l)} \\ c_N(l) &= (1-\beta_T) \left(\frac{P_N(l)}{E(l)}\right)^{-\sigma} \frac{y(l)}{E(l)} \end{aligned}$$

with $y(l)$ the income per unit of land, and $E(l)$ the price aggregate.

Mobility across locations Each worker chooses the location that offers her the highest utility. Individuals value both their consumption bundle, defined by the real wage in each location, and their preference for a location. In addition to individual idiosyncratic preferences across asymmetric locations, the presence of mobility restrictions is modeled by the matrix of iceberg migration costs between locations.

Indirect utility function is a monotonic function of the amenity draw and has a Frechet distribution. Each worker from each location l draws an idiosyncratic indirect utility. Utility is independently drawn across workers and locations from a Frechet distribution:

$$F_l(U) = e^{-\phi_l U^{-\theta}} \qquad \phi_l = b(l)C(l) \tag{3.4}$$

The probability that a worker from origin o chooses to live in location l is now:

$$\frac{N(o,l)}{N^{pre}(o)} = \frac{\kappa_{ol}^{-\theta} b(l)C(l)^{\theta}}{WMA(o)} \tag{3.5}$$

where $N^{pre}(o)$ is the population of location o before the migration choice, and the elasticity of population with respect to real income is determined by the Frechet shape parameter θ. $WMA(o)$ is the worker market access at origin o defined by $WMA(o) = \sum_{l'} \kappa_{ol'}^{-\theta} b(l')C(l')^{\theta}$.

The expected number of workers in location l is now:

$$\frac{N(l)}{N} = \sum_o \frac{N(o,l)}{N^{pre}(o)} \frac{N^{pre}(o)}{N^{pre}} \frac{N^{pre}}{N} \tag{3.6}$$

$$= \sum_o \frac{\kappa_{ol}^{-\theta} b(l)C(l)^{\theta}}{WMA(o)} \frac{N^{pre}(o)}{N^{pre}} \tag{3.7}$$

where θ is a parameter describing the dispersion of shocks among workers and $\sum_{l'} b(l')C(l')^{\theta}$ describes the "attractiveness" of other regions, reflecting their inherent characteristics and their productivity through their ability to offer higher levels of real wages. A higher θ means more heterogeneity in idiosyncratic tastes for locations and a weaker response of migration flows to changes in economic returns of migration. If the migration costs are the same over pairs of origin-destinations, then the probability of workers to be located in l does not depend on migration costs.

Expected utility for a worker across locations is:

$$E(U) = \delta \Big[\sum_{l'} b(l')C(l')^{\theta} \sum_o \kappa_{ol'}^{-\theta} \frac{N^{pre}(o)}{N^{pre}} \Big]^{\frac{1}{\theta}} \tag{3.8}$$

with $\delta = \Gamma((\theta - 1)/\theta)$ and $\Gamma()$ denotes the gamma function.

3.2 Production technology

Production in each sector occurs under conditions of perfect competition and constant returns to scale. The production technology takes the Cobb-Douglas form so that output per unit of land is:

$$\begin{aligned} q_N(l) &= z_N(l) n_N(l)^{1-\alpha_N} \\ q_X(l) &= z_X(l) n_X(l)^{1-\alpha_X} \\ q_M(l) &= z_M(l) n_M(l)^{1-\alpha_M} \end{aligned}$$

where $0 < \alpha_i < 1$ is the land intensity in sector i with X the exported good, M the imported good, and N the non-tradable good. Agriculture is assumed to be more land-intensive than manufacturing and the production of non-tradables ($\alpha_A > \alpha_M > 0$, $\alpha_A > \alpha_N > 0$). Manufacturing is assumed to be less land-intensive than agriculture but more land-intensive than non-tradables.

Profit maximization In each sector and location, firms choose employment density taking as given goods and factor prices. Firms make zeros profit. Land rents are given by:

$$r_i(l) = max_{n_i(l)}\{P_i q_i(n_i(l)) - w(l) n_i(l)\} \quad for\ i = X, M, N$$

Sectoral employment and wage-rental ratio Using profit maximization and zero profits, equilibrium sectoral variables can be written in terms of the wage-rental ratio $\omega_i(l) = \frac{w(l)}{r_i(l)}$.

$$n_i(l) = \frac{1-\alpha_i}{\alpha_i} \frac{1}{\omega_i(l)} \tag{3.9}$$

$$\omega_i(l) = \left(\frac{w(l)}{P_i(l) z_i(l)}\right)^{\frac{1}{\alpha_i}} \tag{3.10}$$

3.3 Equilibrium

The equilibrium of this economy is defined by the following.

Definition 1 *A general equilibrium consists of allocations $\{L_i(l)\}_{i=N,M,X}$, and $\{n_i(l)\}_{i=N,M,X}$, wages $w(l)$, land rents $r(l)$, and prices $\{P_i(l)\}_{i=N,M,X}$ for all $l \in \Lambda$ such that*

- *workers maximize utility and choose their location optimally*
- *land is allocated optimally across sectors*

$$r(l) = max(r_X(l), r_M(l), r_N(l))$$

- *the land market clears in each location*

$$\sum_{i=M,N,X} L_i(l) = L(l)$$

- *the labor market clears in each location*

$$\sum_{i=M,N,X} \frac{L_i(l)}{L(l)} n_i(l) = n(l)$$

- *the non-tradable goods market clears in each location*

$$c_N(l) = \frac{L_N(l)}{L(l)} q_N(n_N(l))$$

- *traded goods prices ae determined by no arbitrage:*
  - *if a location l exports to the rest of the world, its price equals the price at the nearest hub less transport costs, $P_X(l) = \frac{P_X^*}{\delta(l)}$, where $\delta(l)$ is the iceberg transport cost from location l to reach a transport hub.*

  - *if a location l imports from the rest of the world, its price equals the price at the nearest hub more transport costs, $P_M(l) = P_M^* \delta(l)$, where $\delta(l)$ is the iceberg transport cost from location l to reach a transport hub.*

The existence of the equilibrium is proved in Fajgelbaum and Redding (2018) and remains the same with migration costs. The model determines the structure of each local economy l (the pattern of specialization across sectors and goods with their respective employment and labor shares), the level of economic activity (population density and income per worker), and the distribution of income between labor and land. We use this equilibrium definition to create counterfactuals given changes in transport costs.

If a region trades with the rest of the world, constant returns to scale and population mobility implies that only one traded sector is produced. We assume that agriculture is the only traded good that is produced.

The spatial Balassa Samuelson effect This model predicts a spatial Balassa-Samuelson effect, in which locations with better access to world markets have higher population densities, higher shares of employment in the non-traded sector, higher relative prices of non-traded goods, and higher land prices relative to wages (Fajgelbaum and Redding, 2018). Differences in relative good and input prices drive the pattern of development. In well-connected areas, labor is cheap relative to land, which gives an advantage to labor-intensive activities, here non-traded goods (services and local manufacturing). This effect explains that locations with low trade costs to international markets, such as regions close to ports or railway lines, feature a high relative price in the non-traded sector and high land rents relative to wages. The paper develops a model of multi-industry and multi-location country to conclude that: proximity to trade hubs is associated with (i) high employment density, (ii) high land rents relative to wages and (iii) structural transformation away from agriculture.

The spatial Balassa-Samuelson effect has been used to rationalize empirical patterns observed on the role of internal geography in shaping the effects of external integration in Argentina during the period 1870-1914. Similarly to the large-scale increase in external integration that happened in Argentina, the BRI is expected to have large effects on Central Asian countries through a reduction in transport and trade costs. The choice of this model to produce counterfactuals for Central Asia is also justified by some similarities in economic development and trade patterns between Central Asian countries and Argentina, and in the comparative advantage of Central Asian countries for agricultural exports. We put aside the main commodity exports from Central Asian countries, minerals and oil.

Validation of the spatial Balassa Samuelson effect in China and Central Asia Both in China and Central Asia, population density and urban shares increase with proximity to the main gateways. In China, the development of maritime routes towards Europe and America has led most export gateways to be located on the East Coast (Figure Annex.1a). In landlocked Central Asian countries, gateways are borders that have been differently opened in the past. While borders towards Russia have been favored during the most part of the 20th century, China used to be a main partner in a more distant past, and most recently all borders have been very thick reducing regional trade to very low levels. Population density is higher along the borders in Kazakhstan, Uzbekistan, and Kyrgyz Republic (Figures Annex.1b, Annex.1c in Annex).

3.4 Quantitative analysis

We use the model as a quantitative tool to obtain counterfactuals from changes in transport costs. Following Fajgelbaum and Redding (2018), we first calibrate the model's parameters. Second we solve for the unobserved values of the sufficient statistics $\{b(l), \tilde{z_X}(l), z_N(l)\}$ for which the observed data are an equilibrium values of the model. These statistics correspond to structural residuals or wedges to ensure that the model's predictions are consistent with the data. Finally we undertake counterfactuals for changes in transport costs keeping all other parameters unchanged.

Calibration Standard parameters are used for factor intensity ($\alpha_A = 0.2 > \alpha_N = 0.1$)[11]. However the share of tradables is increased in the basked of consumption from 0.3 to our parameter $\beta_T = o.4$.

The migration elasticity to wages (θ) is a parameter that has not been extensively estimated. Redding (2016) varies the Frechet parameter for worker preference heterogeneity from 3 to 5. Monte et al. (2018) estimate an elasticity of 3.30 using commuters. Caliendo and Parro (2015) estimates an elasticity of 0.2 for a 5-month frequency. For non-US estimates, Morten and Oliveira (2018) finds an estimate of 1.91 from Brazil and Zhu and Tombe (2015) estimate an elasticity of 2.5 from Chinese data. Without considering origin-destination migration costs, Diamond (2016) estimates an elasticity of between 2 and 4. In the rest of the paper, we assume $\theta = 4$. Migration costs are assumed to be iceberg costs that depend on the distance between districts, as explained later.

Recovering the sufficient statistics Similar to the case with perfect mobility in Fajgelbaum and Redding (2018), there is a one-to-one mapping from the observed data and the model parameters to the unobserved statistics $(b(l), \tilde{z_A}(l), z_N(l))$. The relative price of tradables can be determined from observed share of employment in agriculture $\nu_A(l)$:

$$\frac{E_T(l)}{E(l)} = \left[\frac{1}{\beta_T}\frac{(1-\alpha_N)\nu_A(l)}{(1-\alpha_A)+(\alpha_A-\alpha_N)\nu_A(l)}\right]^{\frac{1}{1-\sigma}} \tag{3.11}$$

Second the wage-rental ratio $\omega(l)$ can be uniquely determined from observed share of employment in agriculture and population densities $n(l)$:

$$\omega(l) = \frac{1}{n(l)}\frac{(1-\alpha_A)(1-\alpha_N)}{\alpha_N(1-\alpha_A)+(\alpha_A-\alpha_N)\nu_A(l)} \tag{3.12}$$

Third, adjusted aggregate agricultural productivity $\tilde{z_A}(l)$, productivity in non-tradables $z_N(l)$ and the amenity $b(l)$ can be determined. First the productivity wedges are determined using the following equations:

[11] Keeping the same parameters as in the case of Argentina in Fajgelbaum and Redding (2018) is not a wrong approximation given the level of development of most agricultural production system in Central Asia. Poor incentives often do not push farmers for innovations or capital investments to change the input intensity.

$$
\begin{aligned}
\tilde{z_A}(l) &= \frac{E(l)}{E_T(l)} \frac{C(l)}{\omega(l)^{\alpha_A}} \\
z_N(l) &= \frac{C(l)}{\omega(l)^{\alpha_N}} \left(\frac{1-\beta_T}{1-\beta_T\left(\frac{E(l)}{E_T(l)}\right)^{\sigma-1}} \right)^{\frac{1}{1-\sigma}} \\
\text{with} \qquad C(l) &= \left[\beta_T(\omega(l)^{\alpha_A}\tilde{z_A}(l))^{\sigma-1} + (1-\beta_T)(\omega(l)^{\alpha_N} z_N(l))^{\sigma-1}\right]^{\frac{1}{\sigma-1}}
\end{aligned}
$$

Second, the amenity wedges can be determined using the following equation:

$$
b(l) = \frac{n(l)L(l)}{N}\Big[\sum_o \frac{\tilde{\kappa}_{ol}^{-\theta} C(l)^\theta}{\sum_{l'} \tilde{\kappa}_{ol'}^{-\theta} b(l')C(l')^\theta} \frac{N^{pre}(o)}{N^{pre}}\Big]^{-1}
$$

with $\{\tilde{\kappa}\}$ the pre-BRI matrix of migration costs between locations.

Producing counterfactuals Given counterfactual values for land area, total population and the sufficient statistics $(\tilde{z_A}(l), z_N(l), b(l))$, we solve for the counterfactual levels of the endogenous variables $\{n(l), \omega(l), E_T(l)/E(l), C(l)\}$ using the following system of equations:

$$
\begin{aligned}
C(l) &= \left[\beta_T(\omega(l)^{\alpha_A}\tilde{z_A}(l))^{\sigma-1} + (1-\beta_T)(\omega(l)^{\alpha_N} z_N(l))^{\sigma-1}\right]^{\frac{1}{\sigma-1}} \\
b(l)C(l)^\theta &= \frac{n(l)L(l)}{N}\Big[\sum_o \frac{\kappa_{ol}^{-\theta}}{WMA(o)} \frac{N^{pre}(o)}{N^{pre}}\Big]^{-1} \\
\frac{E_T(l)}{E(l)} &= \frac{1}{\tilde{z_A}(l)\omega(l)^{\alpha_A}} C(l) \\
n(l) &= \left(\frac{1}{\alpha_N + (\alpha_A - \alpha_N)\beta_T(\frac{E_T(l)}{E(l)})^{1-\sigma}} - 1 \right) \frac{1}{\omega(l)} \\
\sum_l \frac{L(l)}{L} n(l) &= \frac{N}{L} \\
\omega(l) &= \frac{1}{n(l)} \frac{(1-\alpha_A)(1-\alpha_N)}{\alpha_N(1-\alpha_A) + (\alpha_A - \alpha_N)\nu_A(l)}
\end{aligned}
$$

3.5 Data

3.5.1 Economic activity

Administrative level For Central Asian countries, we choose each location to be at the district administrative level, called *raions* in most post-Soviet states[12]. There are 174 districts in Kazakhstan, 162 districts in Uzbekistan, and 45 districts in Kyrgyzstan. For China, the third administrative level is chosen with 2048 locations. Recovering the sufficient statistics (amenity, productivity, prices) for each district requires the following observed variables: employment for the export sector (agriculture or manufacturing) versus non-tradable sectors (services, local manufacturing), land area, total population, and estimates for changes in transport costs. Assuming that agriculture will be the sector to benefit from access to new corridors in Central Asian countries, we also collect data on urban and rural populations for each district.

Land data Land areas cover currently-used areas for productive activities, excluding large areas that are empty of population and economic activities. For Central Asian countries, we use European Satellite Agency data to keep irrigated land and urban areas for each loction. For China, the land area that is considered to be allocated between manufacturing and services is the built-up area per location.

Employment in the tradables sector For Central Asian countries with a comparative advantage in agriculture, employment in agriculture at the district level is not directly available. While some papers use rural shares as a proxy, workers in rural areas can also work in rural services, and such percentages vary across regions. To adjust the shares in rural population, we use available employment surveys, sufficiently representative at the provincial level, to build a correction factor to consider both the share of employment in the population and the share of employment in agriculture in total employment at the provincial level. Rural shares and employment shares in agriculture are positively but imperfectly correlated (Annex D). In China, manufacturing is the sector with comparative advantage. We use employment data collected at the firm level with information on the postal code of the firm and its sector of production. Employees in manufacturing firms are summed at the district level, and adjusted with the share of employees in total population at the national level to obtain the share of employment in manufacturing per district.

3.5.2 Transport costs

Following the economic geography literature, we use changes in transport times to measure changes in iceberg transport costs.

[12] Raions are subnational levels and belong to oblasts, translated as provinces in English

Tranport times Transport times include three components: (i) the time to reach a domestic hub using the road network, (ii) the time from this domestic hub to reach a main gateway using international corridors, and (iii) the time to cross borders between the domestic hub and the gateway using the best transport route. For each location, shippers first choose the optimal domestic hub that minimizes their transport time to reach gateways. Each distric location is proxied by its geographic centroid. Using geo-referenced data software and open data for transport networks (OSM road networks), times to reach each possible transport hub on main rail corridors through the optimal path, measured as the path that minimises travel time given our speed assumptions for different types of road, are calculated. Second, times between every domestic hub and the main international gateways are computed. To reach main markets, Central Asian shippers have to reach Moscow, Istanbul and Urumqi (main city of the Xinjiang province in Western China). These travel times are given for all scenarios: pre-BRI, post-BRI only with infrastructure investments and post-BRI with both infrastructure investments and border crossing time reductions. Total times include transport and borders times. Along with the standard clearance formalities, border-crossing times include waiting time, unloading or loading time, and time taken to change rail gauges, among other indicators. More details are given in Annex B. Finally shippers choose their optimal domestic hub comparing the average time to reach all three gateways starting from their district[13].

From time to cost: Measuring the iceberg costs Several methods have been used to parameterize iceberg costs. Trade costs between locations o and d are modeled 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 (2017), we assume an exponential functional form, that has been used extensively in the economic geography literature, and ensures that infrastructure cost are always equal or greater than one.

$$t_{ij} = exp(\kappa \times time_{ij}^{\alpha}) \tag{3.13}$$

with $time_{ij}$ the time to travel from i to j in hours[14]. The parameter κ was estimated for the United-States using traffic between the main cities (Allen and Arkolakis, 2017). They estimate the effect of travel time on traffic and choose to calibrate trade costs using $\kappa = 0.0108$, indicating that a five hour trip incurs an ad valorem tariff equivalent trade cost of 5.5%. A more recent version of the paper finds that a one hour trip incurs a 7% trade cost. The parameter is estimated using the average trade cost of 20% ad valorem tariff equivalent, consistent with the literature on domestic distribution costs in the US, see e.g. Anderson and van Wincoop (2004). Other papers have assumed a linear form with $t_{od} = 1 + time_{od}^{0.6}$ (Alder, 2017; Roberts et al., 2012). In the

[13] A simple average is used here to aggregate times to reach the main gateways. We do not make any assumption on a favorite destination for each district.

[14] $\alpha = 1$ in Allen and Arkolakis (2017)

trade literature, Hummels and Schaur (2013) estimate that each day in transit is equivalent to an ad valorem tariff of 0.6 to 2.1 percent depending on the time sensitivity of the products. Traffic data are not available for the countries of interest. Given that the focus is on internal transport for global traders, we choose a lower κ than Allen and Arkolakis (2017) which is likely to include all osrts of traffic such as commuting patterns between cities too. In the rest of the paper, we assume the following parameters $\kappa = 0.003$ and $\alpha = 1$ to calibrate iceberg costs. Compared to the ad valorem tariff of 0.6 to 2.1 percent generated by Hummels and Schaur (2013) for US international trade, this functional form delivers an ad valorem tariff equivalent trade costs of 7.4% for a day of transport time. Compared to the ad valorem tariff of 5.5 percent% for a 5-hour trip generated by Allen and Arkolakis (2017) for intranational trade in the US, the ad valorem tariff equivalent trade costs is 1.5% for five hours of transport time.

Using this parametrization, we estimate changes in transport costs due to the BRI that will affect prices of tradable goods. Changes in adjusted productivity of the tradable good into the contributions of changes in each of these components (trade costs, terms of trade and technology) are decomposed such that only the contribution of changes in trade costs over the productivity of the tradable sector remains.

$$\hat{z}_A(l) = \underbrace{-2(1-\gamma_A)\hat{\delta}(l)}_{domesticcosts} + \underbrace{(1-\gamma_A)(\hat{P}_A^* - \hat{P}_M^*)}_{termsoftrade} \tag{3.14}$$

with $\delta(l)$ the iceberg cost for the district l and $\hat{\delta}(l) = dln(\delta(l))$.

External integration, such as large changes in transport technologies, will affect the terms of trade, the global prices (P_A^*, P_M^*) that can be offered at the borders. Changes that affect only the supply or demand of a small country will not affect the terms of trade. World prices may however be affected by the overall completion of the BRI projects and of the other simultaneous competing transport projects.s

3.5.3 Migration costs

For simplicity, we assume that migration costs are function of geographical distance, measured as the optimal distance in kilometers between district centroids along the domestic transport network. Iceberg migration costs are assumed to be larger than one and to increase with geographical distance. They are assumed to be unaffected by the BRI interventions. Similarly to trade costs, they are defined as an exponential function whose parameter κ^M is defined in order to reach a certain average.

$$migration_{ij} = exp(\kappa^M \times distance_{ij}) \tag{3.15}$$

with κ^M defined such that the average of $migration_{ij}$ across all locations is equal to $\tilde{\kappa}$. Given the lack of estimates for migration costs in Central Asia, several scenarios are considered for $\tilde{\kappa}$. No mobility restriction implies $\tilde{\kappa} = 1$, while high mobility restrictions are assumed to be given by $\tilde{\kappa} = 1.15$[15]. Migration costs $\{migration_{ij}\}$ are dispersed around each chosen mean.

4 The economic and welfare impacts of large transport and border investments in China and Central Asia

In this section, we (a) provide counterfactuals on the spatially differentiated impacts of BRI integration within countries, and (b) examine how domestic labor mobility mediates the impact of BRI investments on spatial inequalities. We consdier saptial development in China and in Central Asia.

4.1 Improving transport connections and reducing border times

Three categories of BRI investments are considered. First, rehabilitation of roads and rail routes which will decrease transport time because of higher speed due to better road quality or lower congestion from new lanes. Second, the development of new corridors will give access to gateways towards new markets and will develop new transport hubs along these economic corridors that will improve the access of local consumers and producers to the main corridors. Third border investments in new logistic hubs such as dry ports and in new services to reduce border delays are a major part of the investments to facilitate cross-border trade.

New corridors in China Most Chinese exports go through the ports on the East coast to be shipped along the maritime corridors towards Europe, the USA and other distant markets. One potential effect of BRI investments would be the creation of traffic along new routes. Investments in Central and South Asia are expected to attract land freight traffic through transport rail services along these land corridors and give Chinese goods access to new markets in the West and a faster access to European consumers. Maritime shipping will remain the cheapest option but some goods, such as time-sensitive goods and high-value goods, could be moved through these new corridors. In terms of territorial development, such investments also aim at developing the Western parts of China, whose access to Asian and European markets would be improved.

For simplicity, we assume that before the BRI all goods need to be shipped through Eastern ports , while after the BRI, three new gateways can be used to import or export goods. The new gateways are: (1) Khorgos for the New Eurasia Land Bridge Economic Corridor (from

[15]Given the lack of estimates for Central Asian countries, scenarios of high mobility costs assume 1.15 for $\tilde{\kappa}$, while scenarios of low mobility costs assume 1.05. For China, high mobility costs 1.10 and low mobility costs around 1.01.

China to Europe through Kazakhstan) and the China-Central Asia-West Asia economic corridor, (2) Kashgar for the China-Pakistan Economic Corridor, and (3) Kunming for the Bangladesh-China-India-Myanmar Economic corridor and the China-Indochina Peninsula Economic corridor.

Large investments in Central Asia: Kazakhstan, Uzbekistan, and Kyrgyzstan Kazakhstan is a critical node on the BRI with road and rail routes between Europe and China crossing the country. Several domestic projects will improve access to international gateways: the Khorgos Gateway dry port, the rehabilitation of domestic and international road and rail corridors, and the opening of new domestic transport hubs along international corridors. For example, the Khorgos Gateway dry port at the border between Kazakhstan and China aims at reducing border and transloading obstacles to facilitate trade between China and Europe. Given that Kazakhstan is a landlocked country, there are network effects with improvements in the transport network outside of Kazakhstan that would improve accessibility of local producers and consumers to global markets. In this paper, we consider the following projects: rail and road improvements within and outside Kazakhstan (Khorgos-Aktau railway, Moscow-Kazan HSR, and Urumqi-Khorgos rail), and the access to new transport hubs along international corridors. In addition to the traditional hubs of Astana, Aktobe, and Kostanai towards Russia and Europe, new hubs are added in the network: Aqtau towards the Caspian Sea, Shymkent towards other Central Asian countries, and Almaty towards Khorgos and China.

While Kazakhstan had taken some advantage in the routes between China and Europe through Urumqi, the city of Kashgar is another central node in the southern part of Xinjiang, as both a hub connected to Urumqi, and the starting point of the China-Pakistan Economic Corridor (CPEC). The China-Central Asia-West Asia economic corridor is going through Kyrgyz Republic and Uzbekistan. Compared to Kzahstan, additional rail investments will impact Uzbekistan's connectivity: the new rail line "Kashgar-Tashkent" going through the city of Andijan, and the "Samarkand-Mashhad" rail upgrade from Uzbekistan to the Islamic Republic of Iran. In Uzbekistan, three more rail gateways will be added to the existing ones which have traditionally been along the corridors towards Russia (Navoyi, Urgench, Tashkent). The new rail corridor Kashgar-Tashkent will go through the Ferghana Valley to reach Kashgar in China, and therefore a new transport hub is assumed to open at Andizhan. Corridors going towards the Islamic Republic of Iran and South Asia through Turkmenistan or Afghanistan will develop the Southern transport hubs of Samarqand and Bukhara.

For each of the three scenarios (pre-BRI, post-BRI with infrastructure investments, post-BRI with both infrastructure and border investments), local road travel times to reach a transport hub and international rail are added get the final time changes across districts. Times are finally converted to iceberg transport costsfor inclusion in the model (Annex E).

4.2 Counterfactuals

Several factors can explain the spatially-differentiated effects across districts: the locations' characteristics, the nature of the investments, the degree of internal versus external integration, and the level of internal migration frictions. The following results correspond to the post-BRI scenario with or without border improvements, a moderate labor supply elasticity[16], and high internal migration costs[17].

4.2.1 Location characteristics

Locations' characteristics affect population and economic changes across locations: sectoral productivity (productivity wedges $z_A(l), z_M(l), z_N(l)$) and amenity score (amenity wedges $b(l)$). Both productivity and amenity scores depend on the district's geographical location in the country, its distance to the border, its geography and weather, and its endowments. While high productivity scores increase production for given inputs, high amenity scores increase individual preferences to live in a district. Using the framework based on "the spatial Balassa-Samuelson effect" provides a channel to explain the impact of internal geography on the pattern of development across districts (Fajgelbaum and Redding, 2018). However, new results emerge with the addition of internal migration frictions and the focus on changes in connectivity rather than levels to explain the spatial patterns.

Changes in transport costs have direct and indirect effects on workers' incentives, and the overall local economy. Lower transport costs decrease the price of imported goods for consumers and increase the price of exported goods for producers. The local price of imported goods in district l is the difference between given international price P_M^* and the transport cost to reach this market $\delta(l)$, such that $P_M(l) = \delta(l) P_M^*$. For exported goods, the local price in location l is given by $P_X(l) = \frac{P_X^*}{\delta(l)}$ with P_X^* the international price. Lower transport costs increase the local price of the exported good, i.e increase the returns on producing such goods for local producers. Changes in transport costs have indirect effects on the rest of the economy through inputs prices, wages and land rents. Wages in the tradable sectors increase with production prices, given perfect competition and constant returns to scale.

Lower transport costs increase prices in the export sector and push wages and land rents up in this sector. Wages and land rents in other sectors also increase because of perfect labor mobility and mobile land use across sectors within districts. While the amount of land is fixed in each district, workers are mobile across districts, such that additional workers in attractive districts will lower tensions on the labor market and push wages down. In addition because wages are equalized across sectors, prices in the non-tradable sectors also increase. Overall, the net effect for the relative price of tradables over non-tradables is to increase with transport

[16]The Frechet parameter θ is chosen to be equal to 4 in the rest of the simulations for Central Asian countries and equal to 2 for China.

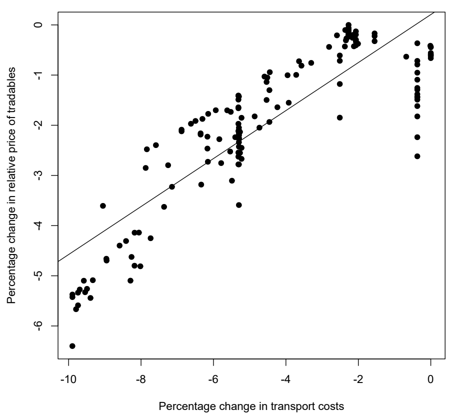
[17]The average iceberg cost for migration is given by $\bar{\kappa} = 1.15$ for Central Asian countries and 1.10 for China.

costs[18].

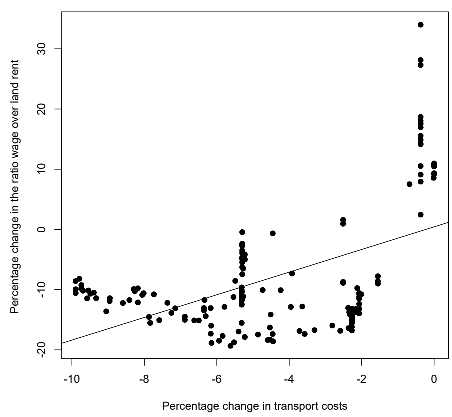
Land becomes more valuable in districts experiencing large decreases in transport costs. Land rents, relative to wages, increase faster in districts that experience large decreases in transport costs (Figure 2b for Uzbekistan). This is because land is immobile and exports are more land intensive. Both agriculture and manufacturing are assumed to be more land-intensive than non-tradable activities, mostly services[19]. The valuation of land with respect to workers increases in better-connected districts with increasing returns in the export sector. Similarly, non-tradable goods become relatively more expensive in districts that experience the largest decreases in transport costs (Figure 2a for Uzbekistan).

Figure 2: Changes in prices due to transport investments in Uzbekistan

(a) Relative price of tradable goods



(b) Relative price of wage over land rent



While population and welfare gains result from the interaction of multiple factors, population changes across districts depend on both increases in real wages that attract workers in the tradable sector and the need for more workers in non-tradable sectors. Districts that experience real-wage increase, either from higher wages or lower prices, tend to attract workers from other districts. While better connectivity benefits exports of tradable goods, the demand for non-tradable goods which are complementary to agriculture and manufacturing goods also increase. Given that non-tradable goods are more labor intensive than tradable goods ($\alpha_N < \alpha_A$), districts that experience fall in tradables prices will need even more workers to respond to the local increasing demand for non-tradable goods, and will tend to experience increasing population density (Figure 3a). Following the same argument, shares of employment in agriculture and manufacturing in total employment tend to decrease more in districts whose transport costs decrease the most (Figure 3b) [20].

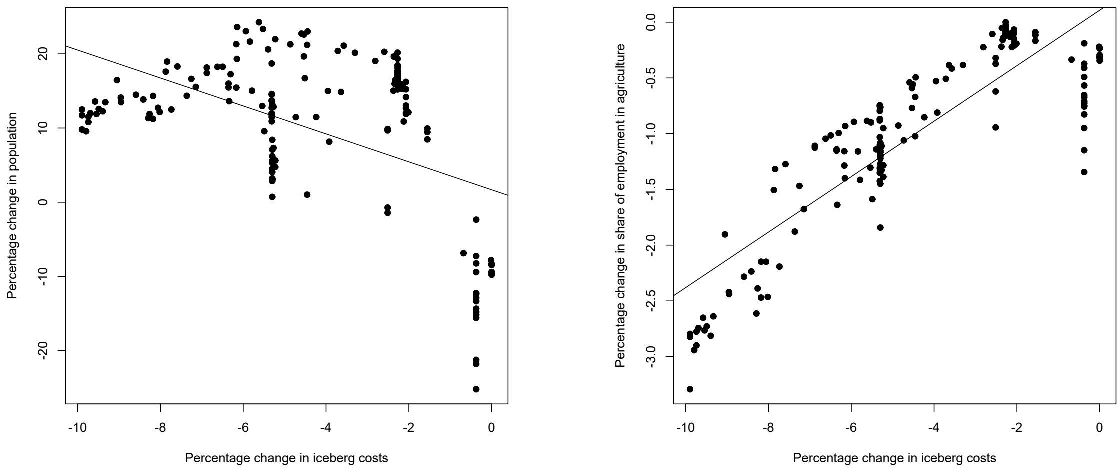
[18]The proof can be found in (Fajgelbaum and Redding, 2018).

[19]In Central Asia, exports are largely in the agriculture sector, which is even more land-intensive than manufacturing

[20]The spatial Balassa-Samuelson effect also implies a change in economic structures within locations (Fajgelbaum and Redding, 2018).

Figure 3: Changes in population and employment shares due to transport investments in Uzbekistan

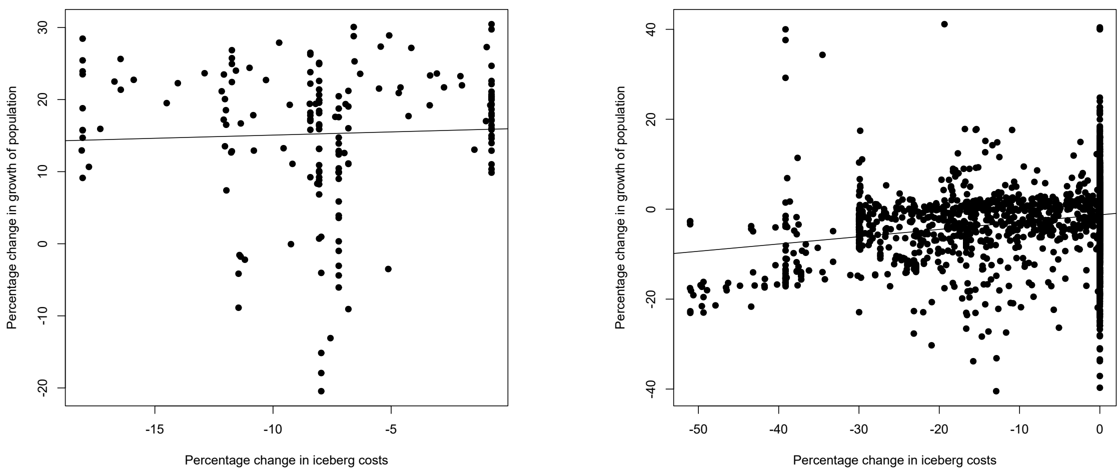
(a) Population (b) Share of employment in agriculture



Decrease in transport costs is not the only explanatory factor for changes in population, and is not a sufficient condition for spatial development. Amenities influence location preferences for workers and relative endowments in the sector with comparative advantage interact with changes in transport costs to affect prices and wages. In the case of Kazakhstan, changes in transport costs (when only infrastructure investments are considered) are not strong explanatory factors (Figure 4a). In China, none of the explanatory factor alone has a strong predictive power to understand the effects of new investments to open new gateways on population growth (Figure 4b). Lower transport costs are not a sufficient condition to develop previously-isolated locations in China.

Figure 4: Changes in population due to transport investments in Kazakhstan and China

(a) Kazakhstan (b) China



4.2.2 Transport investments versus trade-facilitation reforms

Identifying the winners and losers depends whether additional border-crossing improvements are also considered. While investments in transport infrastructure affect only a subset of districts, lower border-crossing time has a large impact on all districts . However, spatial effects will differ across districts and several factors can explain the expansion, the structural changes of the economy and welfare increases. This section compares the effect of three factors - changes in transport costs, the initial economic structure, and amenity wedge - and focus on welfare gains.

When cross-border times are not reduced, changes in transport costs and differences in amenities are stronger predictor than employment in the export sectors to identify the welfare gains from large transport investments. Larger reductions in transport costs are associated with higher increases in real wages (Figure 5a for Kazakhstan and Figure Annex.12a for Uzbekistan). The amenity score is also a very strong predictor of welfare gains for both Kazakhstan and Uzbekistan (Figures 6a and 6b). In the case of transport investments only, districts that will benefit the most in terms of welfare gains are those that experience large decrease in transport costs and are attractive locations for workers, while the relative strength of their comparative advantage in the export sector is less important.

Figure 5: Change in transport costs as predictor of welfare gains in Kazakhstan

(a) Only transport investments (b) With border improvements

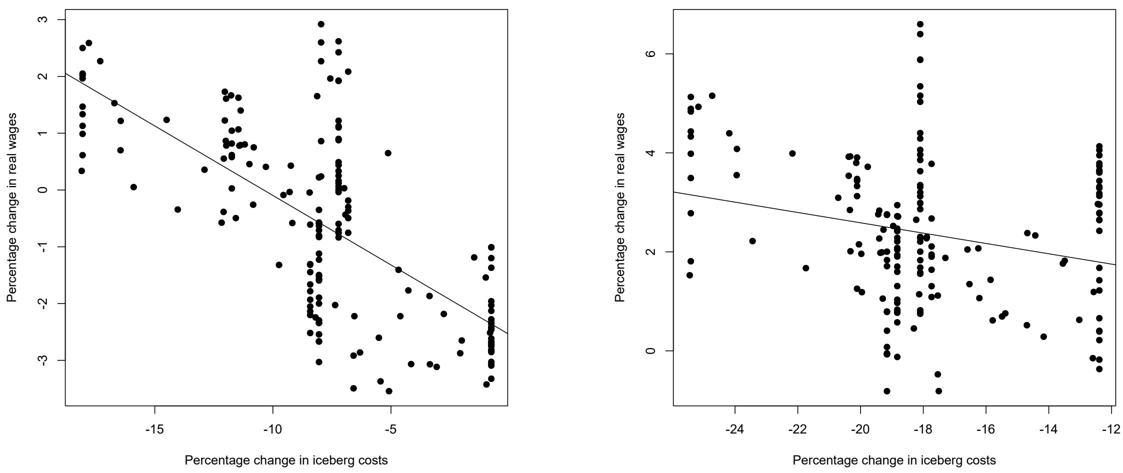
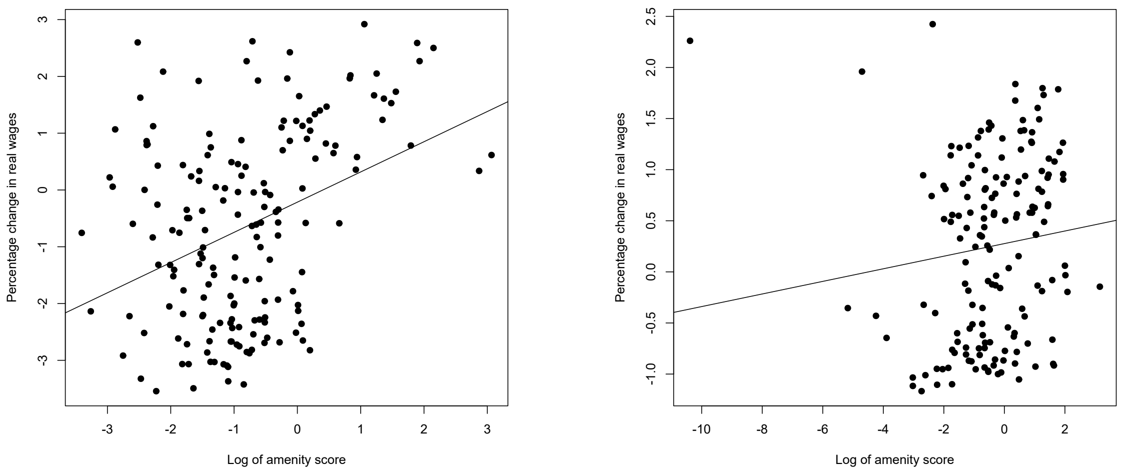


Figure 6: Amenity as predictor of welfare gains in Kazakhstan and Uzbekistan

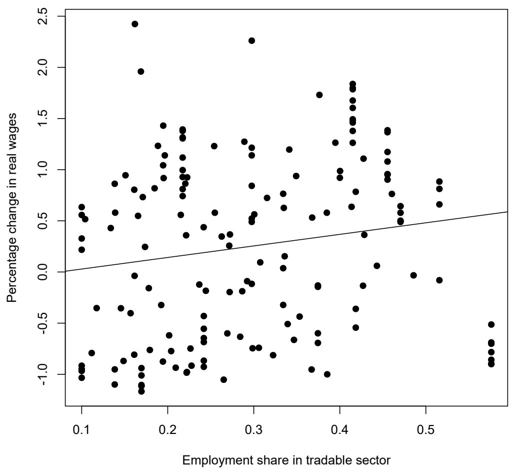
(a) Kazakhstan (b) Uzbekistan



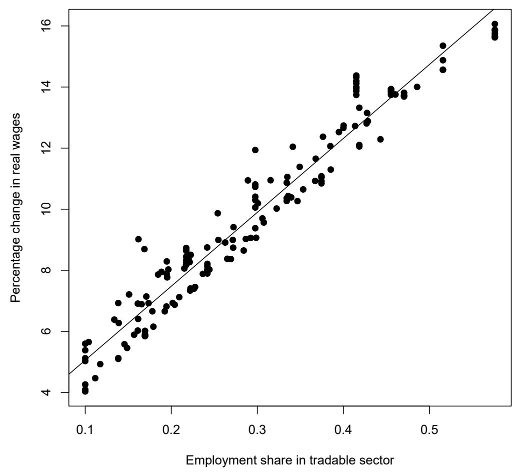
In contrast, the relative strength of comparative advantage in the export sector is a stronger predictor for welfare gains with cross-border improvements (Figure 8b for Kazakhstan and Figure 7b for Uzbekistan). In Uzbekistan, the share of employment in the export sector is strongly associated with increases in welfare gains in the scenario of border improvements, whereas the correlation is weak in the scenario of transport investments only (Figures 7a and 7b). Therefore, districts that gain the most from investments in transport infrastructure and border reforms are districts with a strong comparative advantage in the export sector. Being attractive for workers and experiencing a large decrease in transport costs are additional conditions that reinforce welfare gains.

Figure 7: Initial employment in export sector as predictor of welfare gains in Uzbekistan

(a) Only transport investments



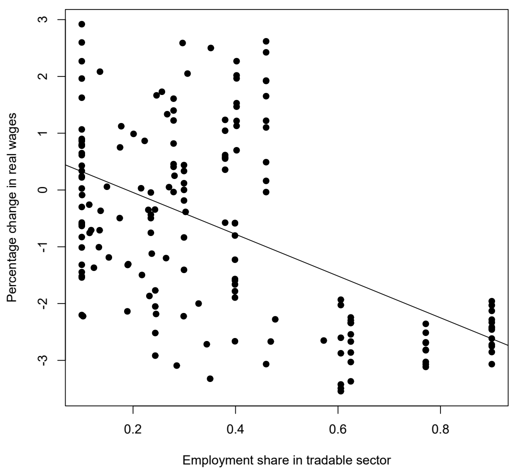
(b) With border improvements



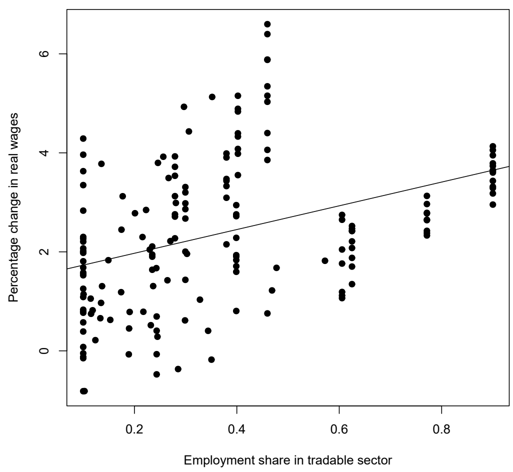
While investment in both transport and trade facilitation benefit almost all locations, investing only in transport infrastructure creates a large number of absolute losers. In Kazakhstan, districts with high employment in agriculture and districts that experience low transport cost reductions will experience negative welfare gains (Figures 5a and 8a for Kazakhstan, Figures Annex.12a and 7a for Uzbekistan). When reducing border costs, almost all districts benefit from lower transport costs and experience positive welfare gains (Figures 5b and 8b for Kazakhstan, Figures Annex.12b and 7b for Uzbekistan).

Figure 8: Initial employment in export sector as predictor of welfare gains in Kazakhstan

(a) Only transport investments



(b) With border improvements

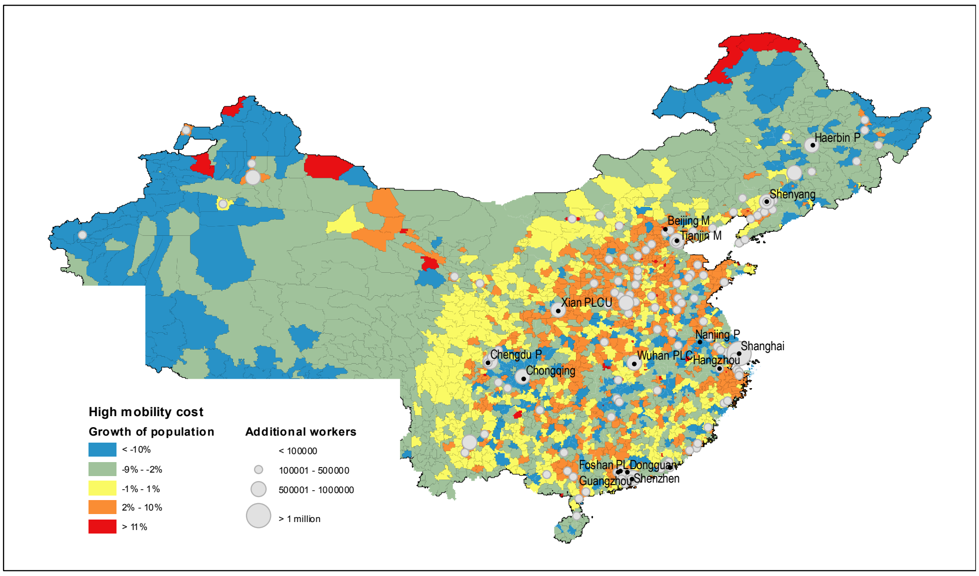


4.2.3 The spatially-differentiated effects per country

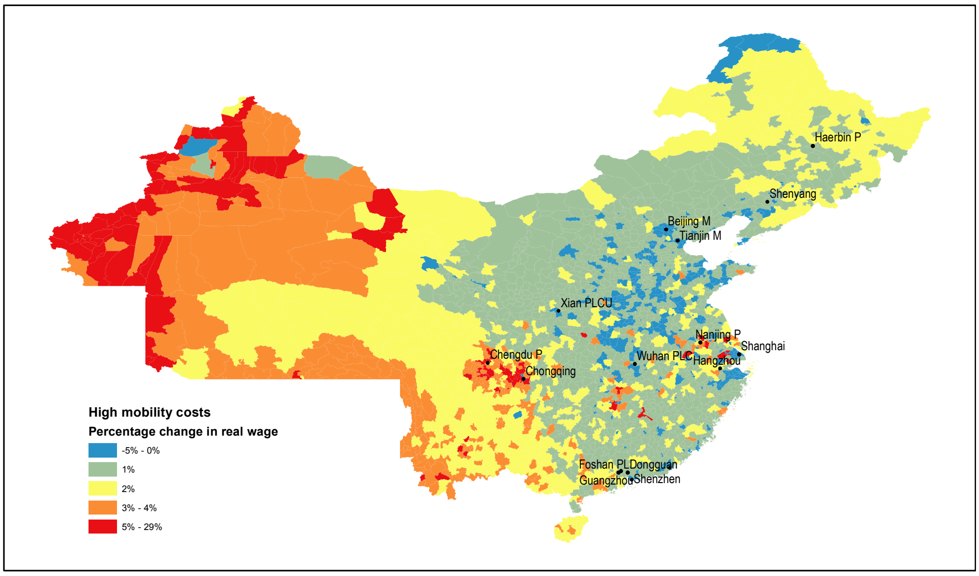
China: While new gateways are created along land borders in the West and South of the country, workers move away from these locations towards Eastern districts. Fast-growing districts are all located in the Eastern part of the country, which is already the richest and most integrated part (Figure 9a). Fewer workers in the most isolated regions of the Western and Southern parts will reduce competition in the labor market and push wages up, which explains the increase in real wages in Western and Southern locations (Figure 9b). In a context of high internal migration costs, reducing access to gateways in the Western parts of the country seems to have the opposite effect of spreading population over the territory and could increase concentration in already well-developed locations.

Figure 9: Spatial effects for new gateways

(a) Population changes



(b) Welfare gains

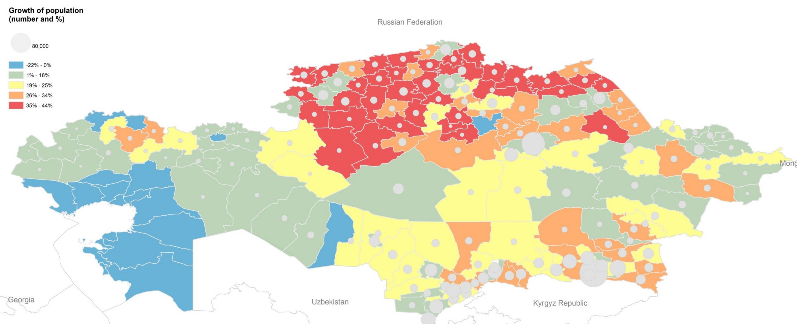


Kazakhstan: In the absence of border reforms, BRI infrastructure disproportionately affects population growth and wages in the South eastern districts around Almaty. In this context, Kazakhstan's comparative advantage in trade with China will be in exporting agricultural products. However, cheaper imports (Almaty will benefit from cheaper manufacturing imports, most likely from neighboring China) and attractive urban amenities mean many workers nonetheless keep moving to large urban hubs. Like Almaty, most large cities in Kazakhstan are specialized in non-tradable services and local manufacturing. Competitiveness of these products can benefit from the larger urban labor market, leading to cheaper wages, though population pressures may also push up housing rents and congestion.

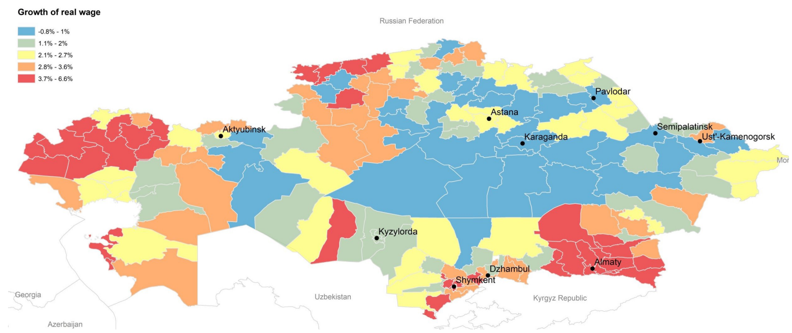
Gains are more equitable across the country when complementary border reforms are also made. A decline in border costs also supports large welfare gains in Northern districts, which are the breadbasket of the country (Figure 10b). Further, the population of these regions also grows in response to new economic opportunities (Figure 10a). Districts' strength in agriculture becomes an even stronger predictor of welfare effects in the presence of complementary border reforms. Yet consistent with Bird et al. (2019), districts with a comparative advantage in agriculture that benefit from lower transport costs will end up with a higher proportion of workers in non-tradable activities that support agricultural activities. Lowering of transport and trade costs therefore support urbanization and non-agricultural employment that complement and support export sector development.

Figure 10: Spatial effects for transport investments and border cost reductions

(a) Population changes



(b) Welfare gains



Uzbekistan: We find that when only transport infrastructure improvements are made, the Western districts of Uzbekistan do not benefit from lower transport costs, and therefore many workers leave these places and move East towards better connected areas. Worker inflows in the East depreciate wages, while the reduction in workers in Western isolated districts result in higher wages and welfare gains for those who do not move. In the East, the gains from cheaper imports do not always compensate wage depreciation and real wages tend to be lower after the transport investments.

A combination of border cost reductions and infrastructure upgrades disproportionately reduces transport costs in the Southern and Eastern part of the country, most notably in the Ferghana valley. The Southern and Eastern districts, around Bukhara, Tashkent and in the Ferghana

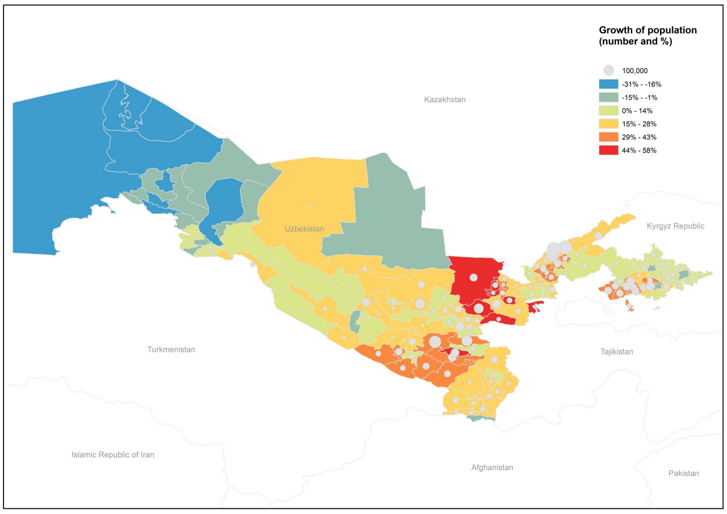
Valley, gain in terms of population growth and welfare gains (Figures 11a and 11b).

The overall gains are much higher in the scenario with border improvements. Large urban centers that are attractive to workers, as well as well-connected agricultural districts, will benefit from these investments. Urban centers, such as Tashkent, Bukhara and Samarqand, keep attracting the largest numbers of workers. In addition, the agricultural regions of Jizzah, Qarshi, Ferghana, and Termez will all attract large number of workers and benefit from large welfare gains (Figures 11a and 11b). Indeed, regions in the South and East of the country have the potential to increase scale and specialization by expanding agricultural production, in traditional crops such as cotton as well as in horticulture.

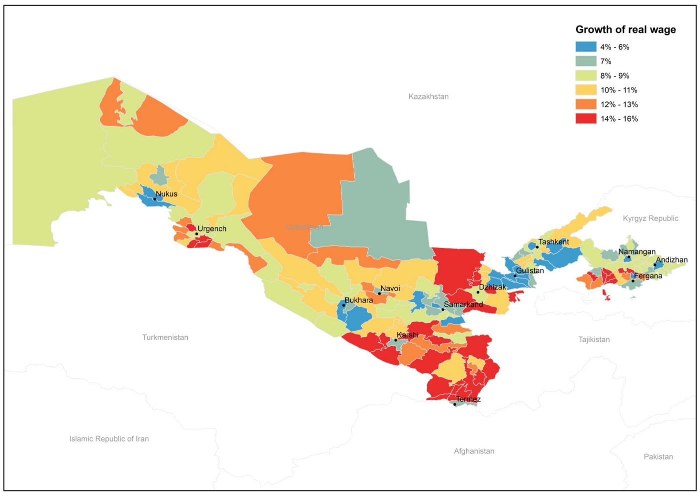
Two types of districts might benefit much less from the large decreases in transport costs and cross-border time reductions: those that do not have a comparative advantage in exporting, and those that are not attractive urban centers. The Western regions are not benefiting as much as the rest of the country, given their geographical isolation and their limited agricultural potential to attract workers there. Reducing transport and border costs will tend to increase the concentration of people and wealth in the eastern parts. Urban centers tend to be attractive but do not have a comparative advantage in producing agricultural goods. However, some urban centers that do not manage to compensate for their lack on comparative advantage might lose workers that will move East. The largest beneficiaries are districts that offer amenities and have a good comparative advantage in producing agricultural goods. In fact, the shares of employment in agriculture are a much stronger predictor of changes in real wages in the case of border-crossing time reductions.

Figure 11: Spatial effects for transport investments and border cost reductions

(a) Population changes



(b) Welfare gains

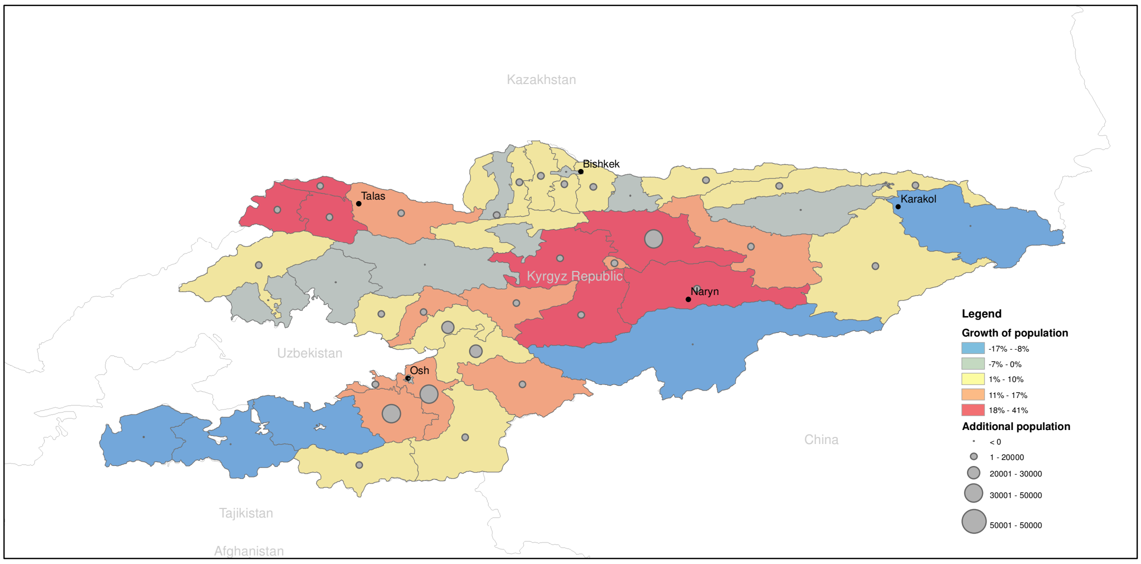


Kyrgyz Republic: Similar to Uzbekistan, the Kyrgyz Republic will see projects that improve its connectivity with its Central Asian neighbors, Uzbekistan, Tajikistan and Kazakhstan, as well as with China. The Kyrgyz Republic will benefit from better access to two main Western Chinese hubs, Kashgar and Khorgos. One of the main corridors connecting Kashgar to Uzbekistan will pass through the South-Western regions of the Kyrgyz Republic where the city of Osh and the broader Osh region are located.

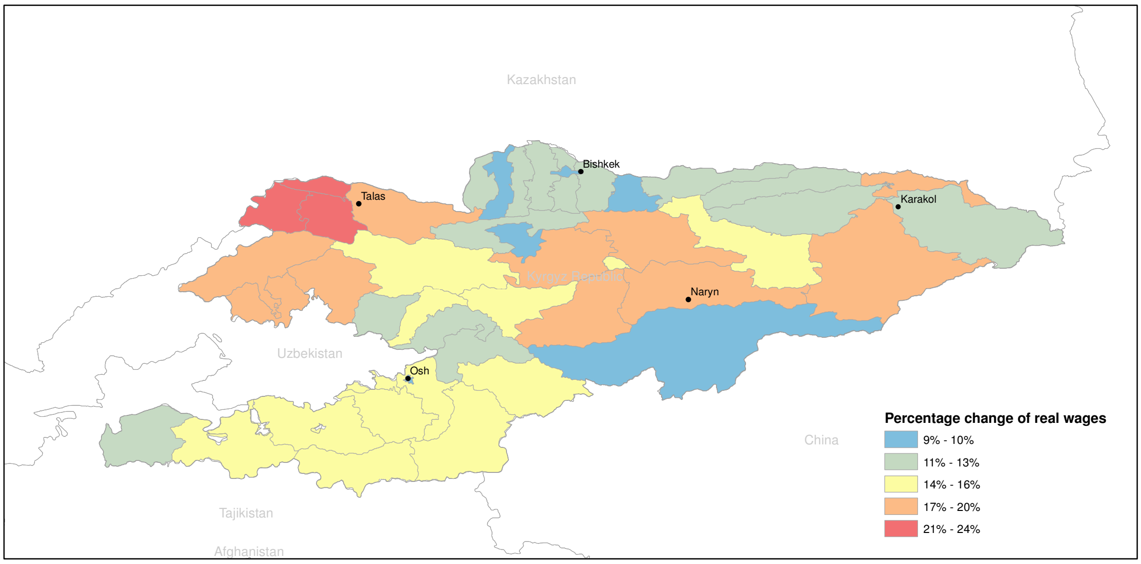
With only infrastructure improvements, large gains happen around Osh and in the center of the country, and the gains are much higher in the scenario with border improvements (Figures 12). The magnitude of local changes in transport costs are the main predictor of local effects, and not surprisingly, the locations close to Osh will gain a lot compared to other districts. The locations that will experience low connectivity increases are expected to lose population, and unlikely to experience any structural change, and lose in terms of aggregate welfare. Osh will attract many new workers while other regions in the South-west and in the Northern parts of the country will lose workers (Figure 12a). Here, districts around Osh will experience even larger real-wage growth rates.

Figure 12: Map of the differentiated spatial effects for Kyrgyz Republic

(a) Population changes



(b) Welfare gains



4.3 Spatial Inequalities and Labor Mobility

The analysis discussed above shows that the gains from BRI investments are likely to be spatially concentrated. While spatial concentration of economic activity can increase the pace of development by levering agglomeration economies, it can also exacerbate spatial inequalities. In this section, we examine how migration frictions contribute to spatial inequalities. While most of the economics literature has assumed either perfect mobility or full immobility of workers across locations within countries, we examine the effect of imperfect mobility due to preferences and migration costs.

Migration frictions are modelled in two ways. First the supply of labor to each location is assumed to be imperfectly elastic at a common real wage (Redding, 2016). Locations differ from one another in terms of their locational characteristics, which are captured in the amenity parameter (Annex F). High amenity is associated with large cities and well-located districts with attractive characteristics that explain a high concentration of individuals. District amenity levels remain the same in the BRI counterfactuals. The supply of labor is parametrized by its elasticity at a common real wage given[21]. Second migration costs are added as an iceberg cost to move from one region to another. While the elasticity is a behavioral parameter to be calibrated, migration costs are administrative or economic costs that individuals have to pay to migrate. Policies, such as a better housing market, lower migration restrictions, or lower administrative costs, can reduce these migration costs.

The probability that a worker chooses to live in location l is given by:

$$\frac{N(l)}{N} = \sum_{o} \frac{\kappa_{ol}^{-\theta} b(l) C(l)^{\theta}}{WMA(o)} \frac{N^{pre}(o)}{N^{pre}} \tag{4.1}$$

where the elasticity of population with respect to real income is determined by the Frechet shape parameter θ.

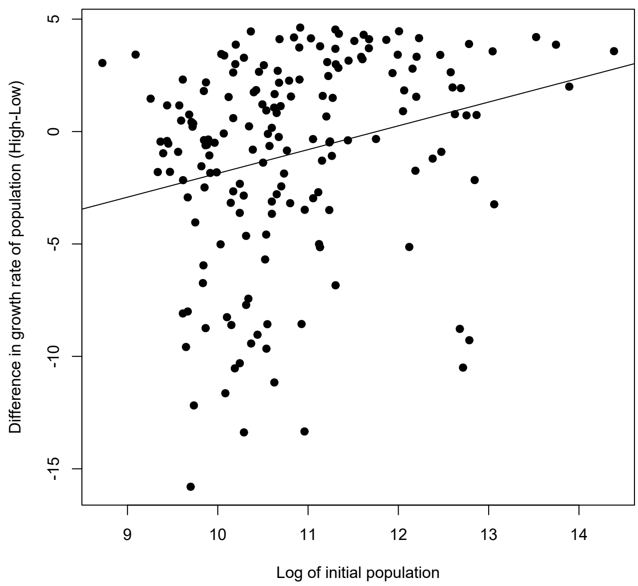
Migration costs and territorial development Migration costs lower the economic gains from moving towards other districts such that workers tend to adjust their migration patterns. These depend on several factors: the distance between two locations, and the regulations that restrict mobility. The distance between two location encompass the geographical distance as well as differences in culture (language, norms) that create barriers for integration. Regulations on mobility can be formal, in the case of a permit system, or informal, in the case of restrictions in the housing or labor markets. They affect the mobility patterns of workers across regions in two ways. They lower the incentives for a worker to leave and affect the choice of locations.

High mobility costs tend to increase concentration by pushing workers towards a smaller number of locations, the large urban centers that have high amenity scores. Figure 13 shows that the most populated districts will attract more workers when mobility restrictions are high on average, while the least populated districts will attract fewer workers and grow less. When

[21] As a reference, Redding (2016) assumes a Frechet parameter from 3 to 5. The elasticity is chosen equal to 2 for China and 4 for the other countries.

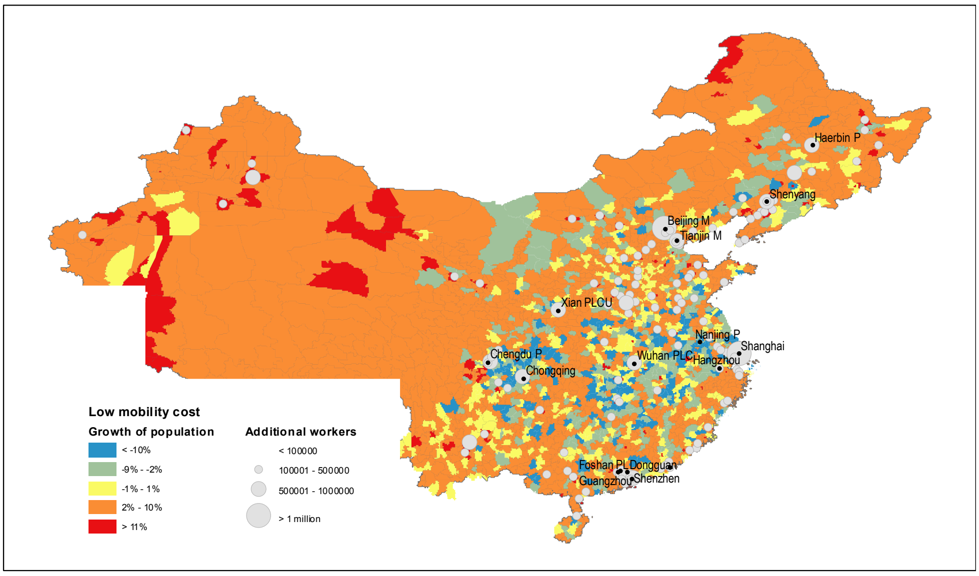
mobility restrictions are high, workers only move to the locations offering the highest economic opportunities that can compensate for the losses due to high migration costs. When migration costs are lower, workers are attracted to urban centers but spread more evenly across locations that benefit from the new investments.

Figure 13: Migration costs and differentiated population growth in Kazakhstan



While the BRI is expected to boost territorial development in the Western part of China, high mobility costs would lead to the opposite effect. Border opening with the rest of Asia brings regional development in the West only for low mobility costs, while it benefits the Center and coastal parts of the country in case of high mobility costs. High mobility restrictions push workers to move East, to the center and coastal regions , where the economic opportunities are the highest (Figure 9a). Only in the case of low migration costs, do Western and Southern locations attract more workers due to better connectivity with the Western and Southern gateways of Urumqi and Kunming (Figure 14).

Figure 14: Lower internal migration costs and territorial development



Migration costs, wage inequality and national welfare The BRI both increases national welfare and decrease spatial inequality in Kazakhstan and Uzbekistan (Figures 15a and 15b). Spatial inequality increases for higher migration costs, and the country's welfare, given by equation 3.8, after the BRI investments is lower in the case of higher migration costs. Lowering migration costs will increase the gains from global market integration. Looking at changes, spatial inequality decreases more after the BRI compared to the baseline situation in China, Kazakhstan, and Uzbekistan (Figure 16). Lowering migration costs does not create a trade-off between more spatial inequality and higher national welfare, but rather reduces the increase of wage inequality from integration and also increases the overall gains from integration. However, not all workers will evenly benefit from the BRI intervention.

Figure 15: National welfare versus Spatial inequality

(a) Kazakhstan

(b) Uzbekistan

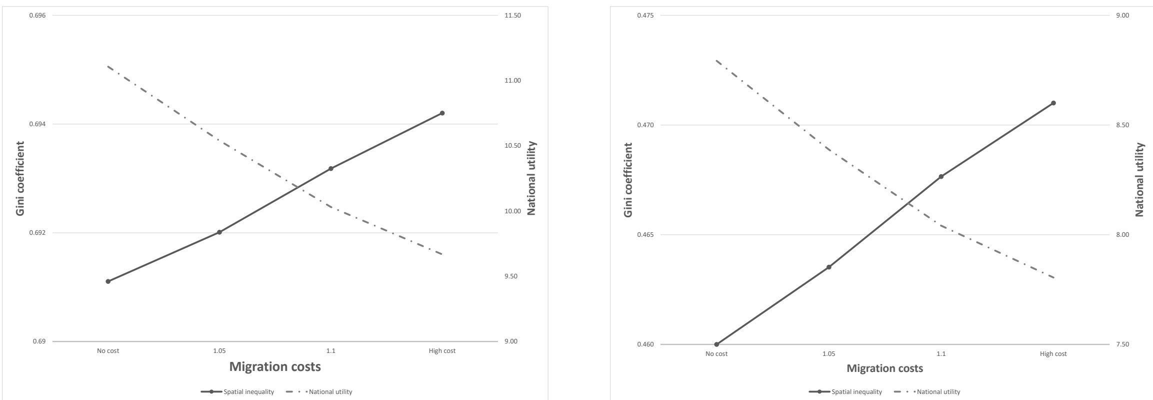
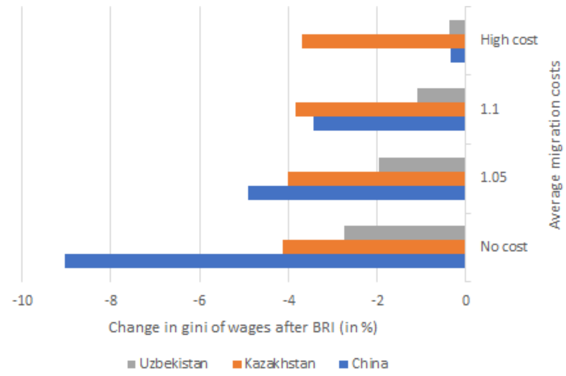


Figure 16: Migration costs and Spatial inequality: before versus after BRI



Migration costs, worker market access and workers's welfare Given the structure of migration costs, workers from different locations will have differential access to future opportunities and therefore have different expected utility for the post-BRI period. The expected utility for a worker living in location o before the BRI intervention is given by:

$$E(U|location = o) = \delta\left[WMA(o)\right]^{\frac{1}{\theta}} \quad with \;\; WMA(o) = \sum_{l'} b(l')C(l')^{\theta}\kappa_{ol'}^{-\theta} \tag{4.2}$$

The expected utility of a worker in location o depends on his economic opportunities, weighted by migration costs, that are defined by $WMA(o)$, the Worker Market Access from location o. Given the structure of migration costs, workers that are farther away from the locations that will experience high utility levels in the future will benefit less from the BRI intervention. In China, workers in the Eastern locations have higher expected utility than workers currently in the South and the West (Figure 17).

Table 1: Ratio of highest over lowest score across districts: Worker Market Access and utility

Worker Market Access

Uzbekistan	Kazakhstan	China	Kyrgyzstan
Low mobility			
1.30	1.19	1.04	1.15
High mobility			
2	1.57	1.46	1.44

Expected utility

Uzbekistan	Kazakhstan	China	Kyrgyzstan
Low mobility frictions			
1.07	1.04	1.02	1.04
High mobility frictions			
1.19	1.12	1.21	1.10

Differences in Worker Market Access reflect the unequal access to opportunities across districts within countries. The highest level of accessibility to future opportunities, measured by Worker Market Access, is 57% higher than the lowest one in Kazakhstan, 146% in China, 200% in Uzbekistan, and 44% in Kyrgyzstan (Table 1). These ratios decrease for lower mobility costs. Facilitating domestic mobility leads to smaller spatial differences in accessibility to opportunities. Worker Market Access is direclty connected to worker's utility in this framework. In Kazakhstan, expected utility is 12% higher in the location with highest expected utility compared to the location with the lowest utility. In Kazakhstan, workers currently located around the urban centers of Almaty, Shymkent, and Astana have the highest expected worker market access and will therefore benefit more the BRI intervention given their possibilities to move (Figure 18). In China, the difference is 21% and workers with high expected utility are located in the center and East of the country (Figure 17). These differences also decrease with smaller mobility costs. Spatial differences in accessing better opportunities across districts, measured by the ratio of the highest over the lowest WMA and expected utlity, are reduced when workers can freely move across districts.

Figure 17: Expected utility from BRI investments in China

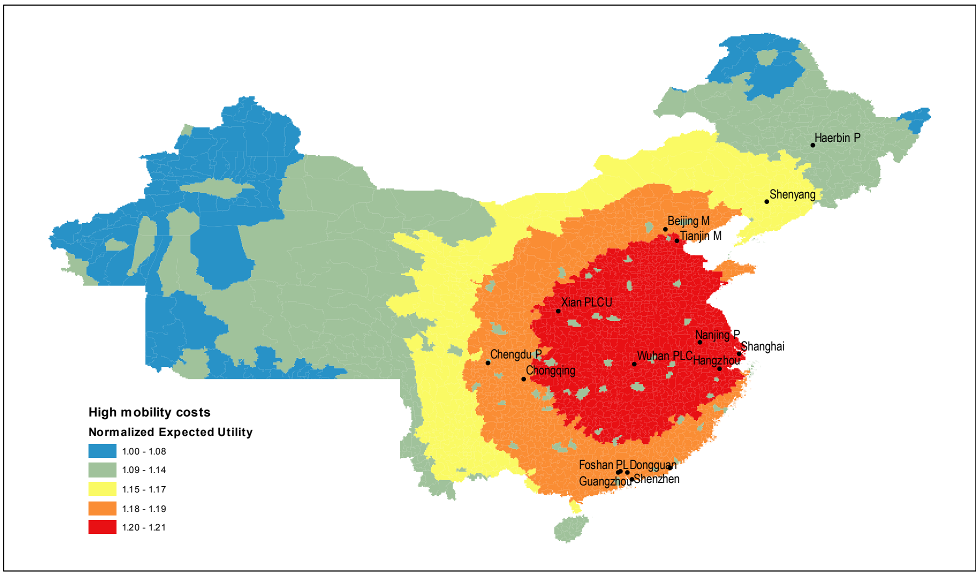


Figure 18: Expected utility from BRI investments in Kazakhstan

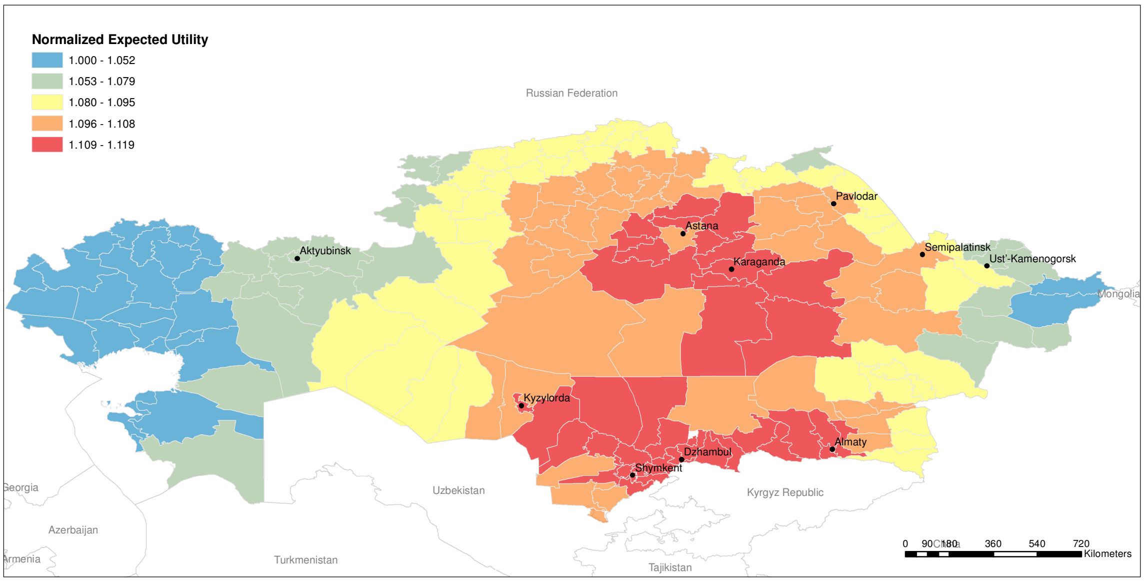
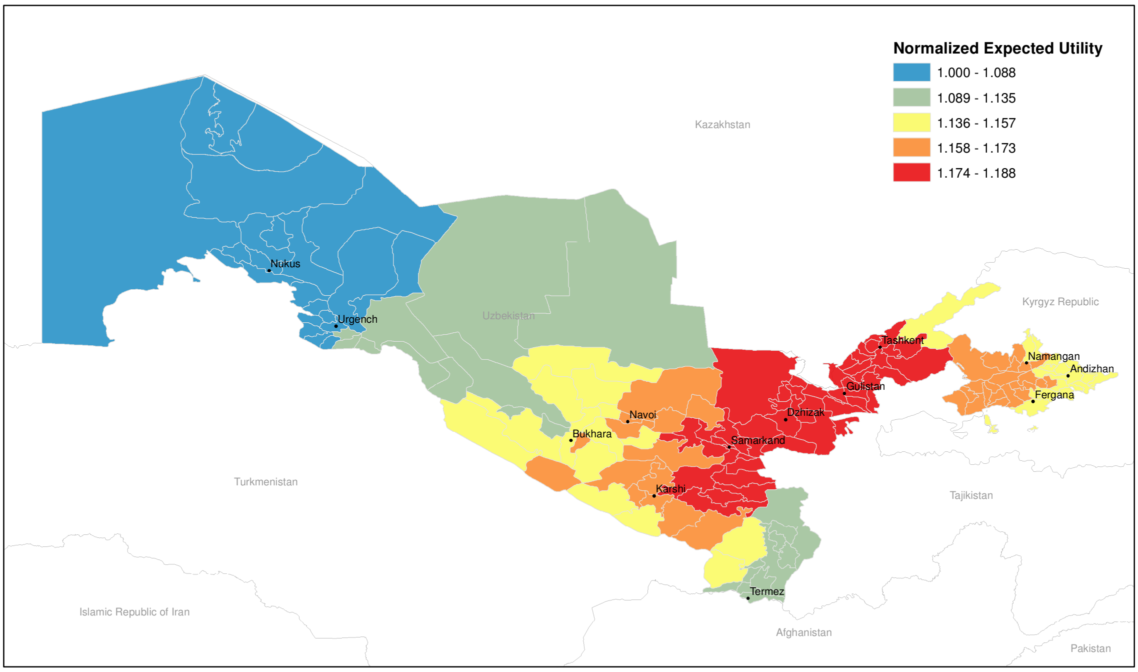


Figure 19: Expected utility from BRI investments in Kazakhstan



5 Conclusion

In this paper, we show that reductions in transport and trade costs from the Belt and Road Initiative have the potential to reshape economic geography within Central Asia and in China. The gains are likely to be concentrated around urban hubs near border crossings, a pattern that is consistent with other international episodes of trade integration where regions with less costly access to foreign markets, such as border or port regions have stood to reap the largest gains.

We also demonstrate that the magnitude of spatial reorganization is magnified when transport investments are supported by complementary policies that reduce delays in crossing national borders.

As such, economic concentration should not be a concern to policymakers if changes in the internal geographies of countries are not associated with any welfare-relevant spatial inequalities. But in reality, the spatial concentration of economic activity is associated with rising spatial inequalities as workers are not fully mobile or are slow to adjust to opportunities that emerge in urban hubs. Such immobility or slow adjustment is likely to enhance spatial inequalities in real incomes and is worrisome to national policymakers who have issues of spatial equity first and foremost on their minds. For example in Kazakhstan, following the BRI, spatial inequalities increase three fold with high mobility costs compared to scenarios with low mobility costs.

Policymakers may want to focus on relaxing domestic policies that restrict spatial mobility. Many Central Asian countries have remnants of the propiska systems, which are "internal passport requirements", and limit mobility and access to services. Obtaining registration is particularly difficult in the largest cities (Tashkent, Astana, Almaty, Bishkek, Dushanbe, Ashgabat etc.). In most cases, a person living in a city without propiska registration cannot be officially employed there, nor are they authorized to access most government services, including health care and public education. Similar systems are in place in China (hukou) and are prevalent in Vietnam (ho-khau) and other countries. Further, addressing major distortions in land and housing markets that limit asset tradability for potential migrants and bids up prices in cities can ease migration costs.

In fact, by supporting measures that enhance domestic labor mobility, policy makers in Central Asia can lever BRI to reshape their economic geographies for faster development and avoid the risk associated with spatial efficiency- equity tradeoffs.

References

Alder, Simon, "Chinese Roads in India: The Effect of Transport Infrastructure on Economic Development," 2017.

Allen, Treb and Costas Arkolakis, "The Welfare Effects of Transportation Infrastructure Improvements," *WP*, 2017.

Anderson, James E and Eric van Wincoop, "Trade Costs," *Journal of Economic Literature*, aug 2004, *42* (3), 691–751.

Bird, J., M Lebrand, and T. Venables, "The Belt and Road Initiative: Reshaping Economic Geography in Central Asia?," 2019.

Caliendo, L. and F. Parro, "Estimates of the Trade and Welfare Effects of NAFTA," *The Review of Economic Studies*, jan 2015, *82* (1), 1–44.

de Soyres, F., A. Mulabdic, S. Murray, N. Rocha, and M. Ruta, "How Much Will the Belt and Road Initiative Reduce Shipment Times and Trade Costs?," 2018.

Diamond, Rebecca, "The Determinants and Welfare Implications of US Workers' Diverging Location Choices by Skill: 1980-2000," *American Economic Review*, mar 2016, *106* (3), 479–524.

Donaldson, Dave, "Railroads of the Raj: Estimating the Impact of Transportation Infrastructure," *American Economic Review*, apr 2018, *108* (4-5), 899–934.

Duranton, G., P. M. Morrow, and M. A. Turner, "Roads and Trade: Evidence from the US," *The Review of Economic Studies*, apr 2014, *81* (2), 681–724.

Fajgelbaum, P. and S. Redding, "Trade, Structural Transformation and Development: Evidence from Argentina 1869-1914 ," *revised version of NBER Working Paper 20217*, 2018.

Hanson, Gordon H., "North American Economic Integration and Industry Location," *Oxford Review of Economic Policy*, 1998, *14* (2), 30–44.

Hummels, David L and Georg Schaur, "Time as a Trade Barrier," *American Economic Review*, dec 2013, *103* (7), 2935–2959.

Morten, Melanie and Jaqueline Oliveira, "The Effects of Roads on Trade and Migration: Evidence from a Planned Capital City *," Technical Report 2018.

Pomfret, Richard, "Modernizing Agriculture in Central Asia," *Global Journal of Emerging Market Economies*, may 2016, *8* (2), 104–125.

Redding, Stephen J, "Goods trade, factor mobility and welfare," *Journal of International Economics*, 2016, *101*, 148–167.

Roberts, Mark, Uwe Deichmann, Bernard Fingleton, and Tuo Shi, "Evaluating China's road to prosperity: A new economic geography approach," *Regional Science and Urban Economics*, jul 2012, *42* (4), 580–594.

Turaeva, Rano, *Migration and Identity in Central Asia*, Routledge, jan 2016.

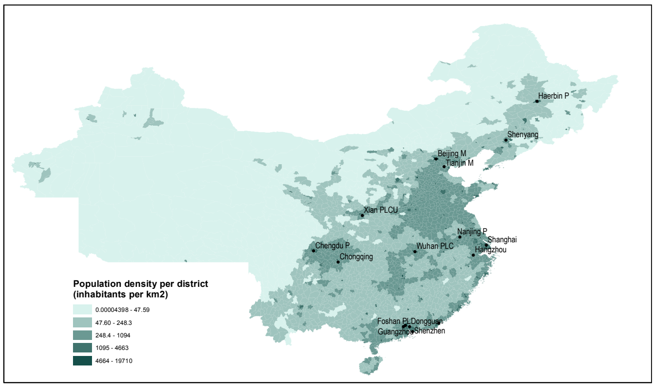
Zhu, Xiaodong and Trevor Tombe, "Trade, Migration and Regional Income Differences: Evidence from China," *2015 Meeting Papers*, 2015.

Appendices

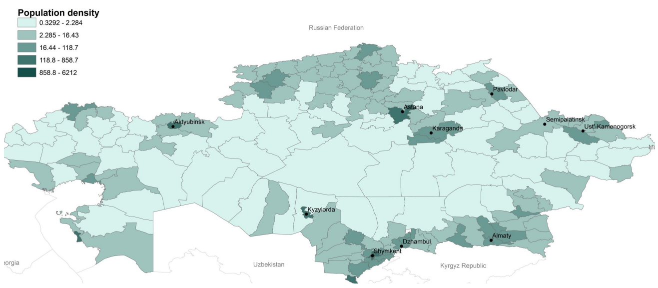
A Validation of the Balassa-Samuelson effect in China and Central Asia

Figure Annex.1: Population density in China and Central Asia

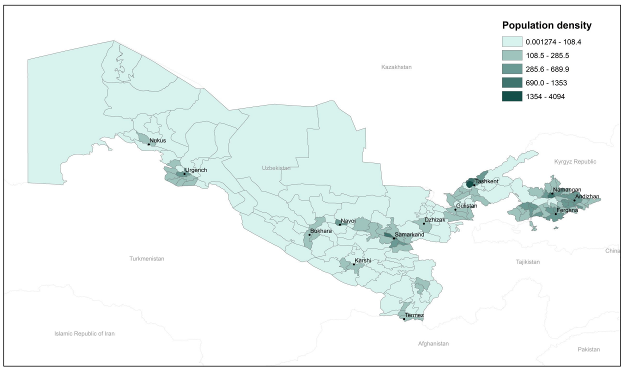
(a) China



(b) Kazakhstan



(c) Uzbekistan



B Annex: The BRI database

Part of the estimates to compute changes in time between the main domestic hubs and the three international gateways (Istanbul, Moscow and Urumqi) come from (de Soyres et al., 2018). This paper studies the effects of the Belt and Road Initiative on shipment times and trade costs for countries that will participate to the Initiative and for the world more broadly. The analysis combines detailed new information on transport infrastructure projects planned as part of the BRI, and a GIS network model to precisely quantify the impact of these projects on shipping times.

The multimodal network used in (de Soyres et al., 2018) was constructed by merging 2 types of features: maritime and rail. These features are largely non-overlapping and separated in space. For our paper, most routes are non maritime. The shortest path algorithm is used to find the shortest routing (in terms of shipping time) between any city-pair in our network and taking into account all possible ways to link the origin city to the destination city. In order to find such optimal route, each network element is associated with a time cost which is accumulated along the route to sum up to the total shipping time. Time is then calculated as the segment length divided by speed, where the speed of distinctive features is presented in Table 1.

Table 2: Speed assumption for different transport modes (de Soyres et al., 2018)

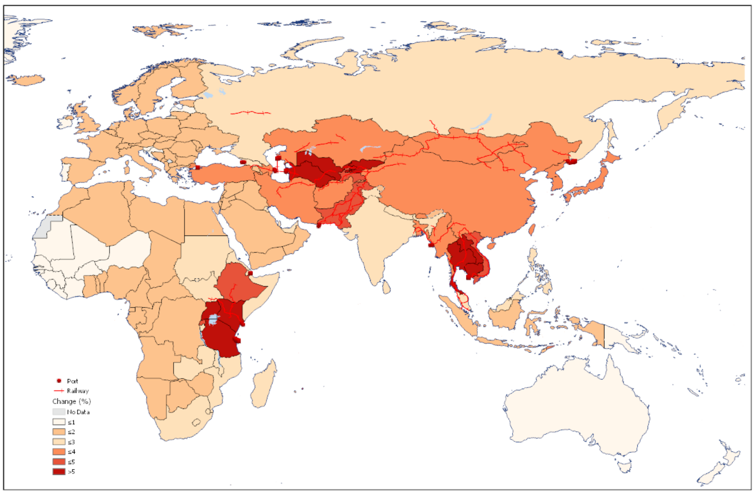
Description	Pre-BRI	Post-BRI
Maritime	25 km/h	25 km/h
Upgraded rail	50 km/h	75 km/h
New rail	-	75 km/h

B.1 Transport networks pre-BRI and post-BRI

We use the upper bound scenario. The upper bound scenario allows changes in transportation mode once the BRI projects are taken into account so that new and upgraded rail links might divert some routes away from long maritime routes towards shorter rail connections.

.

Figure Annex.2: Average decrease of shipping time per country (de Soyres et al., 2018)



B.2 Extension to trade improvements

Transport infrastructures are key elements of the logistic chain and improvement in the transport network can have a significant impact on shipping time and trade costs between countries.

However, by focusing only on planned transport projects related to the BRI, other gains that could be achieved through the BRI might be missed. de Soyres et al. (2018) turns to other policies that can affect shipping times over and beyond the improvement of the physical transport infrastructure: the implementation of trade facilitation policies (proxied by a reduction in the border processing time).

BRI economies are very heterogenous in terms of their customs policies. Bartley Johns et al. (2018) finds that the trade facilitation performance is below average along BRI corridors. Using data on border compliance from the World Bank's Doing Business 2018 report, they analyze additional scenarios using GIS network analysis in which import and export border delays for BRI countries are reduced by 50 percent. Table 4 presents the results with reduced border delays for BRI countries. In terms of delays, all regions experience a decrease in the average time to cross borders.

Table 3: Export and Import processing time at the border (from the Doing Business Database)

Region	Time to export: Border compliance (hours)	Time to import: Border compliance (hours)
East Asia / Pacific	55.9	70.5
Europe / Central Asia	28	25.9
Latin America / Caribbean	62.5	64.4
Middle East / North Africa	62.6	112.3
South Asia	59.4	113.8
Sub-Saharan Africa	100.1	136.4

Table 4: Average time to trade (hours) (de Soyres et al., 2018)

	East Asia/ Pacific	Europe/ Central Asia	Latin America/ Caribbean	Middle East/ North Africa	North America	South Asia	Sub-Saharan Africa
Border Delay	126.96	75.5	122.4	156.87	67.51	166.56	175.47
Reduced border delays	95.61	57.82	109.77	111.32	55.25	102.19	159.43

C Annex: Land in Kazakhstan

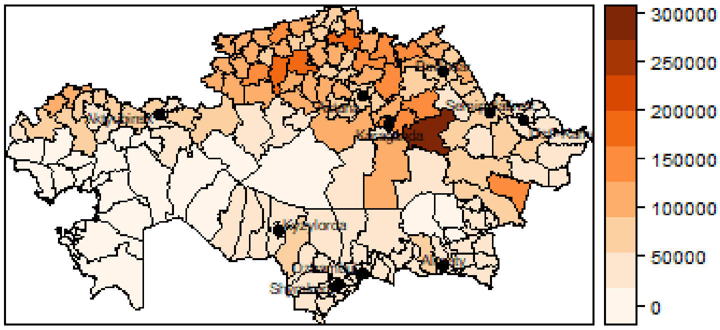


Figure Annex.3: Land size for each district (crop and urban lands) in pixels 300m*300m. *Source: ESA land categories with the land used for agriculture defined as irrigated, rainfed, and mosaic croplands.*

D Annex: Employment in agriculture

Employment and rural population data come from official statistics for Kazakhstan, Uzbekistan and Kyrgyzstan for 2016 or the latest year when not available. Employment data are gathered at the province level while share of rural population is given at the district level. The share of employment in agriculture at the district level is obtained by the following computation:

$$\text{Share in employment in agriculture} = \frac{\text{Employment in agriculture}}{\text{Total employment}}$$

$$\text{Employment in agriculture} = \text{Probability of being employed in agriculture when living in a rural area} \times \text{Rural population}$$

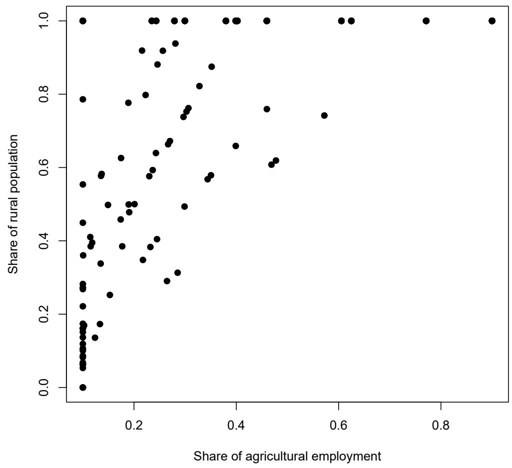
$$\text{Total employment} = \text{Probability of being employed} \times \text{Population}$$

with "Probability of being employed in agriculture when living in a rural area" given by the observed frequency at the provincial level, and "Rural population" at the district level; and with "Probability of being employed" given by the observed frequency at the provincial level, and "population" at the district level.

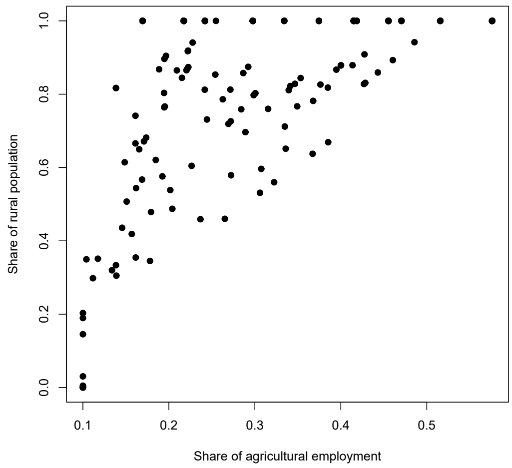
The following tables show the computation for the provincial variables and the correction factor to be applied to share of rural population given in the district database. Figures Annex.4 compare the share of rural population with the share of employment in agriculture for the three countries. Rural employment consists in both agriculture production and local manufcaturing and services for the rest of the rural population (food service, health, education, government sectors, etc). Urban populations are assumed as having no employment in agriculture.

Figure Annex.4: Rural shares versus share of employment in agriculture at the district level

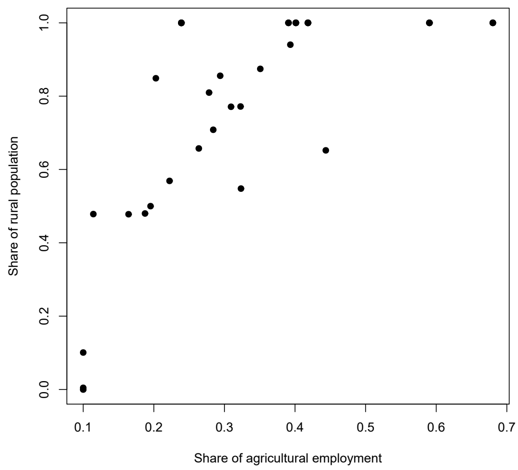
(a) Kazakhstan



(b) Uzbekistan



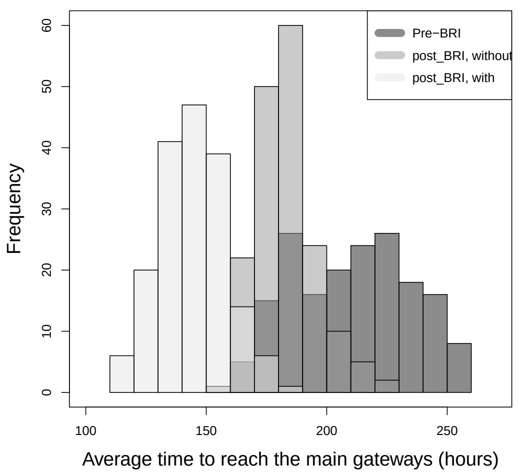
(c) Kyrgyzstan



E Annex: From time to costs

Figure Annex.5: Kazakhstan

(a) Change in transport times: 3 scenarios



(b) Change in transport costs: 3 scenarios

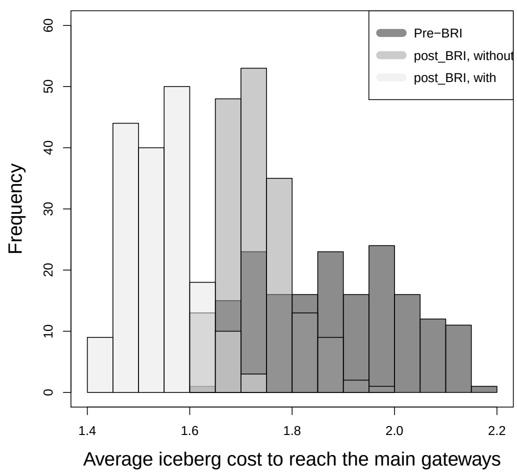
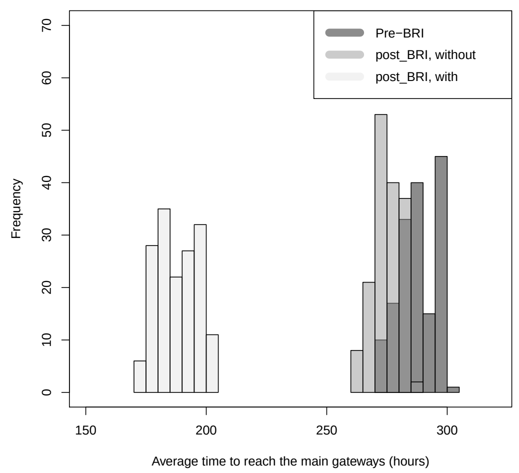


Figure Annex.6: Uzbekistan

(a) Change in transport times: 3 scenarios



(b) Change in transport costs: 3 scenarios

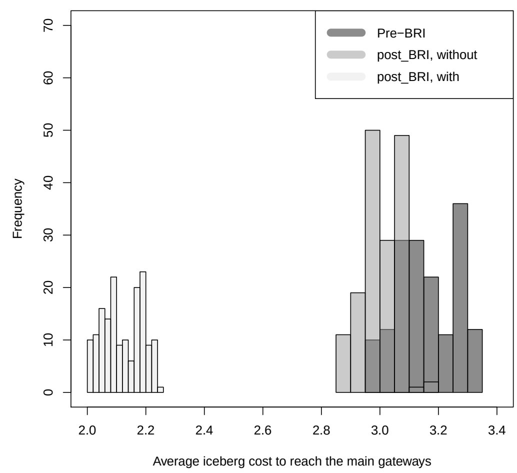
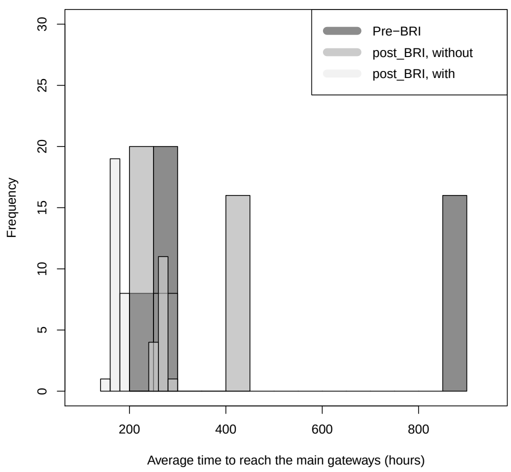
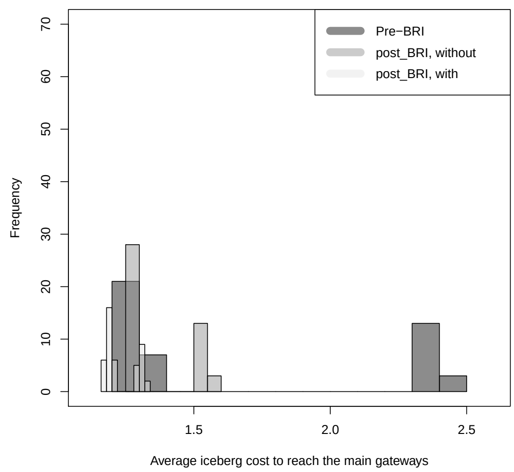


Figure Annex.7: Kyrgyzstan

(a) Change in transport times: 3 scenarios



(b) Change in transport costs: 3 scenarios



F Annex : Amenity levels

Figure Annex.8: District amenity level in Kazakhstan

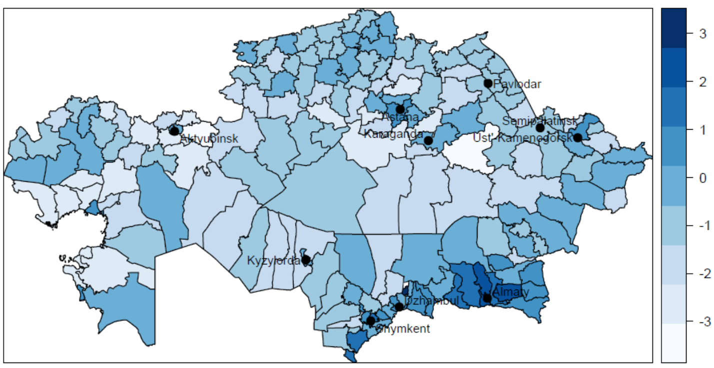


Figure Annex.9: District amenity level in Uzbekistan

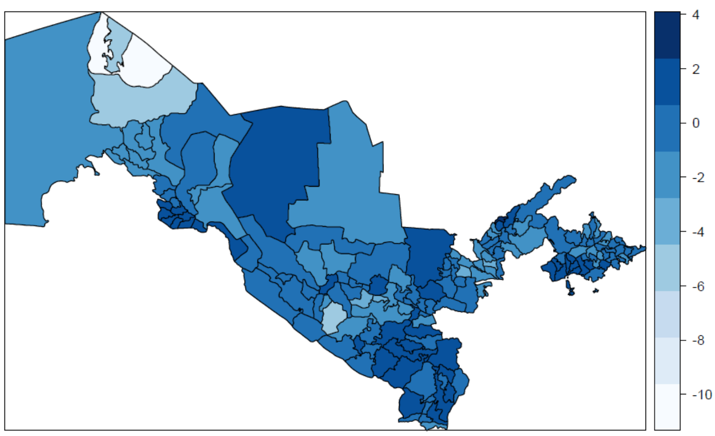
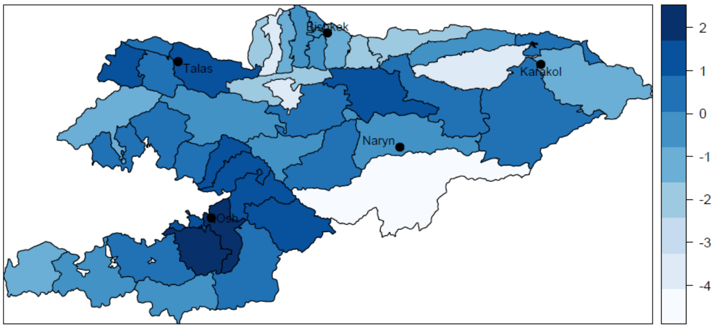


Figure Annex.10: District amenity level in Kyrgyzstan

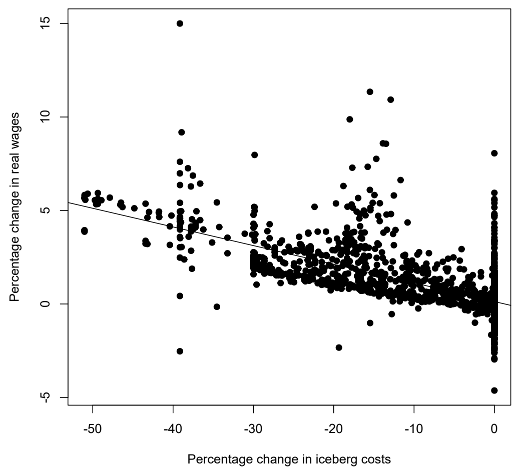


G Annex: China

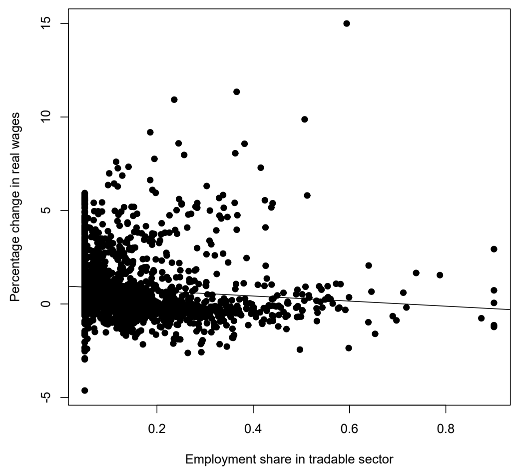
G.1 China: main counterfactuals

Figure Annex.11: Predictors of welfare gains

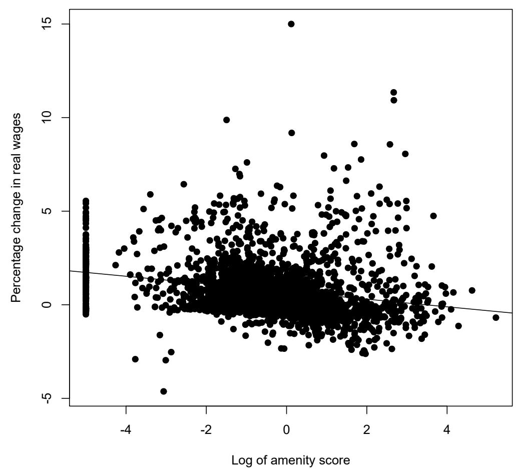
(a) Transport costs



(b) Employment



(c) Amenity



H Annex: Uzbekistan

H.1 Uzbekistan: main counterfactuals

Figure Annex.12: Uzbekistan: Change in transport costs as predictor of welfare gains

(a) Only transport investments (b) With border improvements

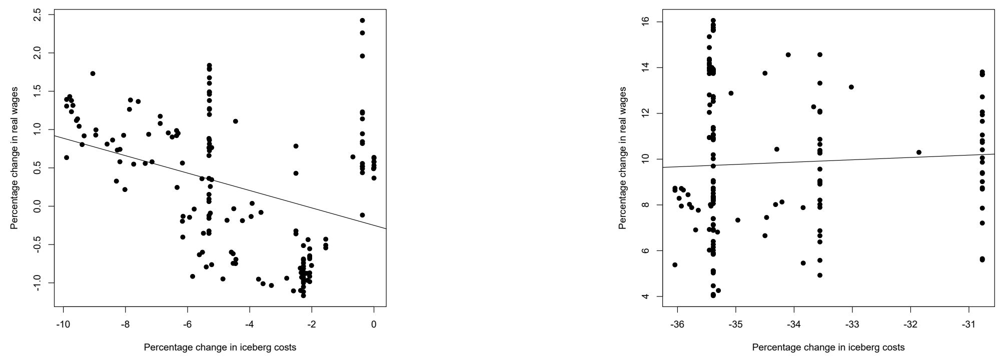


Figure Annex.13: Uzbekistan: Initial employment in export sector as predictor of welfare gains

(a) Only transport investments (b) With border improvements

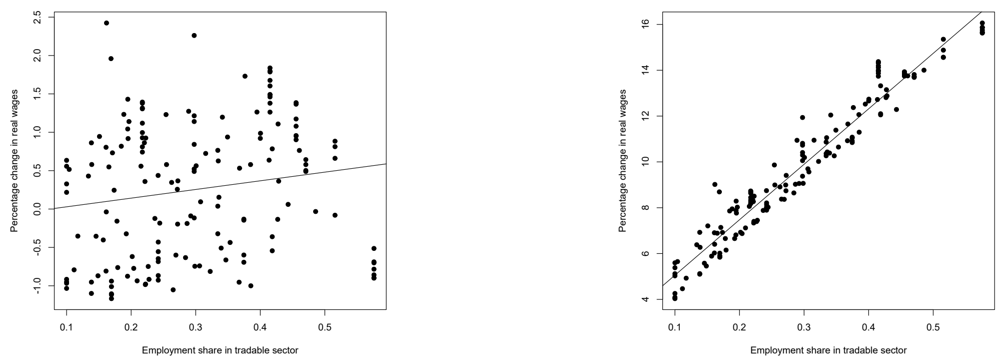
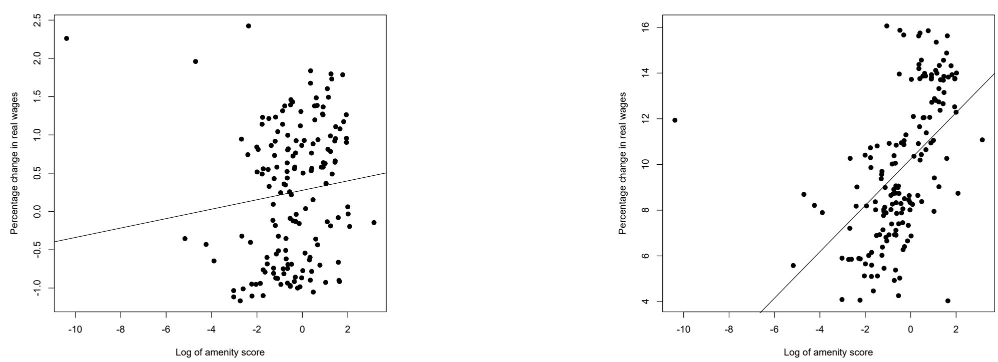


Figure Annex.14: Uzbekistan: Amenity as predictor of welfare gains

(a) Only transport investments (b) With border improvements



I Annex: Kyrgyz Republic

Similar to Uzbekistan, Kyrgyz Republic will benefit from projects that improve its connectivity with its Central Asian neighbors, Uzbekistan, Tajikistan and Kazakhstan, as well as to China. Kyrgyz Republic will benefit both from a better access to the two main Western Chinese hubs, Kashgar and Khorgos when the route through Kazakhstan is prefered. The following new rail projects that are part of the "China-Central Asia-West Asia Economic Corridor" will improve the connectivity of Kyrgyz Republic:

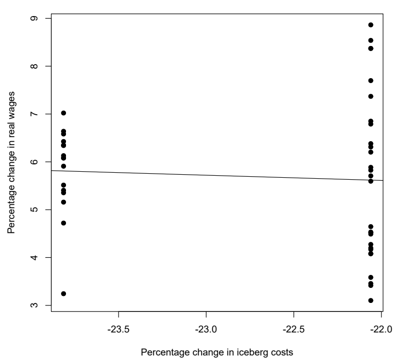
Name	Cities	Country	Type of investment
Kashgar-Tashkent rail	Kashgar-Pap -Tashkent	China, Kyrgyzstan, Uzbekistan	New rail
Kashgar-Dushanbe rail	Kashgar-Elok -Dushanbe	China, Kyrgyzstan, Tajikistan	New railroad

No new rail hub is assumed, even if Osh is considered as a new outpost as it was highly isolated in the pre-BRI scenario. One of the main corridor connecting Kashgar to Uzbekistan will pass through the South-Western regions of Kyrgyzstan where the city of Osh is located. Figure Annex.7a shows the total change in transport times also considering the time to reach the closest domestic transport hub. A major shift happens for the region close to Osh that were previously isolated and that highly benefit from the new investments.

I.1 Kyrgyz Republic: main counterfactuals

Figure Annex.15: Kyrgyz Republic: Change in transport costs as predictor of welfare gains

(a) Only transport investments



(b) With border improvements

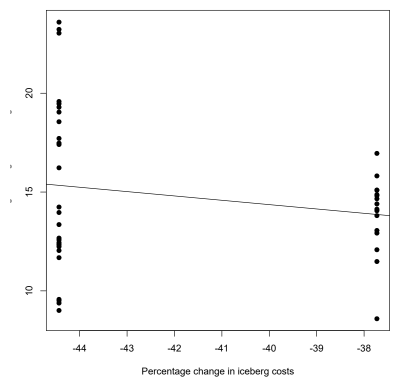


Figure Annex.16: Kyrgyz Republic: Initial employment in export sector as predictor of welfare gains

(a) Only transport investments (b) With border improvements

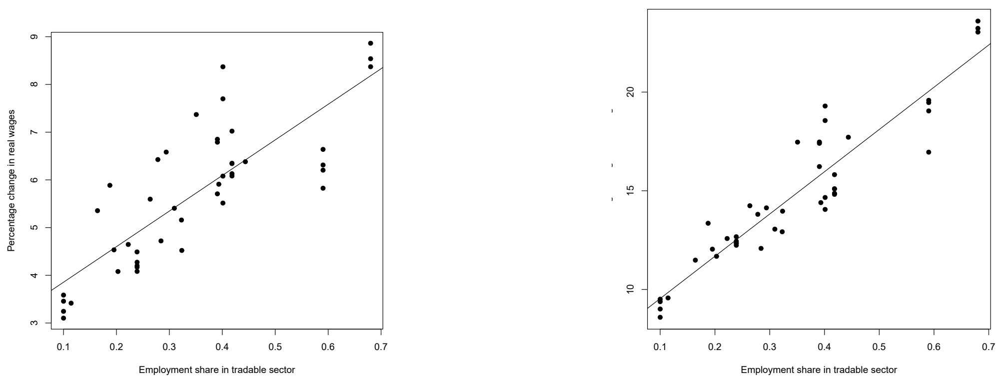


Figure Annex.17: Kyrgyz Republic: Amenity as predictor of welfare gains

(a) Only transport investments (b) With border improvements