# Common Transport Infrastructure: A Quantitative Model and Estimates from the Belt and Road Initiative[1]

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**Abstract**

This paper presents a structural general equilibrium model to analyze the effects on trade, welfare, and gross domestic product of common transport infrastructure. Specifically, the model builds on the framework by Caliendo and Parro (2015) – a Ricardian model with sectoral linkages, trade in intermediate goods and sectoral heterogeneity – to allow for changes in trade costs due to improvements in transportation infrastructure, financed through domestic taxation, connecting multiple countries. The model highlights the trade impact of infrastructure investments through cross-border input-output linkages. This framework is then used to quantify the impact of the Belt and Road Initiative. Using new estimates on the effects on trade costs of transport infrastructure related to the initiative based on Geographic Information System analysis, the model shows that gross domestic product will increase by up to 3.4 percent for participating countries and by up to 2.9 percent for the world. Because trade gains are not commensurate with projected investments, some countries may experience a negative welfare effect due to the high cost of the infrastructure. The analysis also finds strong complementarity between infrastructure investment and trade policy reforms.

*Keywords*: Transportation Infrastructure, Trade, Structural General Equilibrium, Belt and Road

*JEL Codes*: F10, F11, F14

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## 1. Introduction

Through trade agreements, countries have for a long time cooperated to reduce trade costs resulting from tariffs and other policy barriers to international trade. Cooperation on building common transport infrastructure is a more recent and less frequent phenomenon, but potentially as important to reduce international trade costs. For example, since the 1990s the European Union set up a common infrastructure policy to support the functioning of the internal market. The Trans-European Transport Network (TEN-T), in particular, is focused on the implementation and development of a Europe-wide network of transport infrastructure. China's Belt and Road Initiative (BRI) proposes infrastructure investments along the Silk Road Economic Belt -the "Belt"- and the New Maritime Silk Road -the "Road"- which will connect Asia, Europe and East Africa. Large-scale common transport infrastructure projects, or corridors as they are sometimes referred to, are becoming more prominent in Central Asia (e.g. Central Asia Regional Economic Cooperation (CAREC) program), Africa (e.g. Maputo Corridor, Abidjan-Lagos Corridor) and other parts of the developing world.[2]

Common transport infrastructure can improve welfare, but it also creates challenges for countries participating in the projects. For any country, building a railway or a road has some value, but it also has value to the countries around it since improvements in one part of the transport network reduce shipping times for all countries in the network. If each country alone decided how to invest in infrastructure, there are spillovers that would not be taken into account. The value of these investments also depends on what countries do, such as the standards that are used to build these infrastructures or the procedures that countries require to clear goods at the border. This is even more true when transport infrastructure crosses one or more borders pointing to the value of international cooperation in this area. But common transport infrastructure also creates challenges, as it has large implications for public finances and may have asymmetric effects on the trade and gross domestic product (GDP) of individual countries. This raises the possibility that the countries that will build - and bear the cost of – large sections of the project may not be the ones that will gain from it the most.

This paper presents a framework to analyze the trade, GDP and welfare effects of common transport infrastructure. This is an indispensable first step to assess the value of large-scale projects for the countries that will participate, as a group and individually, and for non-participating countries. Our analysis is based on the framework developed by Caliendo and Parro (2015), which we extend to study the impact of infrastructure investment.[3] The underlying framework is a Ricardian model of sectoral linkages, trade in intermediate goods and sectoral heterogeneity in production. Specifically, we enrich the Caliendo and Parro (2015) framework in two ways. First,

[2] See for instance ADB et al. (2018).
[3] The Caliendo and Parro (2015) model builds on the seminal contribution from Eaton and Kortum (2002).

we allow trade costs to depend on shipping times, which will be directly affected by the investment in transport projects, in addition to tariffs and policy barriers. The importance of time as a trade barrier has been established in a number of papers including Hummels (2001), Hummels, Minor, Reisman and Endean (2007), Djankov, Freund and Pham (2010), and Hummels and Schaur (2013). For instance, Hummels and Schaur (2013) estimate that a one-day delay in shipping time is equivalent to an ad-valorem tariff of around 5 percent.[4] Second, we account in the model for the implications of infrastructure investment for the government budget and domestic taxation. Hence, relative to quantitative models for trade policy analysis, the study of common transport infrastructure requires information on the changes in bilateral trade costs associated to the changes in shipping times due to the new infrastructure and estimates of the cost of building the transportation infrastructure for each country.

Despite its complexity, this framework presents the advantage that regardless of the number of sectors and how complicated the interactions between sectors are, the model can be reduced to a system of one equation per country. Moreover, counterfactuals can be performed without prior knowledge of fundamentals such as sector-level total factor productivity or employment, rendering this framework ideal for policy analysis. The model is therefore well suited to analyze the shock due to common transport infrastructure. It shows that when a sector experiences a decrease in the price of its imported inputs as shipping times/trade costs fall, it passes on the associated reduction in production costs to downstream industries, propagating the benefits across the world. These input-output linkages lead to potentially complex reallocation of comparative advantage, production and trade, thus increasing welfare. At the same time, the need to finance transport infrastructure leads to higher taxes that reduce real consumption. The net welfare effect for each country results from the combination of the trade gains and the share of the costs of the common infrastructure.

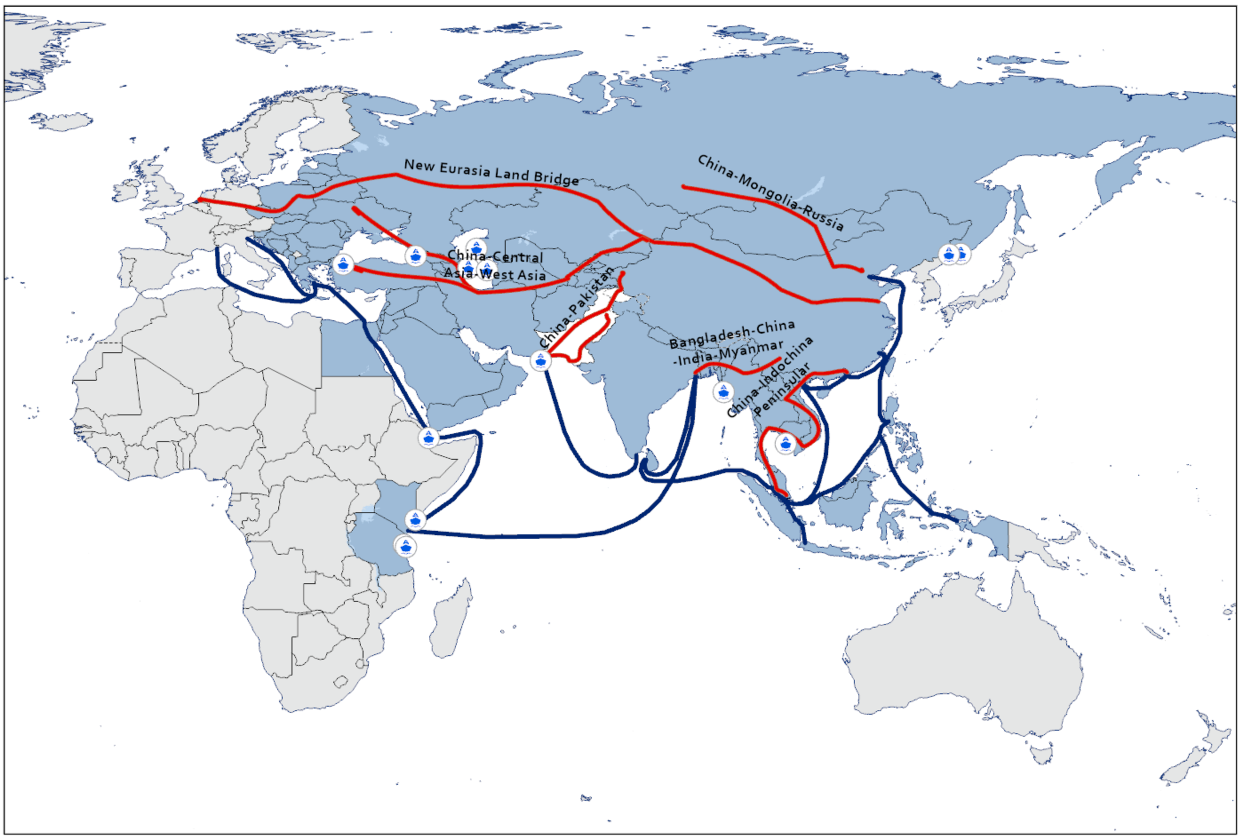
We then use this framework to estimate the trade, GDP and welfare effects of the transport infrastructure related to the Belt and Road Initiative for 55 participating countries and a total of 107 countries/regions in the world (Figure 1). We use a combination of geographical data and network algorithms to compute the reduction in shipping time and trade costs between all country pairs in the world.[5] The computations are based on the Shortest Path Algorithm on both the current

[4] Hummels and Schaur (2013) estimate the "value of time" both at the sectoral level as well as for all goods together. When including all goods and controlling for product fixed effects, they find that a one-day delay in shipping time is equivalent to an ad-valorem tariff of 0.6 to 2.3 percent. Separating each HS2 in different regressions, the average across all products is around 5 percent. de Soyres et al (2018) use the rich heterogeneity of Hummels and Schaur's (2013) estimates at the HS2 level in order to account for each sector's specificity in their sensitivity to time barriers.

[5] The infrastructure projects considered in this study are the ones currently being constructed, planned or proposed as part of the BRI (see de Soyres et al., 2018, for the full list). We do not consider the question of

network and an improved network enriched with infrastructure projects covered under the BRI. As a result, the paper estimates the impact of the BRI on the reduction in shipping time between all pairs of cities, which are subsequently aggregated at the country-pair level. Using Hummels and Schaur (2013) sectoral estimates of "value of time", those shipping time reductions are then transformed into reductions in ad-valorem trade costs. We also construct our estimates of the infrastructure costs associated with the BRI for each country.[6]

*Figure 1: The Belt and the Road*




whether this set of infrastructures is optimal for participating countries as a group or for individual countries.

[6] When constructing our estimates, it is important to ensure that the list of projects we are taking into account is exactly the same as the projects used in the estimation of trade cost reduction in de Soyres et al (2018). As a result, one cannot simply use aggregate cost estimates from official sources (when available) since those numbers do not include only transport projects. In this paper, we re-estimate the costs using a bottom-up approach as described in Section 3. An important caveat is that we assume projects are implemented fully and efficiently -e.g. costs related to corruption or other forms of unproductive behavior are not considered in the analysis.

Our results show that BRI transport infrastructure projects increase GDP for BRI economies by up to 3.35 percent and welfare, which accounts for the cost of infrastructure, by up to 2.81 percent.[7] These effects are equivalent to the impact of a coordinated tariff reduction by one-third for all BRI economies. We also show that gains from trade are not necessarily commensurate to the investments paid by each country. Indeed, we find that three countries (Azerbaijan, Mongolia and Tajikistan) experience welfare losses as infrastructure costs overweigh gains. The welfare effects of BRI transport projects would increase by a factor of 4 if participating countries would reduce by half the delays at the border and tariffs, stressing the importance of complementary policy reforms. All countries gain when the infrastructure projects are associated to policy reforms.

The model also shows that BRI-related transport projects could increase GDP for non-BRI countries by up to 2.61 percent and for the world as a whole by up to 2.87 percent. These numbers are larger than typical findings for regional trade agreements such as NAFTA using a similar methodology. Contrary to regional trade agreements, which decrease tariffs within a narrowly defined set of countries, the BRI is expected to decrease trade costs between a very large number of countries, including many economies that are not part of the initiative but whose trade flows will benefit from the improved transport infrastructure network when accessing (or transiting through) BRI countries.

Our work contributes to the three strands of the literature in international and development economics. First, as already mentioned, we extend a by now standard general equilibrium framework to analyze the effects of trade policy cooperation (Caliendo and Parro, 2015) to address the question of the impact of common transport infrastructure. Second, our work relates to the recent literature on the economic effects of transport infrastructure (Donaldson and Hornbeck, 2016; Allen and Arkolakis, 2017; Fajgelbaum and Schaal, 2017; Donaldson, 2018; Santamaria, 2018). Differently from these papers, our focus is on the quantification of the international trade effects of common infrastructure projects. The third recent strand of the literature focuses on the economic effects of the Belt and Road Initiative. Recent papers have looked at various aspects, including trade effects using a gravity model (Baniya et al., 2018) and Computable General Equilibrium analysis (Zhai, 2018; Maliszewska and van der Mensbrugghe, 2019), spatial effects

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[7] Those results are quantitatively higher than the Computable General Equilibrium (CGE) analysis in Maliszewska and van der Mensbrugghe (2018). Differently from the CGE analysis, our structural model assumes stronger complementarities between foreign and domestic inputs, with a Cobb-Douglas aggregation in the production function, as in Caliendo and Parro (2015). Moreover, Maliszewska and van der Mensbrugghe (2018) have a more detailed structure of the economy, which comes at the expense of higher level of aggregation of countries into large regions. The finer disaggregation in our model allows to capture the impact of lower trade costs associated to BRI transportation projects on trade flows for a larger number of countries. These intra-regional effects appear to be quantitatively relevant as most country-pairs in the world will experience a decrease in trade cost due to the BRI transportation projects. This effect is magnified when there are important complementarities between foreign and domestic inputs in production.

(Bird et al., 2019; Lall and Lebrand, 2019), and debt sustainability (Bandiera and Tsiropoulos, 2019).

The paper is structured as follows. Section 2 presents a quantitative model to study the effects of common transport infrastructure. The following section estimates the effects of transport infrastructure projects related to the Belt and Road Initiative on 53 participating countries and a total of 107 countries in the world. Concluding remarks follow.

## 2. A model of infrastructure investment and international trade

In order to quantify the consequences of common transport infrastructure, we use a quantitative model of international trade based on Caliendo and Parro (2015). We extend this framework along two dimensions: we allow for changes in trade costs due to the reduction in shipping times associated to transport infrastructure and we adapt the model to account for budgetary implications of the infrastructure projects we include in our analysis.

### a. Households

Consider a world economy with $N$ countries indexed by $i$ and $n$, and $J$ sectors indexed by $j$ and $k$. Following Caliendo et al. (2018), households supply labor in return for a wage $w_n$ and are also the owner a fixed factor (land/structures).[8] In particular, we assume that each country has an endowment of $H_n$ units of land and structures which are rented to firms at a rental rate $r_n$. We assume the presence of a global portfolio and consider the case in which all rents from the fixed factor are sent to the global portfolio and in return each country receives $\iota_n \chi$, where $\chi = \sum_{n=1}^{N} r_i H_i$ is the global income from the portfolio and $\iota_n$ the share of the global portfolio income that country $n$ obtains.

In country $n$, a representative agent choses consumption in order to maximize its indirect utility

$$v_n = max \prod_{j=1}^{J} \left(C_n^j\right)^{\alpha_n^j}$$

where $c_n^j$ are goods from sector $j$ consumed in country $i$, and $\alpha_n^j$ is the share of sector $j$ in total final consumption in country $n$, with $\sum_j \alpha_n^j = 1$.

[8] As discussed in Caliendo et al. (2018), the presence of a fixed factor in the model allows to endogenize trade imbalances in a static framework.

In order to account for the cost of building transport infrastructure, we assume that households are subject to a lump-sum tax, $\tau_n^L$, which is set so that tax revenue equals the estimated building costs of transport infrastructure. On top of labor income and the rent from the fixed factor, households also receive the proceeds from import tariffs $t_{ni}^j$. The household budget constraint is then given by:

$$\sum_{j=1}^{J} p_n^j C_n^j = w_n L_n - \tau_n^L + \iota_n \chi + T_n \equiv I_n$$

where $p_n^j$ and $c_n^j$ are the price and consumption level of sectoral goods $j$ from country $n$ and $T_n$ is total revenues from import tariffs. Denoting by $M_{ni}^j$ total country $n$'s imports from country $i$ in sector $j$, the associated tariff revenues is simply defined by:

$$T_n \equiv \sum_{j=1}^{J} \sum_{i=1}^{N} \frac{t_{ni}^j}{(1 + t_{ni}^j)} M_{ni}^j \quad (1)$$

Denoting by $P_n = \prod_{j=1}^{J} \left(P_n^j / \alpha_n^j\right)^{\alpha_n^j}$ the price index in country $n$, the value of consumption is then given by $P_n C_n = I_n$ and welfare in country $n$ is given by:

$$U_n = \frac{I_n}{P_n} = \frac{w_n L_n + \iota_n \chi + T_n}{P_n} - \frac{\tau_n^L}{P_n}. \quad (2)$$

In the above equation, it is apparent that the welfare effect of investing in transport infrastructure depends on the difference between the welfare gains that can be achieved through higher real consumption (the first term) and the real cost of investment. Note that all variables in equation (2) represent annual values. We will come back to this conceptual issue in Section 3.

### b. Production and trade

Representative firms in each country $n$ and sector $j$ produce a continuum of intermediate goods with idiosyncratic productivities $z_n^j$, using a Cobb-Douglas aggregate of domestic labor and fixed factors as well as intermediate inputs from all other sectors. The production function of a variety with idiosyncratic productivity $z_n^j$ is given by:

$$q_n^j(z_n^j) = z_n^j \left[A_n^j h_n^j(z_n^j)^{\beta_n} \ell_n^j(z_n^j)^{(1-\beta_n)}\right]^{\gamma_n^j} \prod_{k=1}^{J} M_n^{jk}(z_n^j)^{\gamma_n^{jk}}. \tag{3}$$

where $\ell_n^j$ is the quantity of domestic labor and $M_n^{jk}(z_n^j)$ denotes the composite input from sector $k$ used in the production of variety $z_n^j$. With Cobb-Douglas production and abstracting from capital input, one can simply interpret the coefficient $\gamma_n^j$ as being the share of value added in gross output in sector $j$ and country $k$, while the set of coefficients $\gamma_n^{jk}$ for all $k$ are the sectoral shares in production. We assume that $\gamma_n^j + \sum_{k=1}^{J} \gamma_n^{jk} = 1$, ensuring constant returns to scale in production, which, together with a perfectly competitive behavior leads to the absence of profit in the model.

Following Eaton and Kortum (2002), we use a probabilistic representation of technology and assume that production efficiency in sector $j$ and country $n$ is the realization of a random variable $Z_n^j$ drawn independently for each pair $(n, j)$ from a Fréchet distribution with a cumulative distribution function $F(.)$ defined as: $F_n^j(z) = e^{-K_n^j z^{-\theta^j}}$. Parameter $K_n^j$ governs the location of the distribution with a bigger $K_n^j$ implying that a high efficiency draw for a variety in sector $j$ and country $n$ is more likely and is related to the notion of absolute advantage. The parameter $\theta^j$, which we treat as common across countries for each sector, is an inverse measure of the amount of variation within the distribution and is related to the notion of comparative advantage.[9] Productivity of all firms is also determined by a deterministic productivity level $A_n^j$ which can be thought of as the fundamental TFP.

Given the production function (3), standard cost minimization yields the following expression for the cost of the input bundle needed to produce varieties in $(n, j)$:

$$x_n^j = B_n^j \left[r_n^{\beta_n} w_n^{(1-\beta_n)}\right]^{\gamma_n^j} \prod_{k=1}^{J} (P_n^k)^{\gamma_n^{jk}} \tag{4}$$

where $B_n^j$ is a constant.[10] The unit cost of a good of a variety with draw $z_n^j$ in $(n, j)$ is then given by:

$$c(n, j, z_n^j) = \frac{x_n^j}{z_n^j} \left(A_i^j\right)^{-\gamma_n^j} \tag{5}$$

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[9] We assume that $1 + \theta_n^j > \sigma^j$, which is a necessary condition for the prices to be well defined. See Eaton and Kortum (2002) for more on this.

[10] $B_n^j = \left[\gamma_n^j\right]^{-\gamma_n^j} \prod_{k=1}^{J} \left[\gamma_n^{jk}\right]^{-\gamma_n^{jk}}$.

Firms are perfectly competitive and production exhibits constant returns to scale, implying that prices are equal to marginal cost. As is standard in models with input-output linkages, the price of any given sector depends on the price of its suppliers as well as the suppliers of its suppliers, so that all prices in the economy must be jointly solved and are the solution of:

$$p_n^j(z^j) = min_i \left\{ \frac{x_i^j \kappa_{ni}^j}{z_i^j} \left(A_i^j\right)_i^{-\gamma_n^j} \right\} \quad \forall\, j, n \tag{6}$$

where $\kappa_{ni}^j$ are ad-valorem trade costs which are defined as follows: For each country-pair and sector, $\kappa_{ni}^j$ is assumed to take the form

$$\kappa_{ni}^j \equiv \left( \left(1 + t_{ni}^j\right) + transport_{ni}^j + s_{ni}^j\left( \{G_k\}_{k=1}^N \right) \right) * \ \tilde{d}_{ni}^{\,j} \tag{7}$$

where $t_{ni}^j$ and $transport_{ni}^j$ are the sector-specific ad-valorem tariff and transport costs respectively for imports from country $n$ into country $i$. $s_{ni}^j$ measures the specific barrier due to shipping time from country $n$ to country $i$ as discussed for example in Hummels and Schaur (2013). Common transport infrastructure investment between any two countries affects this component of the trade cost. As is apparent in the notation, this latter component is affected by infrastructure spending not only in countries $n$ and $i$ but also potentially in all countries in the world. Indeed, in our network analysis in Section 3, we actually see that the shipping time between two countries can decrease even if neither of those countries improve their own transport network. This typically happens when any middle country or group of countries, along the way from $i$ to $n$, invests in its own transport infrastructure. Intuitively, in a network an improvement in any link can potentially yield benefit for many nodes, not only the nodes directly connected to the improved link. Finally, $\tilde{d}_{ni}^j$ are other trade barriers that are non-tariffs, non-transport and non-shipment time related.

Prices in a given sector and country is the aggregate of the prices of all varieties using a CES function. Given the assumptions of Fréchet distribution, the resulting price index in sector $j$ and region $n$ can be written in closed form as:

$$P_n^j = \xi_n^j \left( \sum_{i=1}^{N} \left(x_i^j \kappa_{ni}^j\right)^{-\theta^j} \left(A_i^j\right)^{\theta^j \gamma_i^j} \right)^{-\frac{1}{\theta^j}} \tag{8}$$

where $\xi_n^j$ is a constant and the cost of the input bundle $x_i^j$ is defined in (4).

Finally, using the properties of the Fréchet distribution we can derive expenditure shares as a function of technologies, prices and trade costs as:

$$\pi_{ni}^{j} = \frac{X_{ni}^{j}}{X_{n}^{j}} = \frac{\left(x_{i}^{j}\kappa_{ni}^{j}\right)^{-\theta^{j}}\left(A_{i}^{j}\right)_{i}^{\theta^{j}\gamma_{i}^{j}}}{\sum_{i'=1}^{N}\left(x_{i'}^{j}\kappa_{ni'}^{j}\right)^{-\theta^{j}}\left(A_{i'}^{j}\right)^{\theta^{j}\gamma_{i}^{j}}} \tag{9}$$

where $X_n^j$ is total expenditure in country $n$ and sector $j$. Note that $\pi_{ni}^j$ increases as TFP in country $i$, $A_i^j$, increases and it decreases with increases in country $i$'s input costs, $x_i^j$, and trade costs, $\kappa_{ni}^j$, respectively.

### c. Equilibrium conditions

An equilibrium of this economy is defined as a vector of input prices (wages and rental rate of structure) as well as sector-country prices that satisfy equation (8) and such that all markets clear.

In the goods market, the clearing condition simply equates total production for each sector-country with total absorption, including intermediate and final good flows:

$$X_{n}^{j} = \sum_{k=1}^{J}\gamma_{n}^{j,k}\sum_{k=1}^{J}\frac{\pi_{in}^{k}}{1+t_{in}^{k}}X_{i}^{k} + \alpha_{n}^{j}I_{n} \tag{13}$$

with trade shares defined by (9) and total household income defined as:

$$I_{n} = w_{n}L_{n} - \tau_{n}^{L} + \iota_{n}\chi + T_{n} \tag{14}$$

Finally, in the presence of cross-country transfers governed by the global portfolio, trade balance is given by equating the sum of exports and the portfolio payment to total imports:

$$\sum_{j=1}^{J}\sum_{i=1}^{N}\frac{\pi_{ni}^{j}}{1+t_{ni}^{j}}X_{n}^{j} + \Upsilon_{n} = \sum_{j=1}^{J}\sum_{i=1}^{N}\frac{\pi_{in}^{j}}{1+t_{in}^{j}}X_{i}^{j} \tag{15}$$

where $\Upsilon_n = r_nH_n - \iota_n\chi$ is the net contribution to the global portfolio. As in Caliendo et al (2018), we assumed that portfolio shares are fixed and will be calibrated to match the observed level of total trade imbalance for each country. When performing counterfactuals, this means that changes in total trade imbalances will be solely governed by changes in the size of the portfolio.

Following Dekle et al. (2008) and Caliendo and Parro (2015), we write equilibrium conditions in relative changes after a policy shock. Differently from the literature, which focuses on changes in trade costs due to trade policy shocks, in this paper we keep tariffs constant and instead consider a change in shipping times due to improvements in transportation infrastructure. Financed through domestic taxation. We now express an equilibrium under trade costs $\kappa_{ni}^{j'}$ relative to a base year equilibrium with trade costs $\kappa_{ni}^{j}$, for all $n$, $i$ and $j$.

**Definition** Define, for any variable $x$, the ex-post value as being $x'$ and the relative change as $\hat{x} = x'/x$. Using the equations above, the equilibrium conditions in relative changes satisfy the following set of equations:

Cost of inputs

$$\hat{x}_n^j = \left[\hat{r}_n^{\beta_n} \hat{w}_n^{(1-\beta_n)}\right]^{\gamma_n^j} \prod_{k=1}^{J} \left(\hat{P}_n^k\right)^{\gamma_n^{jk}} \tag{16}$$

Prices

$$\hat{P}_n^j = \left(\sum_{i=1}^{N} \pi_{ni}^j \left(\hat{x}_i^j \hat{\kappa}_{ni}^j\right)^{-\theta^j} \left(\hat{A}_i^j\right)^{\theta^j \gamma_i^j}\right)^{-1/\theta^j} \tag{17}$$

Trade shares

$$\hat{\pi}_{ni}^j = \left(\frac{\hat{x}_i^j \hat{\kappa}_{ni}^j}{\hat{P}_n^j}\right)^{-\theta^j} \left(\hat{A}_i^j\right)^{\theta^j \gamma_i^j} \tag{18}$$

Market clearing

$$X_n^{j'} = \sum_{k=1}^{J} \gamma_n^{j,k} \sum_{i=1}^{N} \frac{\pi_{in}^{k'}}{1 + t_{in}^{k'}} X_i^{k'} + \alpha_n^j \frac{I_n'}{1 + \tau_n^{C'}} \tag{19}$$

Income

$$I_n' = \widehat{w_n L_n} w_n L_n - \tau_n^{L'} + \iota_n \chi' + T_n' \tag{20}$$

Trade balance

$$\sum_{j=1}^{J}\sum_{i=1}^{N}\frac{\pi_{ni}^{j'}}{1+t_{ni}^{j'}}X_n^{j'}+\Upsilon_n'=\sum_{j=1}^{J}\sum_{i=1}^{N}\frac{\pi_{in}^{j'}}{1+t_{in}^{j'}}X_i^{j'} \tag{21}$$

where $\Upsilon_n' = r_n' H_n' - \iota_n \chi'$.

### d. Effects of infrastructure investment

Before moving to the calibration and the quantitative assessment of the Belt and Road Initiative, we pause to make some comments on the prediction that can be derived using this structural model.

First, as is apparent from the pricing equation (17) and the equilibrium trade shares (18), reducing trade costs $\kappa_{ni}^{j}$ across many country-pairs and sectors is associated with an increase in trade flows through both a direct and an indirect channel. Equation (18) shows that, everything else constant, any reduction in trade costs leads to a proportional increase in trade shares by a factor $\theta^{j}$. Moreover, because firms use inputs from other countries in their production processes, the reduction in trade costs is magnified by a reduction in the cost of the input bundle $x_n^{j}$ as firms gain access to cheaper suppliers.

Second, as is apparent from the expression of expenditure shares (9), trade flows are governed by comparative advantage and firms optimize their sourcing decisions by comparing all possible options. Hence, whenever the decrease in trade costs (and, through input-output linkages, in production costs) is not uniform across country pairs and sectors, the new equilibrium not only features an increase in trade flows but also a reallocation of comparative advantage and the relative importance of specific trade partners is affected. As a result, the welfare gains that a given country can derive from common infrastructure investments depend on the distribution of trade cost reduction as well as all input-output linkages. Depending on the specific geographic location of the projects, this reasoning also means that the costs and benefits of common infrastructure investments can be very different – a point that will be more apparent when looking at the quantitative results in the next section.

Finally, we consider the interaction between changes in trade policy and in spending on infrastructure. This interaction can be more clearly seen in the price index of a given sector in changes in equation (17). A reduction in tariffs between country $n$ and country $i$ will affect, everything else constant, the level of trade openness in these countries, thus in the context of the price equation, $\pi_{ni}$ becomes higher as tariffs are reduced between these two countries. On the other hand, infrastructure spending reduces the trade costs by reducing the shipment time as discussed above, thus $\hat{\kappa}_{ni}$ falls. Now it is clear that the impact of a decline in trade costs as a consequence of infrastructure spending on prices (thus real wages) will be higher the more open is the country, which is shaped by trade policy. In other words, an important insight from the model is that the impact of infrastructure on a given country will depend on its level of trade openness, which in turn is affected by trade policy.

## 3. Quantifying the effects of the Belt and Road Initiative

In this section, we calibrate our model to assess the impact of the transport infrastructure related to the Belt and Road Initiative. While the scope of the initiative is still taking shape, the BRI is structured around two main components, underpinned by significant infrastructure investments:[11] the Silk Road Economic Belt -the “Belt”- and the New Maritime Silk Road -the “Road” (Figure 1). The “Belt” links China to Central and South Asia and onward to Europe, while the “Road” links China to the nations of Southeast Asia, the Gulf countries, East and North Africa, and on to Europe. Six economic corridors have been identified: (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. The 71 economies highlighted in Figure 1 are those that are geographically located along the Belt and the Road and are considered as “BRI economies” in this paper.

### a. Taking the model to the data

The simple equilibrium structure of the model presented in the previous section allows to simulate counterfactuals with a large number of countries and sectors without any computational issue. This is important given the global nature of the shock we are studying: due to network effects, BRI transport infrastructure investments are expected to change bilateral trade costs among many country pairs in the world and not only for countries that will participate to the initiative. A key advantage from solving the model in relative changes is that it minimizes the data requirements to calibrate the model.

We use the newly available database in GTAP 10 to calibrate our model and consider a total of 107 countries and “regions” and 31 sectors.[12] To compute the model and perform counterfactual analysis, the following aggregates are used for all the countries considered in the analysis and for a constructed rest of the world, based on GTAP 10 data.

- $\gamma_n^j$: share of value added in gross output by country and sector.

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[11] Transport projects are estimated to cover about one-quarter of total BRI investment (Bandiera and Tsiropoulos, 2019).

[12] See Annex A for the full list of countries and regions used in this paper.

- $1-\beta_n$: share of payment to labor in value added by country.
- $\gamma_n^{jk}$: input-output coefficients, consumption of materials from sector $k$ in gross output in sector $j$.
- $\alpha_n^j$: share of sector $j$ in total final consumption in country $n$.
- $w_n L_n^j + r_n H_n^j$: value added by country and sector.
- $X_{ni}^j$: bilateral trade flows across countries for each sector (including all countries in the sample and a constructed rest of the world).
- $X_{nn}^j$: domestic sales, constructed as gross output minus total exports.
- $t_{ni}^j$: bilateral tariffs across countries for each sector (including all countries in the sample and a constructed rest of the world).
- $G_n$ : spending in infrastructure by country estimated in the subsequent section.
- $\hat{\kappa}_{ni}^j$: proportional changes in trade costs associated with BRI transport projects, for each origin-destination-sector, estimated in de Soyres et al (2018), and discussed below.

We use the sectoral trade elasticities $\theta^j$ from Caliendo and Parro (2015) which were estimated for 20 tradeable sectors and which we map to our 31 sectors (Table 1). Their estimations are performed using trade and tariff data, without assuming bilaterally symmetric trade costs as is standard in the literature. Moreover, their method is consistent with any trade model that delivers a gravity-type trade equation.[13]

[13] We assume an elasticity 4.0 for the Oil, Gas and Coal industry to account for the fact that it takes time to renegotiate energy contracts and that some countries may not be able to source energy from alternative suppliers due to infrastructure constraints such as existing gas pipelines.

*Table 1: Sectoral Trade Elasticities*

| Sector | Elasticity | Sector | Elasticity |
|---|---|---|---|
| Beverages and tobacco products | 2.55 | Machinery and equipment nec | 1.52 |
| Communication | 7.07 | Manufactures nec | 5 |
| Construction | 4.55 | Minerals nec | 2.76 |
| Dwellings | 4.55 | Meat products nec | 2.55 |
| Electronic equipment | 10.6 | Other Agriculture | 8.11 |
| Metal products | 4.3 | Other Services | 4.55 |
| Forestry | 8.11 | Transport equipment nec | 4.55 |
| Fishing | 8.11 | Paddy rice | 2.55 |
| Gas manufacture, distribution | 5 | Petroleum products, plastics and Chemicals | 19.16 |
| Leather and wood products | 10.83 | Paper products, publishing | 9.07 |
| Metals | 7.99 | Textiles | 5.56 |
| Dairy products | 2.55 | Transport | 4.55 |
| Motor vehicles and parts | 4.55 | Trade | 4.55 |
| Mineral products nec | 2.76 | Wearing apparel | 5.56 |
| Food products nec | 2.55 | Water and Electricity | 4.55 |
| Oil, Gas and Coal | 4.0 | | |

## Estimated changes in trade costs

We briefly review the methodology used to estimate the impact of the BRI transport infrastructure on trade times and trade costs in de Soyres et al. (2018). First, we identify the longitude and latitude of the two most populous cities in each country in addition to all the cities in the world with population greater than 500,000. Second, we compute the shipment times between each city-pairs using the shortest path algorithm applied to the existing network of railways and the location of major ports using data from Atlas of the Earth (DAE), 2015 release, and Global Shipping Routes (CIA, ESRI, 2012) respectively. Finally, we identify the effect of BRI infrastructure projects on shipment times at city-pair level by applying the shortest path algorithm to an improved network that includes manually digitized information on BRI projects based on Reed and Trubetskoy (2018).

The BRI transport infrastructure investments considered in this analysis are those related to new or improved rail and port projects.[14] To obtain more accurate time estimates, we complement the georeferenced data with proxies for port quality using data from Slack, Comtois, Wiegmans and Witte (2018) on the amount of time spent in port by vessels. Additional data on

[14] See de Soyres et al (2018) for the full list of projects.

border delays related to border compliance come from the "trading across borders" section in the World Bank's Doing Business Database.[15] Border compliance data capture the time associated with compliance with the customs clearance and mandatory inspections regulations. To account for the very high share of maritime shipping in international trade due to price differentials, the algorithm opts for maritime if the shipping time is lower than four times the shipping time incurred using rail links. In the improved scenario of the network simulation, when a project involves building a new port or upgrading an old port, the associated "processing time" is assumed to decrease to 50 percent of the port delay in the region or to the lowest worldwide processing time, whichever is higher.

Finally, the population weighted time distance between country-pairs is transformed into ad-valorem equivalents using estimates from Hummels and Schaur (2013) on the "daily value of time" at the sector level. These estimates are added to transport costs and data on tariffs from GTAP to obtain country pair-sector values of trade costs. Table 2 presents the results for two scenarios, referred to as the "lower-bound" and the "upper-bound". The "upper-bound" scenario allows for changes in transportation mode due to the new infrastructure while the "lower-bound" scenario assumes that switching mode of transportation is difficult -allowing for modal changes lower than 5 percent with respect to the pre-BRI modes of transport. The decrease in total trade costs associated with the new BRI projects ranges between 1.05 and 2.19 percent. For some country-pairs this decline is zero, while the maximum change ranges between 61.52 and 65.16 percent.

*Table 2:Percentage decrease in trade costs due to the BRI*

| % decrease in trade cost | Min | Max | Mean | Std. Dev |
|---|---|---|---|---|
| | | **World** | | |
| Lower Bound | 0.00% | 61.52% | 1.05% | 2.43% |
| Upper Bound | 0.00% | 65.16% | 2.19% | 3.40% |
| | | **BRI Countries** | | |
| Lower Bound | 0.00% | 61.52% | 1.50% | 3.07% |
| Upper Bound | 0.00% | 65.16% | 2.81% | 4.18% |

*Note: Summary statistics across all country-pairs and sectors in the world.*

[15] For any border, we use the data on "Border Compliance" and the total delay is assumed to be the sum of export time from the exporting country and the import time from the importing country. We do not include documentary compliance, as it does not relate to travel time. All data are available at: http://www.doingbusiness.org/data/exploretopics/trading-across-borders.

## Estimated infrastructure costs

There is little publicly available information on the terms and conditions of BRI projects. In order to compute the total costs associated with BRI transport infrastructure, we combine information from World Bank country teams, which draw from publicly available sources on the costs of a small subset of BRI projects, with a bottom-up approach based on the projects' characteristics and assumptions of construction costs. Specifically, we first start by computing the length (in km) of each new rail junction, improvement of existing rails, tunnels, canals and bridges. Then we use the assumptions presented in Table 3 to quantify the cost for infrastructure projects for which we do not have country specific information, which are the large majority of cases. The cost per kilometer of improvement of existing rail is based on the expected rehabilitation and upgrade cost of the Karachi-Lahore Peshawar railway track. Assumptions on the cost of tunnels and bridges are based on Ollivier, Sondhi, and Zhou (2014).

*Table 3: Assumptions in the construction of Infrastructure Costs*

| Project type | Cost per unit<br>million of USD (per km) |
|---|---|
| new rail | 12.14 |
| improvement of existing rail | 4.37 |
| tunnel | 11 |
| canal | 30 |
| bridge | 10 |
| new port | case-by-case basis |
| improved port | case-by-case basis |

Based on these assumptions, Table 4 presents the total estimated costs of BRI transport infrastructure in each country.

*Table 4: Estimated Total Costs per country (million of USD)*

| Country | Total Country Cost million of USD |
|---|---|
| Afghanistan | 12,252.14 |
| Azerbaijan | 2,262.44 |
| Bangladesh | 6,880.27 |
| Cambodia | 2,039.68 |
| China | 63,706.51 |
| Georgia | 5,146.44 |
| Greece | - |
| India | 3,400.00 |
| Iran, Islamic Rep. | 10,621.36 |
| Kazakhstan | 21,305.71 |
| Korea, Dem. People's Rep. | - |
| Kyrgyzstan | 5,391.43 |
| Laos | 6,528.57 |
| Malaysia | 12,997.86 |
| Mongolia | 35,515.57 |
| Myanmar | 26,397.86 |
| Pakistan | 49,301.82 |
| Russian Federation | 18,065.90 |
| Singapore | 303.57 |
| Tajikistan | 3,480.29 |
| Thailand | 11,798.27 |
| Turkey | 1,946.71 |
| Turkmenistan | 15,155.30 |
| Uzbekistan | 5,780.94 |
| Vietnam | 8,586.71 |
| Djibouti | 580.00 |
| Ethiopia | 9,131.43 |
| Indonesia | 582.86 |
| Kenya | 23,597.86 |
| Sudan | 4,310.71 |
| Tanzania, United Republic of | 1,100.00 |
| TOTAL | 368,168.23 |

In order to use these estimates in the context of our static model, we cannot simply use the total costs computed above and compare those to a single year of annual gain. Indeed, the model is calibrated using yearly data (trade flows and GDP are annual) and hence total consumption levels found in our simulated results are comparable to one year of consumption.

One way to compare the cost and benefits of investing in transport infrastructure using such a static model could be to compare the one-time initial cost payment to the present discounted value of the benefits that will be felt from the investment onward. Let $G_n$ be the total annual welfare gain for a country in terms of real consumption, $G_n = \frac{I_n}{P_n} - \frac{I'_n}{P'_n}$, and $D_n$ the one-time investment cost. Assuming a constant discount rate r, we could compute the net gain as the difference between the net present value of all gains and the one-time initial cost:

$$\sum_{i=1}^{+\infty} \frac{G_n}{(1+r)^i} - D_n = \frac{G_n}{r} - D_n$$

However, such an approach would assume that the whole cost of infrastructure is paid in full in the first year and the benefits are felt thereafter. In our model, this would imply setting the annual lump sum tax for the household to zero ($\tau_n^L = 0$) and assuming that investment occurs *before* solving for the equilibrium. By doing this, however, we would not properly account for the interaction between the investment cost in the household budget constraint and the equilibrium allocation: since countries have different consumption baskets and sectoral distributions, it is important to be able to incorporate the investment cost within the annual equilibrium structure described above.

To take into account the costs of infrastructures in a way consistent with the static model and its annual equilibrium, we use an "annualized" cost which allows us to compare one year of household revenues to one "yearly equivalent" of the investment cost. To do so, we simply assume that the costs are paid through a perpetuity with interest rate $r$. The equivalent annuity for country $n$, paid by the consumer as lump sum $\tau_n^L$, is then computed as:

$$D_n = \sum_{k=1}^{+\infty} \frac{\tau_n^L}{(1+r)^k} \Longrightarrow \tau_n^L = r \times D_n$$

Assuming an interest rate $r$ of 2.5 percent, the total annual cost of the BRI would be around \$9.2 billion. China, the country with the highest infrastructure costs, is assumed to sustain annual costs around \$1.6 billion which would increase to \$3.9 billion in the case it pays 30 percent of the total cost in other BRI countries in the form of equity investment. These country-specific annualized costs $\tau_n^L$ are then included in the household's budget constraint and in computation of the counterfactual equilibrium as described by equations (16) to (21). Proportional welfare gains from the initiative are given by $(\frac{I_n'}{I_n}) / \hat{P}_n$ .

### b. Results

Based on the estimated reduction in trade costs as well as the infrastructure costs associated to BRI transportation investment, we can compute a counterfactual equilibrium of the model and derive predictions in terms of trade flows and production at the sectoral level for all countries. As described below, our results for BRI transport investments feature overall welfare gains but also important heterogeneities across countries.

Two related elements are worth emphasizing to understand the results obtained with our approach. First, input-output linkages across and within countries propagate and amplify the decrease in production costs that can be associated with a decrease in trade cost. This is because, given the common nature of the shock (i.e. infrastructures are built in multiple countries), the BRI is associated with a decrease in trade costs between many country-pairs in the world and, in some cases, within countries. Second, it is important for our quantitative exercise to keep a very disaggregated version of the world with many countries. Indeed, every time one aggregates two countries that will experience decrease in trade costs between one another, one risks of not accounting for some gains that are linked with the BRI. This is especially important because we are not studying a local policy change which would leave most country-pairs' trade costs unchanged, but rather a change in the overall transportation network. In this sense, using a quantitative framework that can account for input-output linkages while being parsimonious enough to be calibrated and simulated with many countries is quantitatively relevant.

**GDP Changes**

We first present the results of the effect of BRI transport projects on GDP (real wages). These results should be interpreted as the long-term effect of changes in trade costs only. The model used in the simulation features consumption gains from reduction in trade costs for final goods but also production gains that are transmitted through trade in intermediate inputs and sectoral linkages which lead to reductions in firms' production costs. An important caveat is that the counterfactual scenarios abstract from any changes in other costs such as those related to factor movements or technological transfers which are likely to be affected by changes in shipping time as well as from congestion frictions of the transport network.

Figure 2 presents the results for the lower bound scenario in which modes of transport are relatively fixed (country-level results are reported in Annex Table B1). Panel A plots the distribution of GDP gains. The BRI is expected to increase real wages in all countries in the world. The distribution for BRI economies is shifted to the right of the distribution of the gains for the world. The median impact for BRI economies is 1.59 while it increases to 2.99 for BRI core countries[16] -i.e. those that are expected to build rail and port projects listed in Table 4.[17] The average increase is around 1.46 percent with increases in real GDP of up to 6.9 percent for Cambodia.

The impact for BRI countries varies by region and income group. BRI upper middle income and low-income economies are expected to benefit from the infrastructure improvement the most. The results for upper middle income are driven by China's improvement in access to foreign markets, estimated to increase its GDP by 2.48 percent, while the impact for low-income countries is driven by Tanzania with an estimated gain of 2.87 percent. Similarly, the results for Sub-Saharan Africa are high because of the new ports in Tanzania and Kenya that improve substantially the connectivity of those two countries to other BRI countries and the rest of the world. East Asia and Pacific and Europe and Central Asia regions, the most active in terms of BRI projects, are expected to increase their GDPs by 2.14 and 1.46 percent respectively.

[16] See Annex A for the full list of BRI core countries.
[17] To compute the weighted averages of the gains, we use pre-BRI GDPs as weights.

*Figure 2: Impact of BRI Infrastructure improvement on GDP- Lower Bound*

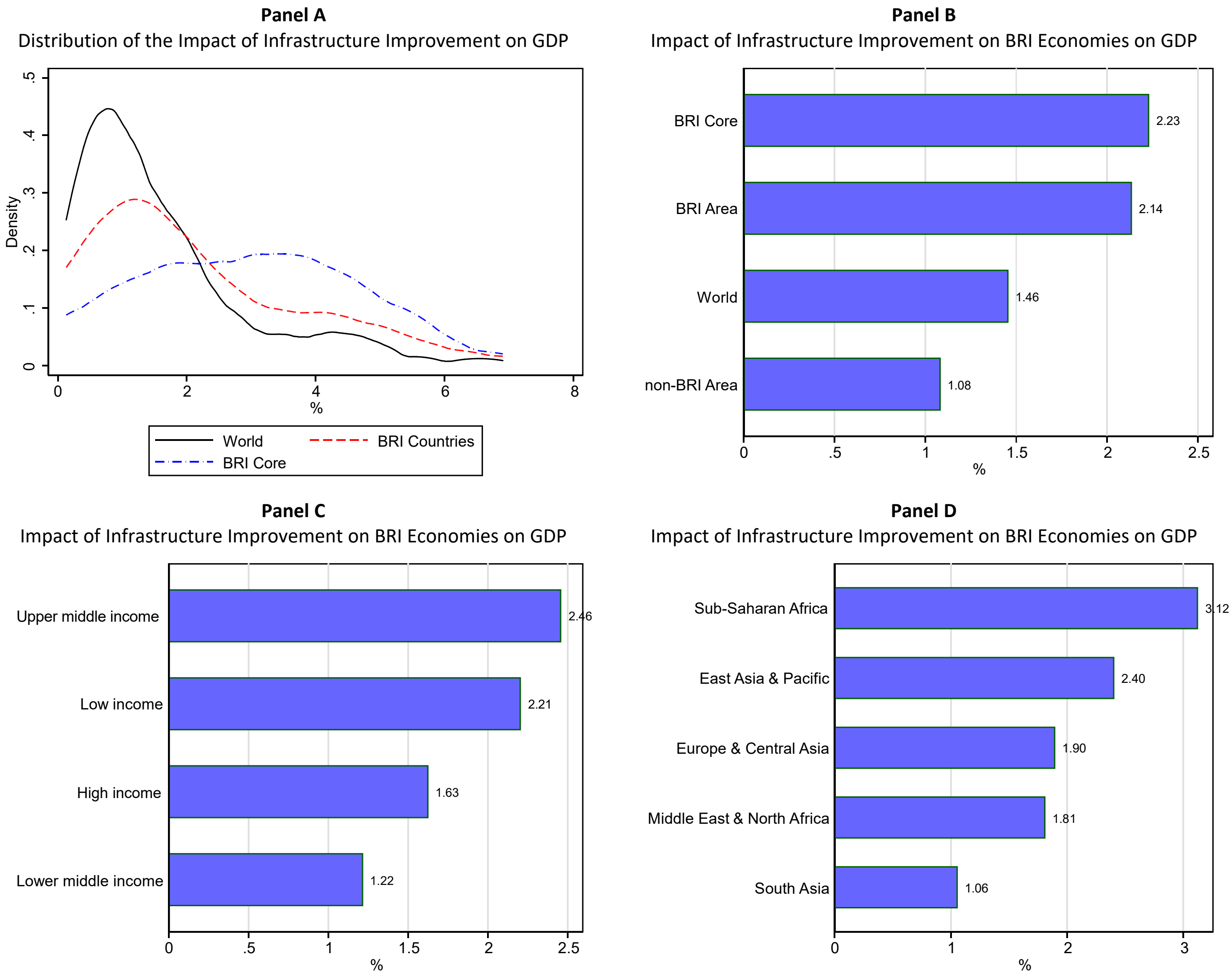
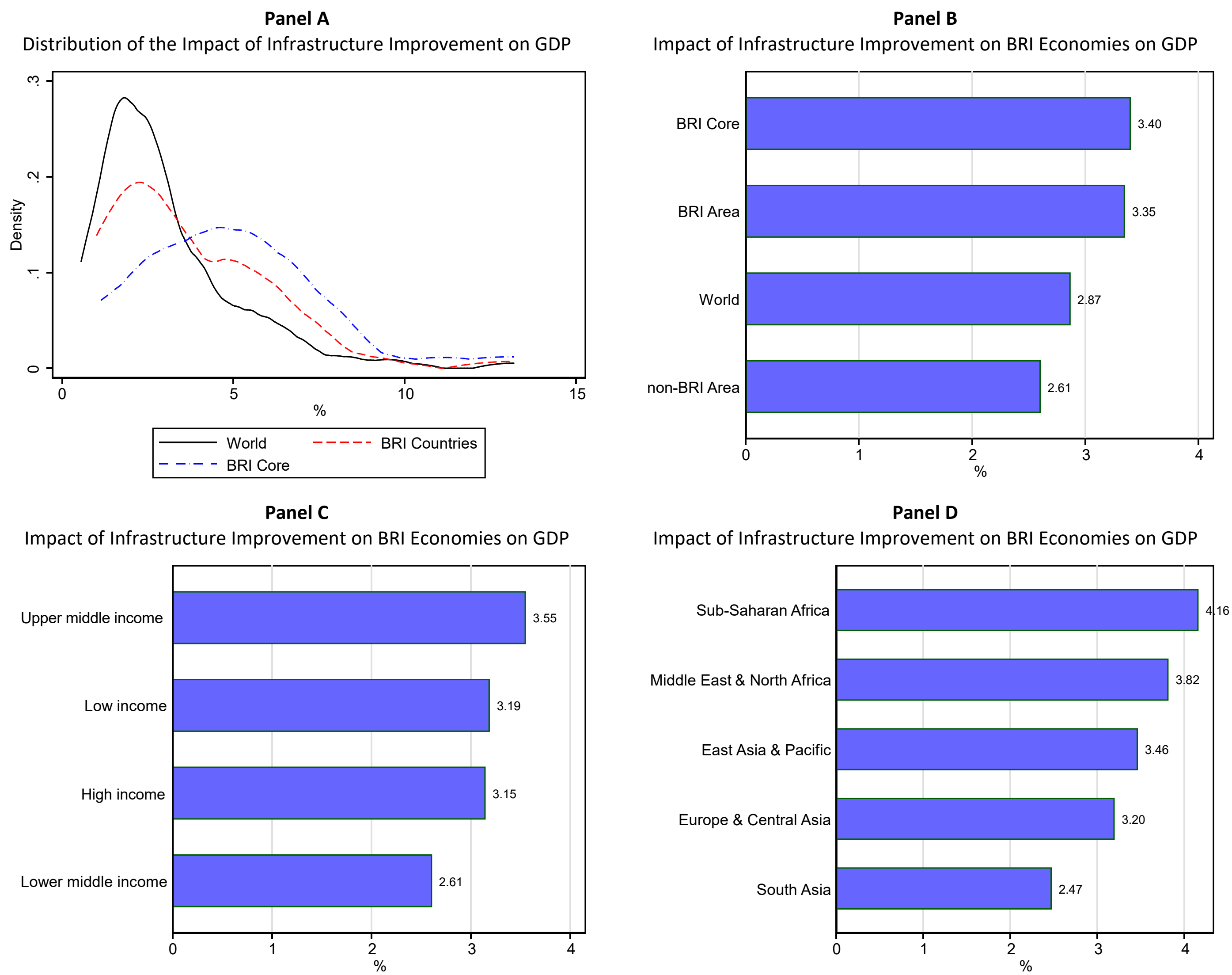


Figure 3 presents the results from the upper-bound scenario that allows for switches in mode of transport. The GDP impact in the upper bound are larger for both BRI and non-BRI economies. The median effect increases by around 50 percent for BRI economies while it more than doubles for non-BRI economies from 0.98 to 2.27. In terms of regions, Middle East and North Africa is estimated to increase its average gains by a factor of two with respect to the lower bound scenario. The gains are driven by large increases in oil-rich economies for which demand is increasing due to the expansion of economic activity in other BRI countries. In terms of country-income groups, this scenario suggests a more uniform distribution of the GDP gains.

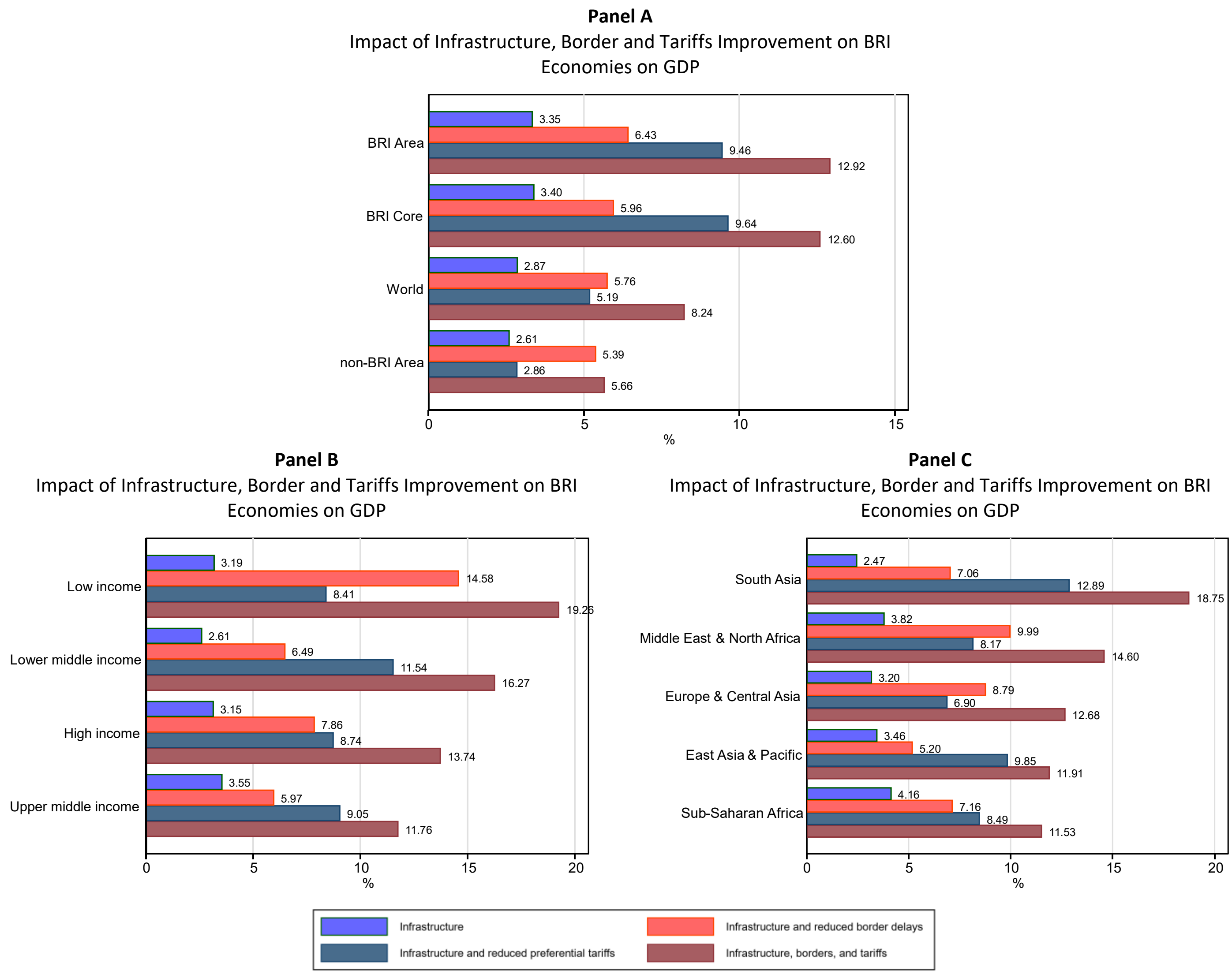
*Figure 3: Impact of BRI Infrastructure improvement on GDP- Upper Bound*



The impact of a more ambitious set of reforms could magnify the gains from the new infrastructure network. Figure 4 presents the results from complementary policies related to border delays and to tariff reduction among the BRI economies. For instance, if in addition to an improved infrastructure network also border delays were reduced by half, BRI economies could double the GDP gains coming from infrastructure investment alone. As all countries, BRI and non-BRI, are subject to border delays we find that non-BRI economies benefit as well from trade facilitation reforms. Low income countries, which trade intensively with countries or tend to have long border delays, would disproportionately benefit from better border management. Better border management would allow firms located in low income countries to access cheaper inputs increasing their competitiveness in foreign markets. As a consequence, demand for labor would increase pushing nominal wages up. Finally, a more efficient use of intermediate inputs and lower transport costs would lead to a decrease in prices of final goods.

As a second exercise, we simulate a 50 percent reduction in applied tariffs among BRI economies. Average tariffs in BRI countries are relatively high compared to tariffs in advanced economies. Applied tariffs in BRI countries vary between around 14 percent in Sub-Saharan Africa and 2 percent in East Asia and Pacific compared to applied tariffs of below 1 percent in G7 countries. Figure 4 shows that trade policy could have a substantial effect on countries in South Asia that could increase the impact of infrastructure improvement alone by a factor of 5. Interestingly, countries located in the Middle East and North Africa and in Europe and Central Asia would benefit more by combining infrastructure investment with trade facilitation polices rather than combining it with trade policies. This result is explained by relatively high border delays in these regions and by the fact that they rely disproportionately more on non-BRI countries in terms of inputs for their production. The effect of combining both a reduction in preferential tariffs and border delays would increase the benefits for both BRI and non-BRI members more than individual complementary policies alone.

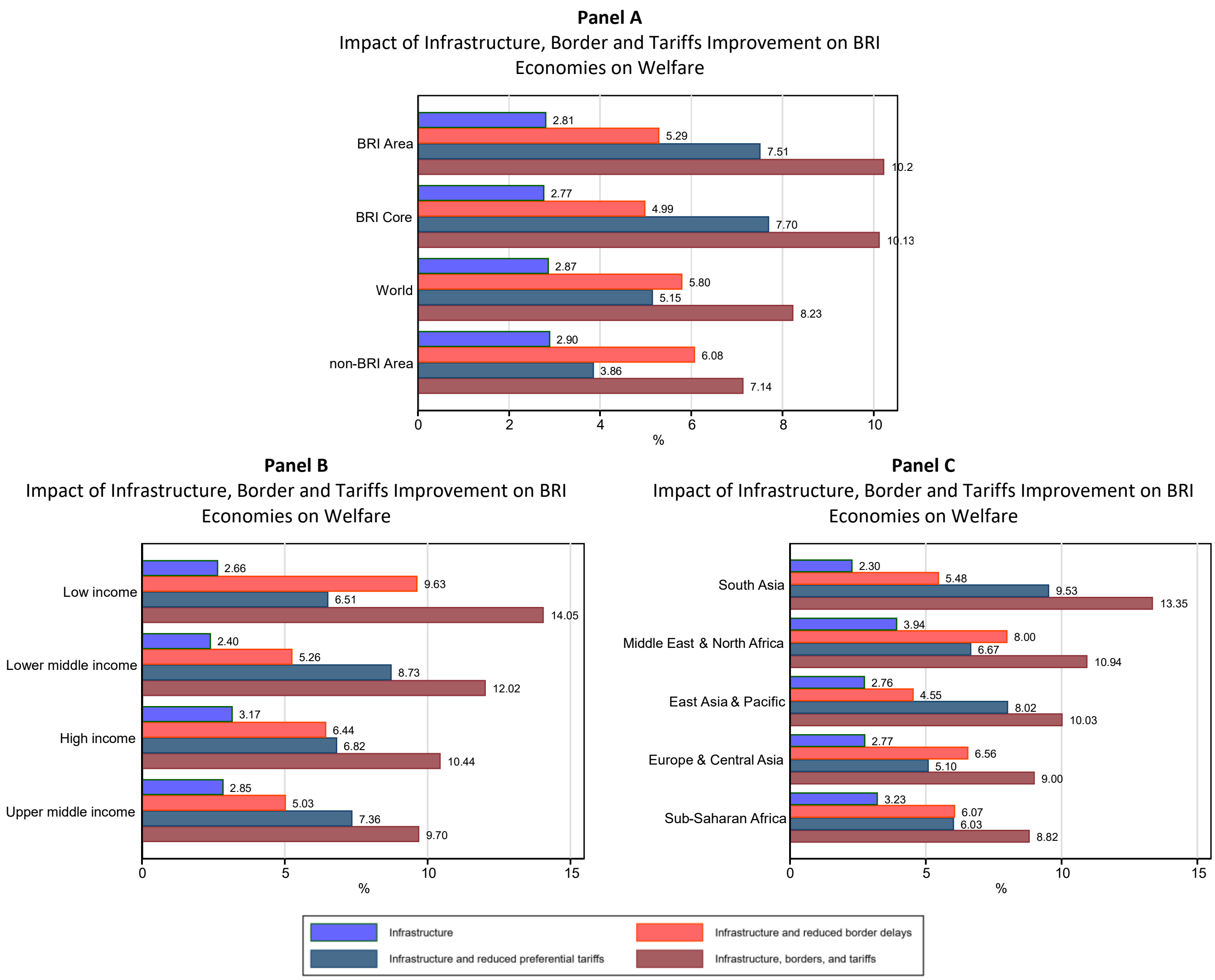
*Figure 4: Impact of Infrastructure and Complementary Policies on GDP – Upper Bound*




## Welfare Changes

We next look at welfare, which is defined as total revenues divided by the relevant consumption price index. It should be noted that total revenue takes into account payment to value added, revenues derived from the portfolio shares and from import tariffs, but also takes into account the (annual) estimated cost of the transport infrastructures presented in Table 4. Figure 5 shows the welfare impact of the different simulations for the upper-bound scenario (country-level results are presented in Annex Table B2). Overall, welfare results are similar in magnitude to the GDP effects. The main difference is that changes in welfare are smaller than those in GDP for BRI countries, especially BRI core countries that pay the annualized cost of the BRI infrastructure. The expected impact for BRI core countries is 18 percent lower in the improved infrastructure network scenario and 20 percent lower when we assume a 50 percent reduction in tariffs which lowers the revenue coming from import tariffs. The impact for non-BRI economies is higher as they do not bear the cost of the new infrastructure.

*Figure 5: Impact of Infrastructure and Complementary Policies on Welfare – Upper Bound*



Because trade gains are not commensurate to project investment, three economies (Mongolia, Azerbaijan and Tajikistan) are shown to have a net welfare loss due to the high cost of infrastructure relative to the trade gains in the lower-bound scenario and two economies (Mongolia and Azerbaijan) in the upper-bound scenario (see Annex Table B2). Complementary reforms aimed at reducing border delays and preferential tariffs could, however, improve the integration gains from transport projects leading to net welfare gains for these countries as well. A caveat is that the analysis assumes that the final cost of the transport projects is not higher than the expected cost, which is rarely the case for large infrastructure projects (e.g. Bandiera and Tsiropoulos, 2019) and that there are no other governance problems (i.e. corruption, failures in public procurement) that would risk to further inflate the cost of infrastructure.

**Trade**

The BRI is expected to reshape trade relations among participating countries with each other and with the rest of the world. High trade times before the BRI contributed to keep intra and extra-regional trade low for these economies. The model predicts that BRI transportation infrastructure projects will increase intra-BRI trade by 7.2 percent. Changes in trade flows will vary by region, depending on how trade costs are affected by the new infrastructure and on the structure of the economy. Table 5 presents the changes in trade among BRI countries and between these economies and non-BRI countries.

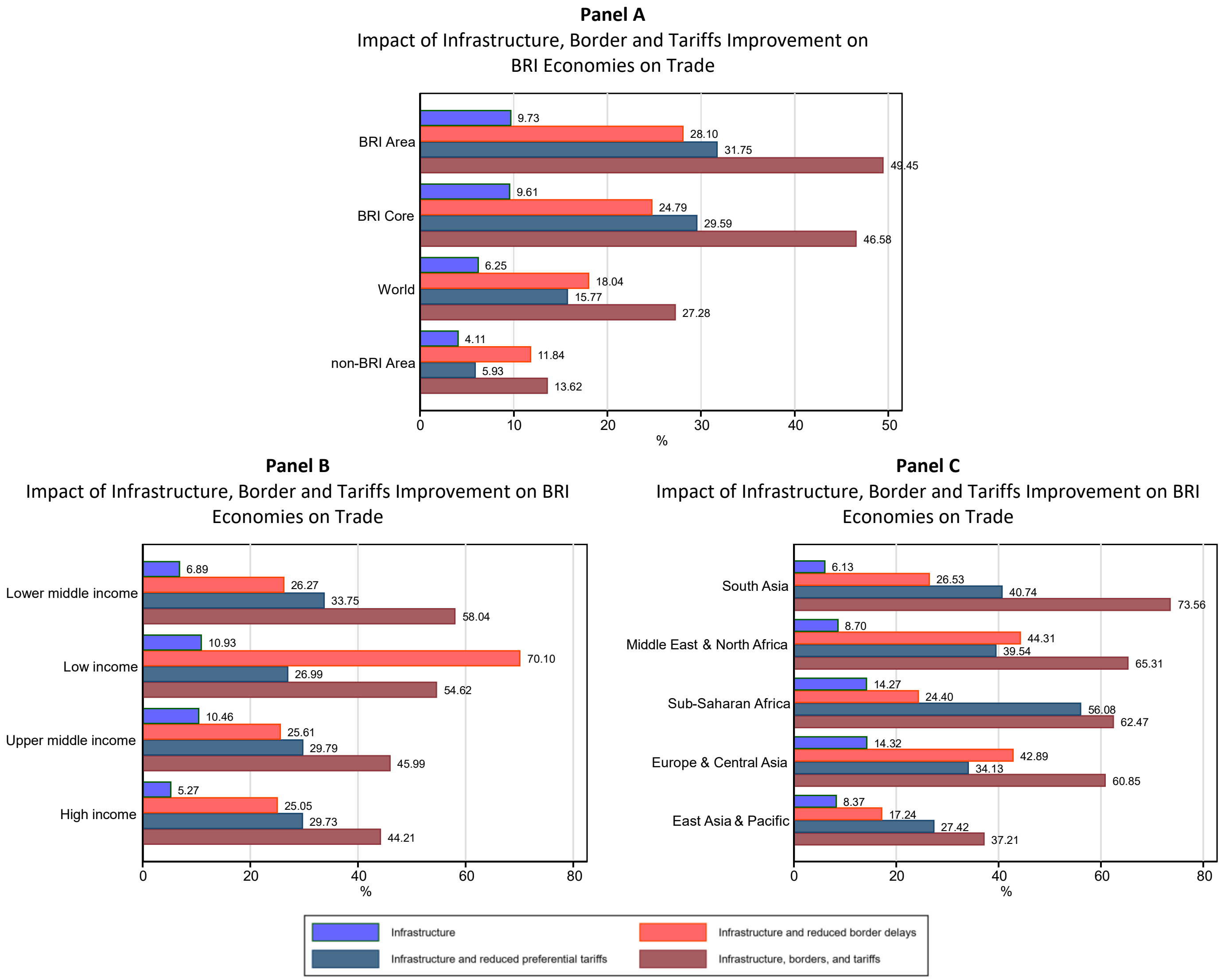
Estimates suggest that all regions, except the Middle East and North Africa, expand their exports to East Asia and Pacific, reflecting the large increase in imports of China and, to a smaller extent, of other economies in the region such as Thailand. The improved connectivity will also allow East Asia and Pacific countries to expand their exports to other BRI regions most notably the Middle East and North Africa and Europe and Central Asia and to themselves reflecting an intensification of regional value chains. Other large changes in bilateral flows include increased exports from the Middle East and North Africa region to South Asia and Europe and Central Asia. This result is explained by firms' access to cheaper inputs from other BRI economies which increase the competitiveness in other markets. Finally, this channel is particularly important for firms located in Europe and Central Asia that expand their exports to non-BRI countries.

Table 5: Changes in Trade Among BRI Countries

| | from BRI to BRI | East Asia and Pacific | Europe and Central Asia | Middle East and North Africa | South Asia | Sub-Saharan Africa | non-BRI Area |
|---|---|---|---|---|---|---|---|
| Exporters | East Asia and Pacific | 5.88 | 8.63 | 10.98 | 0.75 | -4.05 | 9.86 |
| | Europe and Central Asia | 0.27 | 9.59 | 13.69 | 0.29 | 23.82 | 18.35 |
| | Middle East and North Africa | -1.76 | 37.87 | 3.76 | 25.90 | 8.21 | 8.59 |
| | South Asia | 5.98 | 13.86 | 8.52 | 1.12 | -1.45 | 5.65 |
| | Sub-Saharan Africa | 16.95 | 22.37 | 11.00 | 17.43 | -0.28 | 15.03 |

Complementary policies that promote trade facilitation and reduce preferential tariffs among BRI economies would boost their exports. A reduction in border delays would magnify the effects of BRI transportation projects on exports from BRI economies by a factor of three (Figure 6, Panel A). Specifically, if in addition to an improved infrastructure network, border delays were reduced by half, BRI economies could experience export growth of 28.1 percent. This effect is not surprising given the high delays at the border in many BRI economies. Indeed, Panels B and C show that the largest effects would be for low income economies and for Central Asian countries that tend to experience larger border delays. The impact of infrastructure projects could be magnified by a reduction in tariffs among all BRI economies which would create more trade especially among participating countries. Not surprisingly, regions with higher tariffs, such as South Asia, would experience larger trade effects under this policy scenario.

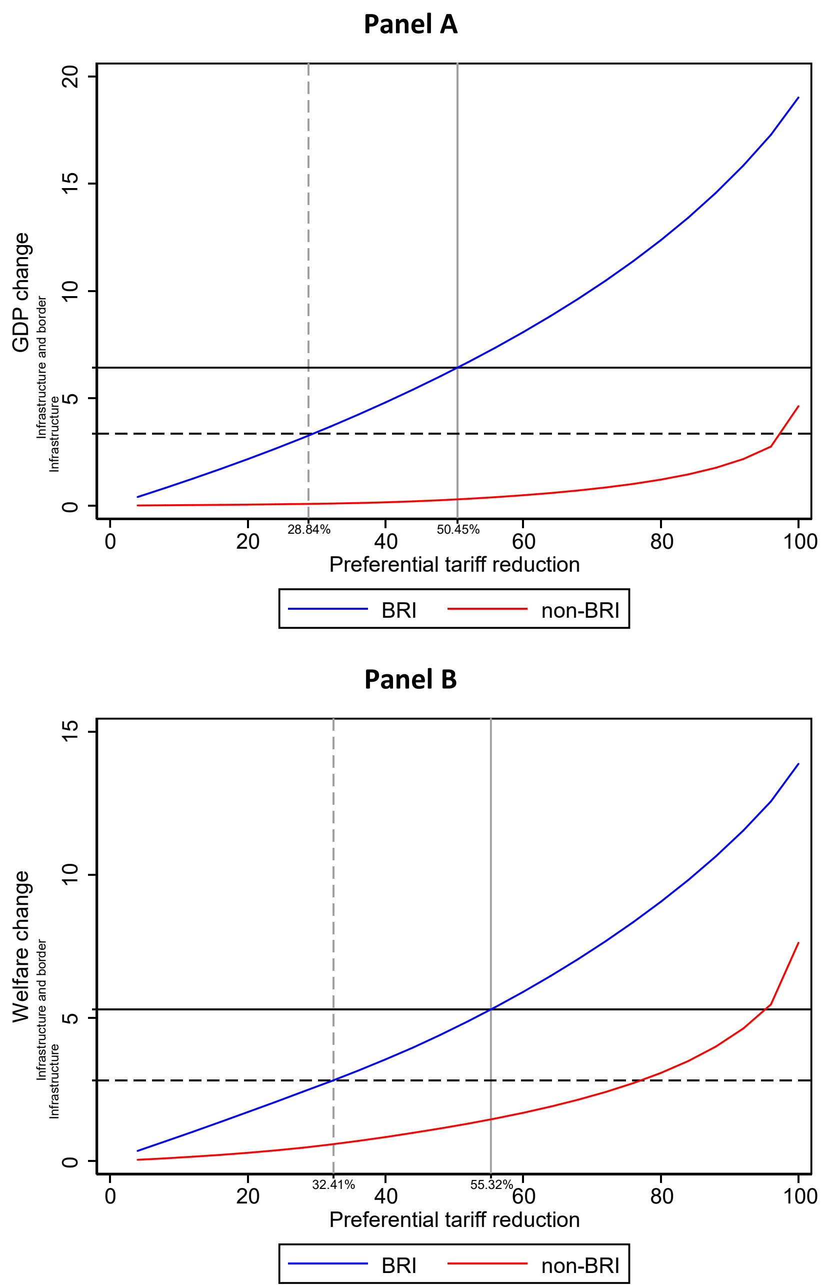
*Figure 6: Impact of Infrastructure and Complementary Policies on Trade – Upper Bound*




## Tariff equivalent of the BRI

This section quantifies the impact of the BRI in terms of a uniform reduction in tariffs among BRI members. In other words, we replicate with trade policy only the overall effect in terms of GDP or welfare of the BRI infrastructure and trade facilitation policy on BRI countries. Figure 7 Panel A, shows that BRI countries would need to reduce preferential tariffs by 28.8 percent to replicate the overall GDP impact of the new BRI infrastructure. Replicating the impact of the new infrastructure and trade facilitation policies would be much more ambitious as it would require tariffs to be reduced by around 50 percent. In Panel B we take into account the loss in revenue due to trade liberalization and match the welfare impact of the BRI, we find that the uniform tariff reductions increase to 32.4 and 55.3 percent in the case of infrastructure and infrastructure and trade facilitation, respectively. Finally, we find that impact of the BRI infrastructure and trade facilitation policies in BRI countries would have a large positive impact on non-BRI members which would not be attainable by a reduction in preferential tariffs in BRI countries.

*Figure 7: Impact of Tariff Reductions on GDP and Welfare of BRI and non-BRI countries*



## 4. Conclusion

In this paper, we present a framework to study the effects of common transport infrastructure. The model builds on structural general equilibrium models used for trade policy analysis, allowing to consider the effect that transport infrastructure has on trade costs through the reduction in shipping time and on government budget and taxation. This allows to estimate the effects on trade, GDP and welfare (i.e. net of taxation) of common transport infrastructure on participating countries as well as the rest of the world.

We then use this framework to quantify the impact of transport infrastructure related to the Belt and Road Initiative using estimates of the reduction in trade costs as well as of the cost of building the associated transport infrastructure. Results show that gains from the BRI are positive on aggregate but unevenly distributed across countries, with some economies potentially losing from the infrastructure investment. Because the BRI is expected to have a systemic impact on the whole network of transportation links, the rest of the world is expected to gain from the initiative. Finally, our paper emphasizes the strong complementarity between BRI transport infrastructure projects and other policy reforms such as trade facilitation and tariff reduction.

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## ANNEX A – Extra Tables and Figures

Table A1: List of countries

| Country/Region Name | GTAP Code | WB Region | WB Income Level | BRI | BRI core |
|---|---|---|---|---|---|
| Azerbaijan | AZE | Europe & Central Asia | Upper middle income | 1 | 1 |
| Bangladesh | BGD | South Asia | Lower middle income | 1 | 1 |
| Cambodia | KHM | East Asia & Pacific | Lower middle income | 1 | 1 |
| China | CHN | East Asia & Pacific | Upper middle income | 1 | 1 |
| Georgia | GEO | Europe & Central Asia | Lower middle income | 1 | 1 |
| India | IND | South Asia | Lower middle income | 1 | 1 |
| Indonesia | IDN | East Asia & Pacific | Lower middle income | 1 | 1 |
| Iran, Islamic Rep. | IRN | Middle East & North Africa | Upper middle income | 1 | 1 |
| Kazakhstan | KAZ | Europe & Central Asia | Upper middle income | 1 | 1 |
| Kenya | KEN | Sub-Saharan Africa | Lower middle income | 1 | 1 |
| Kyrgyzstan | KGZ | Europe & Central Asia | Lower middle income | 1 | 1 |
| Lao PDR | LAO | East Asia & Pacific | Lower middle income | 1 | 1 |
| Malaysia | MYS | East Asia & Pacific | Upper middle income | 1 | 1 |
| Mongolia | MNG | East Asia & Pacific | Lower middle income | 1 | 1 |
| Pakistan | PAK | South Asia | Lower middle income | 1 | 1 |
| Russian Federation | RUS | Europe & Central Asia | Upper middle income | 1 | 1 |
| Singapore | SGP | East Asia & Pacific | High income | 1 | 1 |
| Tajikistan | TJK | Europe & Central Asia | Lower middle income | 1 | 1 |
| Tanzania | TZA | Sub-Saharan Africa | Low income | 1 | 1 |
| Thailand | THA | East Asia & Pacific | Upper middle income | 1 | 1 |
| Turkey | TUR | Europe & Central Asia | Upper middle income | 1 | 1 |
| Vietnam | VNM | East Asia & Pacific | Lower middle income | 1 | 1 |
| Albania | ALB | Europe & Central Asia | Upper middle income | 1 | 0 |
| Armenia | ARM | Europe & Central Asia | Lower middle income | 1 | 0 |
| Bahrain | BHR | Middle East & North Africa | High income | 1 | 0 |
| Belarus | BLR | Europe & Central Asia | Upper middle income | 1 | 0 |
| Bulgaria | BGR | Europe & Central Asia | Upper middle income | 1 | 0 |
| Croatia | HRV | Europe & Central Asia | Upper middle income | 1 | 0 |
| Czech Republic | CZE | Europe & Central Asia | High income | 1 | 0 |
| Egypt, Arab Rep. | EGY | Middle East & North Africa | Lower middle income | 1 | 0 |
| Estonia | EST | Europe & Central Asia | High income | 1 | 0 |
| Greece | GRC | Europe & Central Asia | High income | 1 | 0 |
| Hong Kong SAR, China | HKG | East Asia & Pacific | High income | 1 | 0 |
| Hungary | HUN | Europe & Central Asia | High income | 1 | 0 |
| Israel | ISR | Middle East & North Africa | High income | 1 | 0 |
| Jordan | JOR | Middle East & North Africa | Lower middle income | 1 | 0 |
| Kuwait | KWT | Middle East & North Africa | High income | 1 | 0 |
| Latvia | LVA | Europe & Central Asia | High income | 1 | 0 |
| Lithuania | LTU | Europe & Central Asia | High income | 1 | 0 |

| Country/Region Name | GTAP Code | WB Region | WB Income Level | BRI | BRI core |
|---|---|---|---|---|---|
| Nepal | NPL | South Asia | Low income | 1 | 0 |
| Oman | OMN | Middle East & North Africa | High income | 1 | 0 |
| Philippines | PHL | East Asia & Pacific | Lower middle income | 1 | 0 |
| Poland | POL | Europe & Central Asia | High income | 1 | 0 |
| Qatar | QAT | Middle East & North Africa | High income | 1 | 0 |
| Rest of Former Soviet Union | XSU | Europe & Central Asia | | 1 | 0 |
| Romania | ROM | Europe & Central Asia | Upper middle income | 1 | 0 |
| Saudi Arabia | SAU | Middle East & North Africa | High income | 1 | 0 |
| Slovak Republic | SVK | Europe & Central Asia | High income | 1 | 0 |
| Slovenia | SVN | Europe & Central Asia | High income | 1 | 0 |
| Sri Lanka | LKA | South Asia | Lower middle income | 1 | 0 |
| Taiwan, China | TWN | East Asia & Pacific | High income | 1 | 0 |
| Ukraine | UKR | Europe & Central Asia | Lower middle income | 1 | 0 |
| United Arab Emirates | ARE | Middle East & North Africa | High income | 1 | 0 |
| Argentina | ARG | Latin America & Caribbean | Upper middle income | 0 | 0 |
| Australia | AUS | East Asia & Pacific | High income | 0 | 0 |
| Austria | AUT | Europe & Central Asia | High income | 0 | 0 |
| Belgium | BEL | Europe & Central Asia | High income | 0 | 0 |
| Bolivia | BOL | Latin America & Caribbean | Lower middle income | 0 | 0 |
| Botswana | BWA | Sub-Saharan Africa | Upper middle income | 0 | 0 |
| Brazil | BRA | Latin America & Caribbean | Upper middle income | 0 | 0 |
| Burkina Faso | BFA | Sub-Saharan Africa | Low income | 0 | 0 |
| Cameroon | CMR | Sub-Saharan Africa | Lower middle income | 0 | 0 |
| Canada | CAN | North America | High income | 0 | 0 |
| Chile | CHL | Latin America & Caribbean | High income | 0 | 0 |
| Colombia | COL | Latin America & Caribbean | Upper middle income | 0 | 0 |
| Costa Rica | CRI | Latin America & Caribbean | Upper middle income | 0 | 0 |
| Côte d'Ivoire | CIV | Sub-Saharan Africa | Lower middle income | 0 | 0 |
| Denmark | DNK | Europe & Central Asia | High income | 0 | 0 |
| Finland | FIN | Europe & Central Asia | High income | 0 | 0 |
| France | FRA | Europe & Central Asia | High income | 0 | 0 |
| Germany | DEU | Europe & Central Asia | High income | 0 | 0 |
| Guatemala | GTM | Latin America & Caribbean | Lower middle income | 0 | 0 |
| Guinea | GIN | Sub-Saharan Africa | Low income | 0 | 0 |
| Honduras | HND | Latin America & Caribbean | Lower middle income | 0 | 0 |
| Ireland | IRL | Europe & Central Asia | High income | 0 | 0 |
| Italy | ITA | Europe & Central Asia | High income | 0 | 0 |
| Jamaica | JAM | Latin America & Caribbean | Upper middle income | 0 | 0 |
| Japan | JPN | East Asia & Pacific | High income | 0 | 0 |
| Korea, Rep. | KOR | East Asia & Pacific | High income | 0 | 0 |
| Luxembourg | LUX | Europe & Central Asia | High income | 0 | 0 |
| Madagascar | MDG | Sub-Saharan Africa | Low income | 0 | 0 |
| Mauritius | MUS | Sub-Saharan Africa | Upper middle income | 0 | 0 |

| Country/Region Name | GTAP Code | WB Region | WB Income Level | BRI | BRI core |
|---|---|---|---|---|---|
| Mexico | MEX | Latin America & Caribbean | Upper middle income | 0 | 0 |
| Morocco | MAR | Middle East & North Africa | Lower middle income | 0 | 0 |
| Mozambique | MOZ | Sub-Saharan Africa | Low income | 0 | 0 |
| Namibia | NAM | Sub-Saharan Africa | Upper middle income | 0 | 0 |
| Netherlands | NLD | Europe & Central Asia | High income | 0 | 0 |
| New Zealand | NZL | East Asia & Pacific | High income | 0 | 0 |
| Nigeria | NGA | Sub-Saharan Africa | Lower middle income | 0 | 0 |
| Norway | NOR | Europe & Central Asia | High income | 0 | 0 |
| Panama | PAN | Latin America & Caribbean | Upper middle income | 0 | 0 |
| Paraguay | PRY | Latin America & Caribbean | Upper middle income | 0 | 0 |
| Peru | PER | Latin America & Caribbean | Upper middle income | 0 | 0 |
| Portugal | PRT | Europe & Central Asia | High income | 0 | 0 |
| Rest of the World | XTW | Rest of the World | | 0 | 0 |
| Rwanda | RWA | Sub-Saharan Africa | Low income | 0 | 0 |
| Senegal | SEN | Sub-Saharan Africa | Low income | 0 | 0 |
| South Africa | ZAF | Sub-Saharan Africa | Upper middle income | 0 | 0 |
| Spain | ESP | Europe & Central Asia | High income | 0 | 0 |
| Sweden | SWE | Europe & Central Asia | High income | 0 | 0 |
| Switzerland | CHE | Europe & Central Asia | High income | 0 | 0 |
| Togo | TGO | Sub-Saharan Africa | Low income | 0 | 0 |
| Tunisia | TUN | Middle East & North Africa | Lower middle income | 0 | 0 |
| Uganda | UGA | Sub-Saharan Africa | Low income | 0 | 0 |
| United Kingdom | GBR | Europe & Central Asia | High income | 0 | 0 |
| United States | USA | North America | High income | 0 | 0 |
| Uruguay | URY | Latin America & Caribbean | High income | 0 | 0 |

## ANNEX B – GDP and Welfare Results by Country

Table B1: GDP Impact by Country

| | GDP | | | | | |
|---|---|---|---|---|---|---|
| | Upper Bound | | | Lower Bound | | |
| Country Name | Infrastructure, borders, and tariffs | Infrastructure and reduced border delays | Infrastructure | Infrastructure, borders, and tariffs | Infrastructure and reduced border delays | Infrastructure |
| Albania | 10.98 | 9.08 | 2.50 | 6.56 | 4.37 | 1.83 |
| Armenia | 26.94 | 17.20 | 1.92 | 24.17 | 14.49 | 1.49 |
| Azerbaijan | 21.10 | 17.07 | 6.01 | 18.27 | 14.22 | 5.16 |
| Bahrain | 27.98 | 16.89 | 2.31 | 13.06 | 2.87 | 0.82 |
| Bangladesh | 7.80 | 5.84 | 1.13 | 7.23 | 5.29 | 0.83 |
| Belarus | 16.75 | 12.49 | 2.34 | 11.38 | 7.26 | 0.32 |
| Bulgaria | 12.63 | 8.86 | 2.17 | 10.47 | 6.86 | 1.59 |
| Cambodia | 15.82 | 12.14 | 7.01 | 12.79 | 8.66 | 6.90 |
| China | 11.22 | 4.86 | 3.44 | 9.03 | 2.97 | 2.48 |
| Croatia | 3.04 | 2.10 | 1.01 | 1.92 | 0.72 | 0.67 |
| Czech Republic | 6.46 | 2.59 | 1.35 | 5.52 | 1.50 | 0.81 |
| Egypt, Arab Rep. | 6.95 | 4.94 | 1.54 | 4.36 | 2.46 | 0.68 |
| Estonia | 11.69 | 5.35 | 1.16 | 7.85 | 2.65 | 0.32 |
| Georgia | 4.57 | 3.52 | 2.04 | 3.59 | 2.66 | 1.79 |
| Greece | 6.84 | 4.86 | 2.08 | 5.76 | 4.18 | 1.73 |
| Hong Kong SAR, China | 22.11 | 7.92 | 2.30 | 20.86 | 6.79 | 1.77 |
| Hungary | 11.51 | 2.79 | 1.35 | 9.76 | 0.69 | 0.59 |
| India | 20.56 | 6.39 | 2.09 | 16.36 | 3.45 | 0.93 |
| Indonesia | 8.01 | 2.81 | 1.45 | 6.27 | 1.13 | 0.13 |
| Iran, Islamic Rep. | 15.05 | 13.43 | 6.18 | 11.43 | 9.62 | 4.01 |
| Israel | 7.70 | 2.76 | 1.01 | 6.11 | 1.36 | 0.16 |
| Jordan | 12.80 | 7.60 | 2.18 | 10.57 | 6.51 | 1.32 |
| Kazakhstan | 20.70 | 20.23 | 6.47 | 10.94 | 10.54 | 2.27 |
| Kenya | 9.29 | 6.76 | 4.57 | 7.21 | 4.74 | 3.27 |
| Kuwait | 15.68 | 9.24 | 5.66 | 13.83 | 7.41 | 5.23 |
| Kyrgyzstan | 31.66 | 31.52 | 9.04 | 21.91 | 22.08 | 4.53 |
| Lao PDR | 22.21 | 21.64 | 13.19 | 5.52 | 5.35 | 3.31 |
| Latvia | 20.53 | 9.14 | 3.26 | 12.64 | 1.84 | 0.40 |
| Lithuania | 20.01 | 9.50 | 4.72 | 10.96 | 2.67 | 1.13 |
| Malaysia | 15.49 | 7.63 | 4.64 | 14.75 | 6.81 | 4.27 |
| Mongolia | 24.67 | 25.72 | 5.66 | 21.16 | 22.62 | 4.55 |
| Nepal | 28.31 | 30.30 | 2.56 | 24.37 | 24.71 | 0.66 |
| Oman | 11.22 | 10.29 | 3.76 | 4.45 | 3.73 | 1.09 |
| Pakistan | 14.06 | 12.75 | 6.43 | 7.57 | 6.32 | 2.25 |
| Philippines | 26.32 | 7.29 | 3.57 | 23.89 | 5.51 | 2.34 |
| Poland | 7.91 | 6.34 | 2.10 | 6.31 | 4.62 | 1.13 |
| Qatar | 17.54 | 12.67 | 6.21 | 6.85 | 1.99 | 1.72 |
| Rest of Former Soviet Union | 32.48 | 19.43 | 7.96 | 28.98 | 15.98 | 6.17 |
| Romania | 6.46 | 6.17 | 1.85 | 4.86 | 4.51 | 1.32 |
| Russian Federation | 10.59 | 8.95 | 2.88 | 6.30 | 4.71 | 1.35 |
| Saudi Arabia | 13.71 | 13.03 | 5.02 | 6.66 | 5.94 | 2.01 |
| Singapore | 12.96 | 2.97 | 2.23 | 10.57 | 0.71 | 0.43 |
| Slovak Republic | 13.38 | 10.05 | 3.92 | 8.00 | 4.88 | 2.00 |
| Slovenia | 20.25 | 7.01 | 1.70 | 16.60 | 4.30 | 0.97 |

| | GDP | | | | | |
|---|---|---|---|---|---|---|
| | Upper Bound | | | Lower Bound | | |
| Country Name | Infrastructure, borders, and tariffs | Infrastructure and reduced border delays | Infrastructure | Infrastructure, borders, and tariffs | Infrastructure and reduced border delays | Infrastructure |
| Sri Lanka | 8.46 | 2.14 | 1.49 | 7.44 | 1.22 | 0.91 |
| Taiwan, China | 13.82 | 10.54 | 5.20 | 10.98 | 7.90 | 3.73 |
| Tajikistan | 31.94 | 31.31 | 4.97 | 28.13 | 27.54 | 3.11 |
| Tanzania | 15.37 | 7.84 | 3.46 | 14.56 | 6.84 | 2.87 |
| Thailand | 12.44 | 5.84 | 4.16 | 8.82 | 2.52 | 1.58 |
| Turkey | 17.32 | 7.73 | 4.52 | 16.05 | 6.77 | 4.11 |
| Ukraine | 17.50 | 11.26 | 3.19 | 9.55 | 3.47 | 1.52 |
| United Arab Emirates | 25.25 | 9.12 | 1.59 | 17.86 | 2.87 | 0.33 |
| Vietnam | 18.73 | 8.38 | 6.52 | 15.97 | 5.72 | 4.67 |
| non-BRI East Asia & Pacific | 16.36 | 15.45 | 6.88 | 5.90 | 5.11 | 2.94 |
| non-BRI Europe & Central Asia | 3.02 | 2.87 | 1.26 | 1.45 | 1.31 | 0.55 |
| non-BRI Latin America & Caribbean | 4.89 | 4.76 | 1.88 | 2.78 | 2.61 | 0.62 |
| non-BRI Middle East & North Africa | 3.55 | 2.78 | 1.21 | 3.18 | 2.51 | 0.98 |
| non-BRI North America | 3.68 | 3.55 | 2.29 | 1.43 | 1.31 | 0.88 |
| non-BRI Rest of the World | 5.73 | 5.36 | 2.09 | 3.14 | 2.90 | 1.12 |
| non-BRI Sub-Saharan Africa | 4.02 | 3.57 | 1.94 | 2.83 | 2.35 | 1.17 |

Table B2: Welfare Impact by Country

| Country Name | WELFARE | | | | | |
|---|---|---|---|---|---|---|
| | Upper Bound | | | Lower Bound | | |
| | Infrastructure, borders, and tariffs | Infrastructure and reduced border delays | Infrastructure | Infrastructure, borders, and tariffs | Infrastructure and reduced border delays | Infrastructure |
| Albania | 10.06 | 8.40 | 2.90 | 6.01 | 4.44 | 1.89 |
| Armenia | 20.14 | 11.33 | 2.52 | 17.61 | 8.61 | 1.70 |
| Azerbaijan | 1.94 | -1.29 | -4.06 | 0.85 | -2.33 | -4.13 |
| Bahrain | 16.63 | 6.96 | 2.63 | 12.01 | 2.97 | 1.19 |
| Bangladesh | 6.53 | 6.24 | 1.26 | 5.51 | 5.24 | 0.78 |
| Belarus | 11.40 | 8.13 | 2.45 | 8.42 | 5.23 | 0.64 |
| Bulgaria | 9.44 | 7.79 | 2.70 | 7.49 | 5.98 | 1.83 |
| Cambodia | 9.42 | 6.36 | 4.05 | 7.99 | 4.98 | 3.57 |
| China | 9.53 | 4.23 | 2.70 | 7.61 | 2.49 | 1.92 |
| Croatia | 2.41 | 2.32 | 1.49 | 1.02 | 1.30 | 1.00 |
| Czech Republic | 3.78 | 2.45 | 1.72 | 2.77 | 1.75 | 1.02 |
| Egypt, Arab Rep. | 3.80 | 3.97 | 1.74 | 2.02 | 2.02 | 0.98 |
| Estonia | 5.85 | 4.19 | 1.68 | 4.49 | 2.63 | 0.67 |
| Georgia | 3.93 | 3.30 | 2.19 | 2.67 | 2.10 | 1.59 |
| Greece | 2.30 | 4.06 | 2.35 | 1.04 | 2.31 | 1.58 |
| Hong Kong SAR, China | 18.45 | 6.65 | 1.95 | 16.89 | 5.27 | 1.27 |
| Hungary | 7.77 | 2.89 | 1.72 | 5.99 | 1.28 | 0.85 |
| India | 14.53 | 4.88 | 2.03 | 12.56 | 3.48 | 1.05 |
| Indonesia | 6.59 | 3.21 | 1.87 | 4.70 | 1.49 | 0.63 |
| Iran, Islamic Rep. | 13.61 | 12.73 | 5.34 | 10.25 | 8.59 | 3.72 |
| Israel | 5.09 | 2.27 | 1.07 | 3.89 | 1.11 | 0.51 |
| Jordan | 4.09 | 5.29 | 2.26 | 2.59 | 1.87 | 1.31 |
| Kazakhstan | 8.96 | 8.36 | 4.77 | 5.34 | 4.62 | 2.36 |
| Kenya | 6.32 | 5.55 | 3.53 | 4.45 | 3.67 | 2.43 |
| Kuwait | 11.50 | 8.82 | 5.48 | 9.33 | 6.00 | 4.66 |
| Kyrgyzstan | 5.17 | 4.95 | 2.94 | 3.61 | 3.65 | 0.84 |
| Lao PDR | 0.50 | 0.81 | 4.73 | 1.38 | 1.74 | 1.61 |
| Latvia | 11.43 | 6.62 | 2.81 | 5.09 | 2.46 | 0.77 |
| Lithuania | 9.58 | 6.37 | 1.70 | 6.35 | 2.43 | 1.14 |
| Malaysia | 12.14 | 6.45 | 3.68 | 10.78 | 5.25 | 3.06 |
| Mongolia | 5.33 | 2.93 | -1.95 | 3.64 | 0.93 | -2.96 |
| Nepal | 16.29 | 15.85 | 2.50 | 13.49 | 14.58 | 0.66 |
| Oman | 11.40 | 9.23 | 4.23 | 6.77 | 4.45 | 1.67 |
| Pakistan | 10.51 | 9.85 | 5.18 | 5.24 | 4.64 | 1.48 |
| Philippines | 23.98 | 6.21 | 2.98 | 21.61 | 4.53 | 1.97 |
| Poland | 6.36 | 5.89 | 2.34 | 4.98 | 4.81 | 1.37 |
| Qatar | 10.39 | 7.60 | 5.00 | 2.08 | 1.59 | 1.02 |
| Rest of Former Soviet Union | 14.49 | 3.71 | 0.49 | 14.60 | 3.26 | 0.69 |
| Romania | 6.37 | 5.11 | 2.28 | 4.73 | 3.69 | 1.42 |
| Russian Federation | 8.49 | 7.18 | 2.97 | 5.17 | 3.91 | 1.48 |
| Saudi Arabia | 9.91 | 9.74 | 5.22 | 5.00 | 4.94 | 2.22 |
| Singapore | 11.64 | 3.09 | 2.29 | 9.37 | 0.90 | 0.72 |
| Slovak Republic | 10.19 | 8.68 | 3.78 | 5.88 | 4.42 | 2.07 |
| Slovenia | 16.28 | 5.98 | 2.34 | 13.39 | 3.98 | 1.23 |
| Sri Lanka | 5.74 | 1.58 | 1.23 | 5.08 | 0.75 | 0.56 |
| Taiwan, China | 11.21 | 8.79 | 4.33 | 8.85 | 6.53 | 3.10 |

| | WELFARE | | | | | |
|---|---|---|---|---|---|---|
| | Upper Bound | | | Lower Bound | | |
| Country Name | Infrastructure, borders, and tariffs | Infrastructure and reduced border delays | Infrastructure | Infrastructure, borders, and tariffs | Infrastructure and reduced border delays | Infrastructure |
| Tajikistan | 12.11 | 10.93 | 0.84 | 10.96 | 9.96 | -0.04 |
| Tanzania | 13.09 | 6.96 | 2.72 | 12.03 | 5.68 | 2.07 |
| Thailand | 9.68 | 6.16 | 3.07 | 7.06 | 3.59 | 1.33 |
| Turkey | 14.20 | 7.92 | 3.59 | 12.23 | 6.16 | 2.73 |
| Ukraine | 16.11 | 11.19 | 3.36 | 8.28 | 3.51 | 1.66 |
| United Arab Emirates | 20.81 | 7.68 | 3.37 | 16.17 | 4.15 | 1.32 |
| Vietnam | 14.87 | 7.18 | 4.86 | 12.04 | 4.43 | 3.30 |
| non-BRI East Asia & Pacific | 16.93 | 14.66 | 6.32 | 6.95 | 4.92 | 2.66 |
| non-BRI Europe & Central Asia | 4.51 | 3.59 | 1.82 | 2.73 | 1.90 | 0.89 |
| non-BRI Latin America & Caribbean | 6.88 | 6.11 | 2.44 | 3.84 | 3.04 | 0.93 |
| non-BRI Middle East & North Africa | 5.92 | 3.68 | 1.76 | 4.67 | 2.62 | 1.11 |
| non-BRI North America | 5.27 | 4.62 | 2.55 | 2.26 | 1.68 | 1.08 |
| non-BRI Rest of the World | 7.96 | 6.52 | 2.96 | 4.30 | 3.04 | 1.54 |
| non-BRI Sub-Saharan Africa | 6.19 | 4.92 | 2.51 | 3.92 | 2.67 | 1.43 |