ADBI Working Paper Series

REGIONAL ECONOMIC IMPACTS OF TRANS-CASPIAN INFRASTRUCTURE IMPROVEMENT: IMPLICATIONS FOR THE POST-COVID-19 ERA

Xinmeng Li, Kailai Wang,
and Zhenhua Chen

No. 1274
July 2021

Asian Development Bank Institute

Xinmeng Li is a PhD candidate at the Graduate School of Information Sciences of Tohoku University, Miyagi, Japan. Kailai Wang is an assistant professor at the Department of Construction Management of the University of Houston, Houston, TX, United States (US). Zhenhua Chen is an assistant professor at the City and Regional Planning, Knowlton School of Architecture of Ohio State University, Columbus, OH, US.

Suggested citation:

Li, X., K. Wang, and Z. Chen. 2021. Regional Economic Impacts of Trans-Caspian Infrastructure Improvement: Implications for the Post-COVID-19 Era. ADBI Working Paper 1274. Tokyo: Asian Development Bank Institute. Available: https://www.adb.org/publications/regional-economic-impacts-trans-caspian-infrastructure-improvement-post-covid

Please contact the authors for information about this paper.

Email: chen.7172@osu.edu

Asian Development Bank Institute
Kasumigaseki Building, 8th Floor
3-2-5 Kasumigaseki, Chiyoda-ku
Tokyo 100-6008, Japan

Tel: +81-3-3593-5500
Fax: +81-3-3593-5571
URL: www.adbi.org
E-mail: info@adbi.org

Abstract

With the implementation of the Belt and Road Initiative (BRI) in the People's Republic of China (PRC), the Trans-Caspian International Transport Route (TITR) has received increasing attention. The corridor connects the PRC and Europe via Central Asian countries. Hence, it plays an important role in facilitating international trade through its transportation infrastructure network systems. As the corridor is opening up substantial economic opportunities for transit countries, it is becoming essential to have a proper understanding of the economic impact of potential transportation infrastructure investment on these countries along the TITR corridor. This study conducts a regional economic impact assessment of transportation infrastructure investment to fill this research gap, using a computable general equilibrium analysis. To capture the uncertainty of infrastructure investment given the influence of COVID-19, we evaluated different impacts of the shocks, such as different modes of freight transportation (including rail, road, sea, and air), types of trade (exporting and importing), and levels of investor confidence. The results show that infrastructure investment has heterogeneous multiplier effects on the regional economy (due to the differences in infrastructure quality and country endowment). The impacts of infrastructure investment primarily result from the promotion of exports, and the impacts vary substantially by mode. Overall, the study suggests that, although TITR countries are facing investment uncertainty due to the influence of COVID-19, strengthening infrastructure investment can be a useful tool to stimulate the economy while reducing the negative impact of the epidemic.

Keywords: Trans-Caspian International Transport Route (TITR), transportation infrastructure, trade cost, computable general equilibrium (CGE)

JEL Classification: H54, F16, J60

Contents

1. INTRODUCTION

The Caspian region, as the growth engine of Central Asia, plays a vital role in facilitating trade between Asia and Europe and promotes regional economic development. The region, which includes Azerbaijan, Armenia, Georgia, Iran, Kazakhstan, the Kyrgyz Republic, Tajikistan, Turkey, Turkmenistan, and Uzbekistan, has been actively seeking to cooperate with other major economies, such as the Russian Federation, the United States (US), and the People's Republic of China (PRC), to export its energy resources (e.g., Bilgin 2009; Marketos 2009; Garibov 2016). Since 2013, the PRC's implementation of the Belt and Road Initiative (BRI) has provided new opportunities for economic development in this region. One aim of the BRI is to facilitate trade flows between the PRC and European countries. Under this circumstance, transporting commodities and merchandise goods through Central Asia and adjacent regions, broadly referring to the Trans-Caspian International Transport Route (TITR) countries, is inevitable. As global economic activity will need time to recover after the COVID-19 pandemic (Fernandes 2020; McKibbin and Fernando 2020), attracting transportation infrastructure financing is becoming even more challenging given the uncertainty of foreign investments. This study intends to provide empirical evidence on the economic benefits of transportation infrastructure to the countries along the TITR corridor based on several hypothetical infrastructure investment scenarios.

Large transportation infrastructure projects are the drivers of local and regional economic growth. Positive externalities usually occur with improved regional and interregional connectivity, reduced trade costs, and market integration (Gillen 1996; Harmatuck 1996; Feitelson and Salomon 2000; Bilgin 2009; Rivera, Sheffi, and Welsch 2014; Haynes and Chen 2017; Wang et al. 2020). The booming economy of the PRC, which is progressing from an impoverished developing country to a global superpower, is a particular example of how infrastructure investments can be the primary growth engine. Studies have also widely discussed the potential negative externalities of large projects, such as environmental, social, and corruption risks due to weak governance (Fukuyama, Bennon, and Bataineh 2020; Wang et al. 2020). This research aims to evaluate the impacts of transportation infrastructure on trade and the economy in the TITR countries, taking into consideration the uncertainty of investment strategies.

The outbreak of COVID-19 has severely disrupted the global economy. Given the uncertain nature of the global economy and trade in the post-COVID-19 era, this study estimates the economic impacts of transportation infrastructure under different scenarios for the TITR countries. We begin by fitting statistical models to historical data that we collect from the World Bank and the Caspian countries. More specifically, we consider that the cost change of cross-border and inter-regional trade influences multiple infrastructure projects. Then, we adopt the Global Trade Analysis Project (GTAP) model, with 13 regions and 14 sectors, to assess the impact of Trans-Caspian infrastructure investment on the transit countries. The assessment focuses on the change in real GDP as a result of the reduction of trade costs.

This study has the following research highlights compared with previous related works. Given the nature of the bidirectional influence between infrastructure projects and economic growth (Boopen 2006; Hong, Chu, and Wang 2011; Deng et al. 2014; Chen and Haynes 2015; Chen et al. 2016), this study adopts a combined statistical and simulation approach to analyze the economic impacts of infrastructure investments under different hypothetical scenarios. The growth rates of the real GDP and employment are two measurements of economic indicators. To the authors' knowledge, this is the first assessment to use the computable general equilibrium model for the TITR countries. The results improve our understanding of the impacts of infrastructure projects on real GDP change as a response to improved transportation connectivity and reduced trade costs among the TITR countries. In particular, our study demonstrates two effects of transport improvement on international trade: increased competition in domestic markets and stimulation of the economy through the channel of exports. In addition, we evaluate the complex relationship between the change of trade volume and the transportation infrastructure development of different freight transport modes (sea, air, rail, and road). We expect that the policy implications that we obtain will help to formulate effective responses for multilevel stakeholders in the post-COVID-19 era.

The rest of the paper proceeds as follows. Section 2 provides a review of the current literature and identifies the research gaps. Section 3 introduces the background and status quo of infrastructure development in the TITR countries. Sections 4 and 5 discuss the data and methodology, respectively. We present the simulation results in section 6, while section 7 concludes with remarks and policy implications.

2. LITERATURE REVIEW

Transportation infrastructure investments play an essential role in stimulating economic growth. The development of large-scale infrastructure systems increases the demand for goods and services from customers across different locations, expands regional and national transportation networks, and reduces the cost of firms' inventories (Gillen 1996; Harmatuck 1996). There are several critical transportation networks: pipelines, highways, rail, air, and telecommunications (Feitelson and Salomon 2000; Bilgin 2009). The improvements in logistics-related infrastructure may generate industrial agglomeration gains. Relevant companies and professional workers tend to have more face-to-face interactions and dialogues that widen and deepen the labor market (e.g., Rivera, Sheffi, and Welsch 2014). The widespread use of information and communication technologies (ICTs) and improved transportation infrastructure can jointly promote transportation's accessibility for industries and individuals, reducing their travel time and costs. The time savings can lead to the spatial redistribution of economic activities (Haynes and Chen 2017). These conclusions come from a wide range of empirical studies conducted in the US, the PRC, and European countries.

The endogeneity of transportation infrastructure investments is one of the most widely discussed economic phenomena. Some studies have adopted advanced econometric methods to explore panel data and determined that transportation infrastructure and economic growth have a bidirectional relationship (e.g., Boopen 2006; Hong, Chu, and Wang 2011; Deng et al. 2014). Moreover, different spatial contexts may lead to differences in regional performances when facing exogenous effects (Chen et al. 2016). As a simulation-based framework, the computable general equilibrium (CGE) model is capable of not only assessing the regional impacts of transportation infrastructure improvements but also revealing the potential difference between the short and the long run (e.g., Chen and Haynes 2015). Using this assessment tool, Villafuerte, Corong, and Zhuang (2016) and Zhai (2018) attempted to evaluate the economic impact of infrastructure development in the BRI countries. The predictions showed that infrastructure construction could positively stimulate worldwide economic growth. Focusing on a particular region or sector, some scholars have attempted to assess the economic impact of infrastructure development in the BRI countries using CGE analysis. For instance, Mukwaya and Mold (2018) indicated that, due to the BRI, the GDP growth in East Africa was about 0.4–1.2% with the decline in trade margin costs. Assuming that the cost of using capital for the PRC's iron and steel firms decreases by 50%, Yuan and Tsigas (2017) showed that welfare would increase by $4.78 million in Kazakhstan. Assessing the trade cost reduction effect of BRI projects, Chen and Li (2020) also demonstrated that the economic impact is quite uneven among the related countries.

Recently, a growing body of literature has focused on other economic activities in the BRI countries (e.g., Fukuyama, Bennon, and Bataineh 2020; Wang and Chen 2020). Shi et al. (2018) concluded that many economies in the study region are mainly energy based after analyzing spatiotemporal patterns of electric power consumption (EPC) during the period 1992–2013. The purpose of this study was to reveal regional economic structures. Compared with the population size, the GDP is a better predictor of electric power consumption growth among the studied countries. Chen and Yip (2018) paid special attention to the population dynamics of the BRI countries. The results suggested that the proportion of the older population may be a barrier to economic development for these countries in Eastern Europe and East and Southeast Asia. Some studies have assessed the associations between transportation infrastructure and economic growth. De Soyres, Mulabdic, and Ruta (2019) studied the effects of transportation infrastructure using structural general equilibrium models. The authors estimated the effects of transportation infrastructure on trade, GDP, and welfare. The model showed that the BRI countries' GDP will increase by up to 3.4%. Wang and Chen (2020) examined the linkages between infrastructure and regional economic growth in the BRI countries. Through a dynamic shift-share analysis, they confirmed that regional economic disparities exist across the BRI countries. More specifically, the lack of local advantages in logistics infrastructure causes some sub-regions to lag behind the others. These lagging sub-regions are the Commonwealth of Independent States (CIS), Mid Asia, and Eastern Europe. Indeed, this study performed a descriptive analysis without considering the direct link between changes in employment and infrastructure investments. Fukuyama, Bennon, and Bataineh (2020) discussed the BRI from the perspective of PRC project developers. Because of the domestic experience, PRC project developers appear to overestimate the positive externalities and underestimate the negative ones. The authors further compared the PRC and Western models and argued that the PRC should follow international standards more closely and reminded Western development agencies to be more realistic about the increasingly intense competition in the global market.

The uncertainty surrounding the impacts of the COVID-19 pandemic calls for a better understanding of the relationship between transportation infrastructure investments and economic growth in the TITR countries. Our study contributes to the literature by offering a combined statistical and simulation analysis regarding transportation infrastructure projects' economic impacts among the TITR countries. The following section introduces the status quo of infrastructure development in the TITR countries.

3. INFRASTRUCTURE DEVELOPMENT IN THE TRANS-CASPIAN CORRIDOR

The PRC unveiled the Belt and Road Initiative (BRI) in 2013. It is a global initiative that PRC President Xi Jinping proposed to promote regional economic development and integration across Eurasian countries. Well-connected transport corridors can facilitate access to international markets, promoting trade and commerce between the PRC and European countries via goods transported through Central Asia and adjacent regions (Silin et al. 2017).

The Trans-Caspian International Transport Route (TITR) is one of the BRI's most important interstate trade corridors. Building this 6,500 km long corridor provides Central Asia and the Caucasus countries with benefits in trade and investment flows and logistics infrastructure (e.g., Gigauri and Damenia 2019). The TITR corridor reduces the time of freight transportation from 60 days to 14 days via a modal shift from sea shipping to railroad transportation. In addition, there is an expectation that the total cost will decrease by roughly four times compared with air transport (China Daily 2018). The affordability and efficiency of this corridor make it attractive and will enable current and future stakeholders to become more productive.

From a geopolitical perspective, the TITR countries and adjacent regions have been facing constant aggressive foreign policies of regional hegemonies and destructive local conflicts and crises. The Russian Federation has played a dominant role in this region over the past several decades. Nowadays, the PRC's growing influence in Central Asia is speeding up the competition among the Russian Federation, the US, and other major powers regarding their interests. The BRI can potentially positively impact regional economic growth and thereby mitigate severe political conflicts (Jopp, Kuhn, and Schulz 2018; Kenderdine 2018).

The TITR route increases connectivity across Eurasian countries and gives post-Soviet republics more trading autonomy in the South Caucasus and Central Asia. The BRI has expressed a strong desire to extend cooperation, including a wider spectrum of trade and investment activities. The total trade between the PRC and Central Asia increased from less than $1 billion a year to $41.7 billion a year during the period 1990–2018 (Sun 2007; Umarov 2020). In particular, most of the PRC's infrastructure investments focused on transportation and telecommunication facilities. The TITR represents an integral part of the extensive transportation system that the PRC assimilated into the BRI's framework, which enables the PRC to have a more substantial presence among Eurasian countries.

However, the outbreak of the COVID-19 pandemic has caused unprecedented negative impacts on global economic activity. Companies across the world, regardless of their size, are dependent on inputs from others. The functioning of global supply chains has faced severe disruption. Millions of people have lost their jobs, and many companies have shut down their operations. Consumers have also changed their consumption behaviors, resulting in uncertain effects on the global supply chain system. It is not surprising that foreign investments in infrastructure projects are likely to decrease substantially both in the TITR countries and beyond (Fernandes 2020; McKibbin and Fernando 2020).

As part of the BRI, the TITR is an ambitious transportation project that has the potential to improve the economies of the participating countries and their neighboring economies. Starting in Southeast Asia and the PRC, this route passes through Kazakhstan, the Caspian Sea, Azerbaijan, and Georgia toward European countries. It is noteworthy that agriculture and fossil fuel extraction primarily drive the GDP of the TITR countries.

4. DATA

In our study, we use the transport infrastructure quality to measure the stock of transportation infrastructure investment. We obtain the data for this assessment from various sources for the period from 2011 to 2015. Following Wessel (2019), we obtain the transport infrastructure quality data from the *Global Competitiveness Report* (GCR) of the World Economic Forum.[1] The data describe the quality of railroad, port, and air transport infrastructure. The infrastructure quality index is an average score based on logistics professionals' perceptions of a country's quality of trade and transport-related infrastructure. The original score ranges from one to seven, seven referring to an excellent condition of infrastructure. Specifically, the respondents rated the passenger air transport in their country of operation on a scale from one (underdeveloped) to seven (extensive and efficient by international standards). We collect trade cost data from the World Bank UNESCAP Trade Costs Database[2] and other variables, such as the GDP, population, and tariff, from the World Bank Open Data Website.[3] The trade cost data appear in a tariff-equivalent form (percentage share of CIF prices). Table 1 provides a statistical summary of our variables of interest. Our study considers that the shock of trade cost reduction will occur in the four TITR countries, namely Azerbaijan, Georgian, Kazakhstan, and Turkey, as the core TITR economies. Moreover, we focus on the spillover economic effects in the trading partner countries with close geographic relationships with the TITR countries: Poland, Romania, the PRC, and Ukraine.

Table 1: Descriptive Statistics of the TITR Countries

		TITR Countries				Major Trading Partners				Worldwide
Variables		**Azerbaijan**	**Georgia**	**Kazakhstan**	**Turkey**	**Poland**	**Romania**	**PRC**	**Ukraine**	**Mean**
Trade cost	2011	287.8	268.3	251.7	196.9	212.6	–	181.9	226.5	268.5
	change rate	16.8%	5.1%	19.9%	–9.8%	–6.2%	–	–	–6.4%	–2.1%
GDP (trillion US dollars)	2011	66	15	193	833	529	183	7,552	163	516.8
	change rate	–19.5%	–1.0%	–4.3%	3.3%	–9.7%	–3.0%	45.9%	–44.2%	2.2%
Tariff	2011	8.78	1.2	7.43	2.42	2.12	2.12	8.13	4.11	6.8
	change rate	–3.0%	–64.2%	–7.0%	11.6%	23.1%	23.1%	–3.8%	–0.7%	–12.6%
Quality of road	2011	3.76	4.24	2.50	4.76	2.33	2.10	4.41	2.05	4.03
	change rate	5.4%	–8.4%	24.8%	2.5%	63.7%	31.3%	6.4%	18.7%	1.4%
Quality of rail	2011	3.88	3.87	3.92	2.74	2.47	2.36	4.62	4.36	4.03
	change rate	–1.8%	0.3%	7.7%	12.6%	25.5%	16.9%	8.8%	–4.6%	–16.5%
Quality of airport	2011	5.03	4.20	3.89	5.50	3.65	3.64	4.57	3.90	4.03
	change rate	0.1%	–7.5%	3.9%	–2.8%	11.3%	–2.4%	4.6%	–5. 1%	9.3%
Quality of port	2011	3.71	3.70	3.20	4.58	2.90	2.44	4.88	3.29	4.27
	change rate	5.2%	–4.3%	–18.8%	7.9%	16.7%	24.2%	1.8%	–14. 1%	–4.4%

Notes: The trade cost is in a tariff-equivalent form (share of CIF prices). The denotation "–" indicates that the value is not observable in the original database. We calculate the change rate using the data from 2011 to 2015.

Source: Authors' calculation.

5. METHODOLOGY

We implement the assessment of the economic impact in our model in two steps. In the first step, we use regression analysis to estimate the elasticity of the trade cost concerning the infrastructure quality in four different modes of transportation. In the second step, we adopt the changes in the trade cost in different regions as the impact drivers for the CGE simulation. Then, we calculate the level change of the trade cost in different modes based on the estimated trade cost elasticity and volume of investment. We then summarize and compare the macroeconomic outcomes as a result of the trade cost change shocks among TITR countries and their partner countries.

1 https://tcdata360.worldbank.org/indicators/he81eeee0?indicator=535&viz=line_chart&years=2007,2017.

2 https://www.unescap.org/resources/escap-world-bank-trade-cost-database.

3 https://data.worldbank.org/indicator/TM.TAX.MRCH.SM.AR.ZS.

5.1 Estimating the Elasticity of Trade Costs

In this study, the stock of infrastructure investment is measured as the transport infrastructure index on a country-by-country basis. Following Francois et al. (2009), we estimate the elasticity of trade cost change with respect to the transportation infrastructure investment through the OLS regression equation:

$$ln\,\tau_{i,t} = \beta_0 + \beta_1 lnpGDP_{i,t} + \beta_2\, lntar_{i,t} + \beta_m\, lnINF_{i,m,t} + \varepsilon_{i,j,t} \quad (1)$$

where *i* represents region *i* and t denotes the time period. In the regression model, $\tau_{i,t}$ denotes the trade costs in year t, which appear in a tariff-equivalent form (share of CIF prices) in the data of the World Bank, $lnpGDP_{i,t}$ represents the logged GDP per capita of the country in region *i*, $tar_{i,t}$ denotes the tariff in region *i*, and $INF_{i,m,t}$ represents the quality index of the infrastructure of mode *m*. We denote the elasticity of the trade cost with respect to the transportation infrastructure investment of mode *m* in country *i* as β_m. The following table summarizes the estimated results.

Table 2: Regression Results of the Coefficients of Infrastructure Investment by Modes

Mode	Rail		Sea		Air		Road	
Variables	**Coefficient**	***t-sta.***	**Coefficient**	***t-sta.***	**Coefficient**	***t-sta.***	**Coefficient**	***t-sta.***
$lnINF_{i,m,t}$	–0.149***	–6.29	–0.241***	–8.28	–0.203***	–4.99	–0.086***	–2.74
$lnpGDP_{i,t}$	–0.056***	–10.40	–0.055***	–11.85	–0.060***	12.14	–0.067***	–13.74
$lntar_{i,t}$	0.037***	3.13	0.048***	4.47	0.051***	4.34	0.063***	5.27
Constant	7.037***	54.44	7.190***	63.11	7.273***	60.54	7.223***	59.29
Number of obs.	375		451		451		451	
R-squared	0.480		0.524		0.48		0.46	

*** Significant at the 99% level.

Source: Authors' calculation.

We observe that the infrastructure quality of seaports and airports has a stronger correlation with the international trade costs. The coefficients of the quality of rail and road are relatively small. In the GTAP model, we assume that sea and air transportation infrastructures have a more significant effect on the trade costs, with identical investment growth rates in the four modes. The public and private infrastructure investments in Central and West Asia during the period 2010–2014 represent 2.9% of the GDP. However, the necessary infrastructure investment will account for 6.2% of the GDP in 2016–2030 (ADB 2015). This implies that the infrastructure investment in Central and West Asia should increase by about 29% every 5 years to meet future needs. Combining the regression results of the coefficients, we assume that, in the general case, the trade costs in the modes of rail, air, sea, and road will fall by 4.3%, 5.9%, 7.3%, and 1.9%, respectively.

5.2 GTAP Model

We adopt the Global Trade Analysis Project (GTAP) model, which Hertel (1997) developed, for the economic impact assessment. The model consists of 120 regions and 14 economic sectors. We conduct this analysis as an ex-post assessment of the transportation infrastructure improvement in different modes in the period 2013–2019. The model is based on the Walrasian general equilibrium theory and has an advantage for economic impact assessment related to the effect of the trade policy and the change in the transport margin on the macroeconomic performance and international trade flow (Mukhopadhyay and Thomassin 2010). Our analysis adopts a static version of the GTAP model, which captures multi-market interactions of producers and consumers, given the changes in price, regulations, and external shocks, and the constraints of resources, such as capital, labor, and natural resources (Wei et al. 2019. Essentially, CGE models depict an economy as a set of interrelated supply chains. Researchers have widely used the model to analyze international trade and tax policy (Dixon and Jorgenson 2013). As Rose (1995) indicated, the strength of CGE models lies in their multi-sector detail, focus on interdependencies, a full accounting of all inputs (including intermediate goods and not just primary factors of production), behavioral content, a reflection of the actions of prices and markets, nonlinearities, and incorporation of explicit constraints (Wei et al. 2019).

This study adopts the GTAP 9 database, which various impact assessments of global economic issues have used extensively. The database also contains information on import and export shares and trade costs in different transportation modes. This study focuses on the trade margin reduction between the four core Trans-Caspian countries and the other four trading partner countries, as Table 1 shows.

We base our simulation on the GTAP 9 database, with a reference base of 2004, 2007, and 2011. The original CGE model assumes full employment of all factors to measure the shock in the long term. To gauge the short-run economic impact of transportation infrastructure investment, we apply the short-run closure rule, also known as the Keynesian rule. The labor supply and demand change after the exogenous shock, which we adjust until the factors are equal again at the initial wage.

5.3 Simulation Scenarios

According to the official website of the GTAP, the variable *tms* measures the power of the tax on imports. Meanwhile, the variable *txs* measures the power of the subsidy for exports. In this model, we use these two variables to simulate the trade reduction effect on exports and imports separately in the countries along the TITR.

In this model, we assume that the TITR construction affects the following countries directly by reducing the trade cost on imports: Kazakhstan, Azerbaijan, Georgia, and Turkey. We simulate the spillover effect of the trading partner countries located close to the countries along the TITR: the PRC, Poland, Romania, and Ukraine. The COVID-19 outbreak will also cause the construction of inter-regional transportation infrastructures in the TITR to generate different international trade effects. To capture the uncertainty of infrastructure investment given the influence of COVID-19, we evaluate other impacts as a response to the shocks, such as different modes of transportation (including rail, road, sea, and air), types of trade (exporting and importing), and levels of investor confidence. Our model considers five scenarios of trade cost reduction: very conservative, conservative, general, positive, and very positive. We assume that, in a case with very positive confidence in investment, the trade cost reduction is likely to be 50% stronger than that in the general case. In contrast, the effect is likely to be 50% weaker in a case with very conservative confidence in the investment. Therefore, in scenarios four (positive) and five (very positive), we assume the trade cost reduction levels to be 125% and 150% of those in the general case, respectively. In contrast, in scenarios one (negative) and two (very negative), we assume that the trade cost reduction levels will account for 75% and 50% of those in the general case. In sum, the following table summarizes the trade cost reduction resulting from different transportation modes and different levels of investor confidence.

Table 3: Trade Cost Reduction in Five Scenarios

Scenario	1. Very Conservative	2. Conservative	3. General	4. Positive	5. Very Positive
Rail	–2.2%	–3.5%	–4.3%	–5.6%	–6.5%
Air	–2.9%	–4.7%	–5.9%	–7.7%	–8.8%
Sea	–3.5%	–5.6%	–7.0%	–9.1%	–10.5%
Road	–1.0%	–1.5%	–1.9%	–2.5%	–2.9%
Mean	–2.4%	–3.8%	–4.8%	–6.2%	–7.2%

Source: Authors' calculation.

6. SIMULATION RESULTS

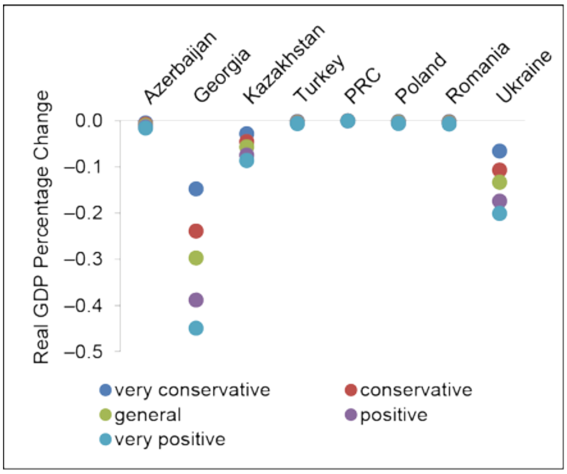
Appendix 1 summarizes the simulation results of various scenarios. Our results suggest that transportation infrastructure investment tends to reduce interregional trade costs significantly, generating positive impacts on the real GDP in the countries around the TITR. The trade cost reduction generates two opposite effects through the channel of imports and exports. When the trade costs for imports are lower, the local markets are more competitive, which may negatively affect the domestic firms. Lower trade barriers also stimulate local production through the channel of exporting. As a result, we observe that the second effect is more substantial in the countries along the TITR. With the construction of transportation infrastructure, the countries along the TITR benefit from GDP growth with lower trade costs. For instance, in the general case (Scenario 3), in which the trade costs in the four modes decrease by 4.8% on average, the average GDP growth rate is 0.3% when considering both channels. We further observe that the effects of trade reduction among the different countries are quite uneven. For instance, Ukraine benefits from the most considerable GDP growth of 1.36% with decreasing trade costs in the general case. However, the stimulation effects on the GDP are relatively minor in the PRC and Azerbaijan, with growth rates of 0.01% and 0.05% in Scenario 3, respectively.

As shown in Figure 1, all the countries suffer a loss in real GDP with decreasing trade costs for imports from foreign markets. For instance, Georgia experiences a significant negative impact from the trade cost reduction on imports, with a GDP change of –0.3% in the general case. Meanwhile, all the countries have a more substantial effect through exports when the trade costs are lower. Specifically, the mean of the GDP growth rates resulting from lower exporting trade costs is 0.369% in the general case. As a result, the economic impact of the improvement of the transportation infrastructure quality is positive. Thus, we can conclude that investment in transportation infrastructure in the countries along the TITR may positively stimulate economic recovery through the channel of trade cost reduction after the shock of COVID-19. Additionally, when implementing this strategy, countries should carefully consider the costs and benefits since the results suggest that it may not be effective in some countries.

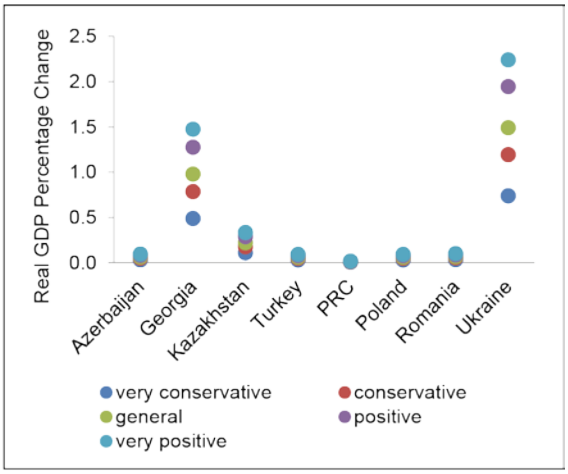
We also analyze the economic impacts of trade cost reduction for four modes of transportation infrastructure: seaport, airport, rail, and road. Figure 2 summarizes the results of the real GDP growth rate in different modes.

Our results suggest that the construction of transportation infrastructure in airports and railroads stimulates GDP growth more extensively through the channel of trade cost reduction. Specifically, the trade costs in the air and rail modes decrease by 5.9% and 4.3% in Scenario 3, leading to average GDP growth rates of 0.11% and 0.10%, respectively. The trade cost reduction in the sea mode is –7.0% in the general case. Georgia benefits most from the investment in seaport construction, with a GDP growth rate of 0.21% in the general case. Regarding the trade cost reduction effect of the other three modes—air, rail, and road—the GDP growth rate is more considerable in Ukraine. For instance, the GDP change rate in Ukraine as a response to the trade cost reduction in the air mode (–5.9% in the general case) is 0.60%. According to the regression model results, trade cost and investment coefficients are larger for seaports and airports. With the assumption of uniformly increasing investment rates, the positive effects are more significant in the models for air and rail. Our study calculates the marginal effect of trade reduction, which equals the real GDP change over the value of trade cost reduction. The growth rates resulting from the construction in all four modes are relatively minor in the PRC, Poland, Romania, and Turkey, with marginal effects smaller than 0.005. Our results indicate that infrastructure investments in airports and railroads have larger positive impacts on GDP growth than investments in seaport and roadway infrastructure. According to the regression results in Table 2, the coefficient quality of railroads is lower than that of the other three modes. Hence, with an identical change rate of the quality index, the railroad's trade reduction effect is more negligible. Furthermore, countries along the TITR are mainly inland countries in which the role of waterway transportation in international trade is smaller.

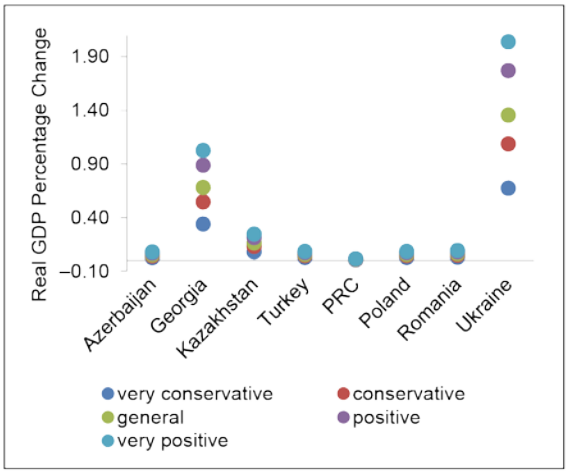
Figure 1: Real GDP Changes as a Response to Transportation Infrastructure Investment



(a) Trade Cost Reduction on Imports



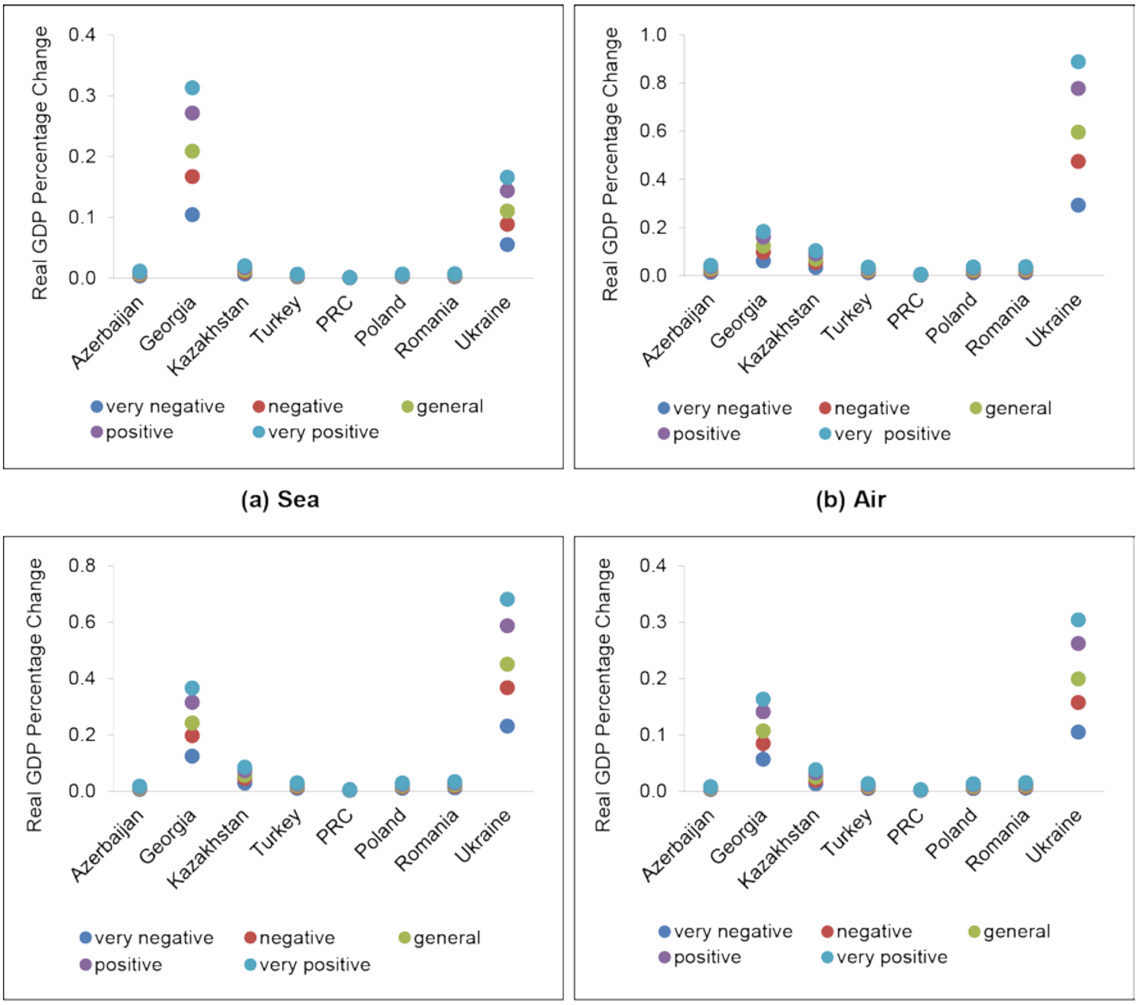
(b) Trade Cost Reduction on Exports



(c) Trade Cost Reduction on Both Imports and Exports

Note: The mean levels of various scenarios of trade reduction in all four modes are as follows: very conservative: –2.4%, conservative: –3.8%, general: –4.8%, positive: –6.2%, very positive: –7.2%.

Figure 2: Real GDP Changes as a Response to Transportation Infrastructure Investment in Different Modes



(a) Sea (b) Air

(c) Rail (d) Road

Notes: The levels of the trade reduction for each scenario of each mode are as follows:

Sea: very conservative: –3.5%, conservative: –5.6%, general: –7.0%, positive: –9.1%, very positive: –10.5%.

Air: very conservative: –2.9%, conservative: –4.7%, general: –5.9%, positive: –7.7%, very positive: –8.8%.

Rail: very conservative: –2.2%, conservative: –3.5%, general: –4.3%, positive: –5.6%, very positive: –6.5%.

Road: very conservative: –1.0%, conservative: –1.5%, general: –1.9%, positive: –2.5%, very positive: –2.9%.

7. CONCLUSION AND POLICY RECOMMENDATIONS

The BRI is a long-term investment program of the PRC that aims to speed up regional economic integration. As a crucial component of the BRI's integrated trade corridors, the TITR corridor consists of extensive transportation infrastructure systems linking trade and economic activities in Eurasian countries. The current outbreak of COVID-19 will exert long-term effects on the global economy and financial markets. This study explores the economic impacts of transportation infrastructure investments for the TITR under various hypothetical scenarios. The results have important implications for multilevel stakeholders as we consider the uncertainty of investment strategies carefully.

This research provides important policy implications. Our econometric analysis enables us to achieve more comprehensive assessment outcomes of the improvement in transportation infrastructure by building different scenarios for the trade cost reduction effects. The economic impact of improving the regional connectivity among different markets is twofold. The lower trade barriers to imports lead to more competitive local markets, which negatively affect the domestic firms. Meanwhile, trade liberalization positively stimulates the economy by encouraging exports. Our results reveal that strengthening infrastructure investments can be a valuable tool to stimulate the economy while reducing the negative impact of the epidemic in the Trans-Caspian countries. Specifically, the improvement of transportation, especially in the quality of airports and railroads, leads to an overall positive effect on real GDP growth in the TITR countries.

Nevertheless, our estimation also demonstrates that the stimulation effects are relatively small in the sea and road modes in the TITR countries and their trading partner countries. Hence, our study suggests that policymakers should be aware that the investments in various transportation modes may generate quite different impacts on the economy. We can also observe that the favorable growth rates are minor in some TITR countries, such as Turkey and Poland. This implies that transport improvement is also related to the market structure and the involvement in international trade. We conclude that investing in transportation infrastructure could still have limitations in stimulating GDP growth directly.

We analyze several countries along the TITR from 2011 to 2015, including Azerbaijan, the PRC, Georgia, Kazakhstan, Poland, Romania, Turkey, and Ukraine. The study estimates the elasticity of trade costs regarding infrastructure investments for four types of transport modes (i.e., rail, sea, air, and road). The analytical results in this step indicate that infrastructure investments in Central and West Asia should increase by almost one-third every 5 years to fulfill future needs. Based on the regression estimates, this study conducts a scenario-based analysis. One of the notable findings is that transportation infrastructure investment can reduce interregional trade costs substantially. The construction of transportation infrastructure benefits the TITR countries by offering GDP growth with lower trade costs. According to the results of our regression model, the economic effects of the quality of airports and railroads are larger than those of the other two modes. Consistent with the regression model, we also find that infrastructure investments in airports and railroads have larger positive effects on GDP growth than investments in seaport and roadway infrastructure. As for the differences across the countries studied, these investments have a relatively smaller impact on the PRC, Poland, Romania, and Turkey. The spillover effects of our simulation only influence these four countries. The decreases in trade costs have a much more substantial adverse impact on imports in Georgia than in other countries.

This study provides detailed guidance for the countries in the TITR region regarding new development in the post-COVID-19 era. We acknowledge that our work has several limitations that require consideration in future studies. First, we calculate the elasticity of trade costs based on the statistical model. The quality of the data sources could significantly influence the values. We encourage future researchers to verify the estimated elasticity of trade costs using a more comprehensive dataset. Second, this study designs simulation models following the standard GTAP model. The basic CGE does not account for the possible spatial and temporal effects of infrastructure investments. Thus, our estimations for these TITR countries and their neighbors may be biased. It would be worthwhile employing better approaches that incorporate a spatial and temporal component into the CGE framework. Despite these limitations, this research offers policymakers and transport practitioners a better understanding of how to formulate effective policy responses to the uncertainties in the post-COVID-19 era.

REFERENCES

ADB. 2015. “Data and Resource of Infrastructure Needs, Asia and the Pacific.” https://data.adb.org/dataset/infrastructure-needs-asia-and-pacific.

Bilgin, M. 2009. “Geopolitics of European Natural Gas Demand: Supplies from Russia, Caspian and the Middle East.” *Energy Policy* 37(11): 4482–92.

Boopen, S. 2006. “Transport Infrastructure and Economic Growth: Evidence from Africa Using Dynamic Panel Estimates.” *Empirical Economics Letters* 5(1): 37–52.

Chen, M., and Yip, P. S. 2018. A study on population dynamics in “Belt & Road” countries and their implications. China population and development studies, 2(2), 158–172.

Chen, Y., N. Salike, F. Luan, and M. He. 2016. “Heterogeneous Effects of Inter- and Intra-city Transportation Infrastructure on Economic Growth: Evidence from Chinese Cities.” *Cambridge Journal of Regions, Economy and Society* 9(3): 571–87.

Chen, Z., and K. E. Haynes. 2015. “Multilevel Assessment of Public Transportation Infrastructure: A Spatial Econometric Computable General Equilibrium Approach.” *Annals of Regional Science* 54(3): 663–85.

Chen, Z., and X. Li. 2021. Economic Impact of Transportation Infrastructure Investment under the Belt Road Initiative. *Asia Europe Journal*. DOI: 10.1007/s10308-021-00617-3.

China Daily. 2018. “B&R Countries Convene on Trans-Caspian Corridor Construction.” Accessed 16 June 2020. http://www.chinadaily.com.cn/a/201802/07/WS5a7add12a3106e7dcc13b5d4.html.

Deng, T., S. Shao, L. Yang, and X. Zhang. 2014. “Has the Transport-Led Economic Growth Effect Reached a Peak in China? A Panel Threshold Regression Approach.” *Transportation* 41(3): 567–87.

De Soyres, F. M. M. R., A. Mulabdic, and M. Ruta. 2019. *Common Transport Infrastructure: A Quantitative Model and Estimates from the Belt and Road Initiative*. The World Bank. https://pubdocs.worldbank.org/en/512331559591299342/BRI-General-Equilibrium-WP-Final.pdf.

Dixon, P. and D. Jorgenson (2013) *Handbook of Computable General Equilibrium Modeling.* Amsterdam, North Holland.

Feitelson, E., and I. Salomon. 2000. “The Implications of Differential Network Flexibility for Spatial Structures.” *Transportation Research Part A: Policy and Practice* 34(6): 459–79.

Fernandes, N. 2020. “Economic Effects of Coronavirus Outbreak (COVID-19) on the World Economy.” Available at SSRN 3557504. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3557504.

Francois, J., M. Manchin, and A. Pelkmans-Balaoing. 2009. “Regional Integration in Asia: The Role of Infrastructure.” In: Francois J., Rana P.B., Wignaraja G. (eds) Pan-Asian Integration. Palgrave Macmillan, London. https://doi.org/10.1057/9780230236974_7.

Fukuyama, F., M. Bennon, and B. Bataineh. 2020. “Chinese and Western Approaches to Infrastructure Development.” In *Development Studies in Regional Science*, 243–64. Singapore: Springer.

Garibov, A. 2016. “The Trans-Caspian Corridor: Geopolitics of Transportation in Central Eurasia.” *Caucasus International* 6(1): 67–83.

Gigauri, I., and N. Damenia. 2019. “Economic Expectations of the Belt and Road Initiative for the South Caucasus, with Emphasis on Georgia.” *Business and Economic Research* 9(1): 173–99.

Gillen, D. W. 1996. “Transportation Infrastructure and Economic Development: A Review of Recent Literature.” *Logistics and Transportation Review* 32(1): 39.

Harmatuck, D. J. 1996. “The Influence of Transportation Infrastructure on Economic Development.” *Logistics and Transportation Review* 32(1): 63.

Haynes, K. E., and Z. Chen. 2017. “Infrastructure and Regional Development.” In *International Encyclopedia of Geography: People, the Earth, Environment and Technology*, 1–8.

Hertel, T. W. (1997). *Global trade analysis: modeling and applications.* Cambridge university press.

Hong, J., Z. Chu, and Q. Wang. 2011. “Transport Infrastructure and Regional Economic Growth: Evidence from China.” *Transportation* 38(5): 737–52.

Jopp, M., T. Kuhn, and J. Schulz. 2018. Preface—Why Focusing on the South Caucasus and Central Asia?” *L’Europe en Formation* 1: 3–6.

Kenderdine, T. 2018. “Caucasus Trans-Caspian Trade Route To Open China Import Markets.” *East Asia Forum*. 23 February 2018. http://www.eastasiaforum.org/2018/02/23/caucasus-trans-caspian-trade-route-to-open-china-import-markets/.

Marketos, T. 2009. “Eastern Caspian Sea Energy Geopolitics: A Litmus Test for the US–Russia–China Struggle for the Geostrategic Control of Eurasia.” *Caucasian Review of International Affairs* 3(1): 2–19.

McKibbin, W. J., and R. Fernando. 2020. “The Global Macroeconomic Impacts of COVID-19: Seven Scenarios.” https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3547729.

Mukhopadhyay, K and P.J. Thomassin. (2010) *Economic and Environmental Impact of Free Trade in East and South East Asia.* London, Springer.

Mukwaya, R., and A. Mold. 2018. “Modelling the Economic Impact of the China Belt and Road Initiative on Countries in Eastern Africa.” https://www.gtap.agecon.purdue.edu/resources/res_display.asp?RecordID=5653.

Rivera, L., Y. Sheffi, and R. Welsch. 2014. “Logistics Agglomeration in the US.” *Transportation Research Part A: Policy and Practice* 59: 222–38.

Rose, A. (1995) Input-Output Economics and Computable General Equilibrium Models. *Structural Change and Economic Dynamic*s, 6, 295–304.

Shi, K., Yu, B., Huang, C., Wu, J., and Sun, X. 2018. “Exploring spatiotemporal patterns of electric power consumption in countries along the Belt and Road.” *Energy* 150: 847–859.

Silin, Y., L. Kapustina, I. Trevisan, and A. Drevalev. 2017. "China's Economic Interests in the 'One Belt, One Road' Initiative." In *SHS Web of Conferences*, Vol. 39, 01025. EDP Sciences.Sun, Z. 2007. The Relationship between China and Central Asia. Eager eyes fixed on Eurasia), Sapporo, Japan: Slavic Research Center, Hokkaido University, 41–63.

Umarov, T. 2020. China Looms Large in Central Asia. Carnegie Moscow Center. https://carnegie.ru/commentary/81402.

Villafuerte, J., E. Corong, and J. Zhuang. 2016. "Trade and Growth Impact of One Belt, One Road on Asia and the World." https://www.gtap.agecon.purdue.edu/resources/res_display.asp?RecordID=5086.

Wang, C., M. K. Lim, X. Zhang, L. Zhao, and P. T. W. Lee. 2020. "Railway and Road Infrastructure in the Belt and Road Initiative Countries: Estimating the Impact of Transport Infrastructure on Economic Growth." *Transportation Research Part A: Policy and Practice* 134: 288–307.

Wang, K., and Z. Chen. 2020. "Infrastructure and Regional Economic Growth in the One Belt and One Road Regions: A Dynamic Shift-Share Approach." In *Development Studies in Regional Science*, 221–41. Singapore: Springer.

Wei, D., Chen, Z., and Rose, A. (2019). Estimating economic impacts of the US-South Korea free trade agreement. *Economic Systems Research*, *31*(3), 305–323.

Wessel, J. 2019. "Evaluating the Transport-Mode-Specific Trade Effects of Different Transport Infrastructure Types." *Transport Policy* 78: 42–57.

Yuan, W., and M. Tsigas. 2017. "Addressing Excess Capacity—The Effect of China's FDI in the Iron and Steel Industry in Five Central Asian States: A GTAP-FDI Model Perspective." https://www.gtap.agecon.purdue.edu/resources/res_display.asp?RecordID=5376.

Zhai, F. 2018. "China's Belt and Road Initiative: A Preliminary Quantitative Assessment." *Journal of Asian Economics* 55: 84–92.

APPENDIX 1: REAL GDP CHANGES AND THE MARGINAL EFFECT OF DIFFERENT SHOCK SCENARIOS

Scenario	Country	Azerbaijan	Georgia	Kazakhstan	Turkey	PRC	Poland	Romania	Ukraine	Mean
Trade Cost Reduction on Imports	very conservative	–0.006	–0.148	–0.029	–0.002	–0.001	–0.002	–0.003	–0.066	–0.032
	conservative	–0.009	–0.239	–0.046	–0.004	–0.001	–0.004	–0.004	–0.107	–0.052
	general	–0.011	–0.297	–0.058	–0.005	–0.001	–0.005	–0.005	–0.134	–0.065
	positive	–0.014	–0.388	–0.075	–0.006	–0.001	–0.006	–0.007	–0.175	–0.084
	very positive	–0.017	–0.449	–0.087	–0.007	–0.001	–0.007	–0.008	–0.201	–0.097
	Marginal effect	**–0.002**	**–0.062**	–0.012	**–0.001**	0.000	–0.001	–0.001	–0.028	**–0.013**
Trade Cost Reduction on Exports	very conservative	0.032	0.487	0.110	0.030	0.006	0.030	0.033	0.739	0.183
	conservative	0.051	0.785	0.178	0.049	0.009	0.049	0.054	1.194	0.296
	general	0.064	0.978	0.222	0.061	0.011	0.061	0.067	1.490	0.369
	positive	0.083	1.276	0.289	0.079	0.015	0.079	0.087	1.944	0.482
	very positive	0.096	1.475	0.334	0.092	0.017	0.091	0.101	2.241	0.556
	Marginal effect	**0.013**	**0.203**	0.046	**0.013**	0.002	0.013	0.014	0.308	**0.077**
Trade Cost Reduction on Both Imports and Exports	very conservative	0.03	0.34	0.08	0.03	0.01	0.03	0.03	0.67	0.153
	conservative	0.04	0.55	0.13	0.04	0.01	0.05	0.05	1.09	0.245
	general	0.05	0.68	0.16	0.06	0.01	0.06	0.06	1.36	0.305
	positive	0.07	0.89	0.21	0.07	0.01	0.07	0.08	1.77	0.396
	very positive	0.08	1.03	0.25	0.08	0.02	0.08	0.09	2.04	0.459
	Marginal effect	**0.01**	**0.14**	0.03	**0.01**	0.00	0.01	0.01	0.28	**0.061**
Sea	very conservative	0.004	0.104	0.007	0.002	0.001	0.002	0.002	0.055	0.022
	conservative	0.006	0.167	0.011	0.004	0.001	0.004	0.004	0.089	0.036
	general	0.008	0.209	0.014	0.004	0.001	0.005	0.005	0.111	0.044
	positive	0.010	0.271	0.018	0.006	0.001	0.006	0.006	0.144	0.058
	very positive	0.012	0.313	0.020	0.007	0.001	0.007	0.007	0.166	0.067
	Marginal effect	**0.002**	**0.047**	0.003	**0.001**	0.000	0.001	0.001	0.025	**0.010**
Air	very conservative	0.014	0.061	0.034	0.012	0.002	0.012	0.012	0.293	0.055
	conservative	0.023	0.098	0.055	0.019	0.003	0.019	0.020	0.474	0.089
	general	0.028	0.123	0.069	0.023	0.004	0.024	0.025	0.596	0.111
	positive	0.037	0.161	0.091	0.030	0.005	0.031	0.032	0.777	0.146
	very positive	0.042	0.184	0.103	0.035	0.006	0.036	0.037	0.888	0.166
	Marginal effect	**0.006**	**0.028**	0.016	**0.005**	0.001	0.005	0.006	0.133	**0.025**
Rail	very conservative	0.006	0.124	0.029	0.010	0.002	0.010	0.011	0.231	0.053
	conservative	0.010	0.197	0.046	0.016	0.003	0.016	0.018	0.367	0.084
	general	0.012	0.242	0.056	0.020	0.004	0.019	0.022	0.451	0.103
	positive	0.015	0.315	0.073	0.026	0.005	0.025	0.029	0.587	0.134
	very positive	0.018	0.366	0.085	0.030	0.006	0.029	0.034	0.681	0.156
	Marginal effect	**0.003**	**0.056**	0.013	**0.005**	0.001	0.005	0.005	0.105	**0.024**
Road	very conservative	0.003	0.056	0.013	0.005	0.001	0.005	0.005	0.105	0.024
	conservative	0.004	0.084	0.020	0.007	0.001	0.007	0.008	0.157	0.036
	general	0.005	0.107	0.025	0.009	0.002	0.009	0.010	0.199	0.046
	positive	0.007	0.141	0.033	0.011	0.002	0.011	0.013	0.262	0.060
	very positive	0.008	0.163	0.038	0.013	0.003	0.013	0.015	0.304	0.070
	Marginal effect	**0.003**	**0.056**	0.013	**0.005**	0.001	0.005	0.005	0.105	**0.024**

Source: Authors' calculation.