ADBI Working Paper Series

THE IMPACT OF INFRASTRUCTURE ON TRADE IN CENTRAL ASIA

Kamalbek Karymshakov
and Burulcha Sulaimanova

No. 1184
September 2020

Asian Development Bank Institute

Kamalbek Karymshakov is an associate professor at the Finance and Banking Department of Kyrgyz-Turkish Manas University in Bishkek, Kyrgyz Republic. Burulcha Sulaimanova is an assistant professor at the Department of Economics also of Kyrgyz-Turkish Manas University.

Suggested citation:

Karymshakov, K. and B. Sulaimanova. 2020. The Impact of Infrastructure on Trade in Central Asia. ADBI Working Paper 1184. Tokyo: Asian Development Bank Institute. Available: https://www.adb.org/publications/impact-infrastructure-trade-central-asia

Please contact the authors for information about this paper.

Email: kamalbek.karymshakov@manas.edu.kg, burulcha.sulaymanova@manas.edu.kg

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

The aim of this paper is to investigate the impact of infrastructure on trade in the case of Central Asian countries. Infrastructure is measured by the aspects of quality and quantity in three Central Asian countries—Kazakhstan, the Kyrgyz Republic, and Tajikistan. Trade flows are measured by the export and import volumes of each of these countries with their main trade partner countries. Empirical estimations are based on panel data for the period 2009–2017. Results show that both the quality and quantity of infrastructure in Central Asia have a positive impact on trade flows. However, estimations by country subsamples show that this effect varies by country. Given the general remote geographical location of Central Asian countries, the findings of this study indicate that a regional approach to the development of infrastructure is important and policy towards infrastructure development should be associated with a further regional economic integration process.

Keywords: infrastructure, trade, Central Asia

JEL Classification: N75, O18, O11, O53

Contents

1. INTRODUCTION

Infrastructure is one of the important determinants of facilitation of international trade and economic growth performance (for instance, see Ilmi 2011). The development of infrastructure is expected to reduce costs of trade and increase trade relationships and regional integration (Bougheas, Demetriades, and Morgenroth 1999). Also, not only hard infrastructure but also soft infrastructure is mentioned as having significant influence over the trade potential of countries (Portugal-Perez and Wilson 2012).

Central Asian economies, due to their remote geographical location, face high transportation costs. This barrier causes a serious burden in regard to international trade activity, which is evident in comparing overland transportation with maritime alternatives (Raballand 2003). Under these conditions improved infrastructure and the development of transportation networks among countries of the Central Asian region have a positive impact on intraregional trade flows (Shepherd and Wilson 2007).

In the last decade, Central Asian countries implemented a considerable number of infrastructure projects, mainly related to road construction and partly to further enhancement of the railroad network. Along with this, it has been argued that air transportation should be developed as one of the priorities of government policy. There are a limited number of empirical studies on the impact of infrastructure on trade in the Central Asian context (Raballand 2003; Grigoriou 2007). However, they do not consider specific types of infrastructure and evaluate its implications in terms of the landlockedness of the location. Nevertheless, examination of the impact of infrastructure on the trade flows of the region according to the most recent available data would provide more insights into the current situation regarding the importance of infrastructure in the region. Although the development of infrastructure does not guarantee facilitation of international trade, it may have a positive economic development impact within the regions of a country (for instance, see Karymshakov and Sulaimanova 2019). Increasing external trade trends can be expressed not only in terms of the "between the countries" of the region, but also with trade partners outside of these countries. Therefore, it can be argued that assessment of the impact of infrastructure on trade can be measured via the trade flows with the main partner countries of each observed economy.

In light of the above, this study aims to investigate the impact of infrastructure on trade in three Central Asian countries, namely Kazakhstan, the Kyrgyz Republic, and Tajikistan, and their main trade partners. Empirical analysis is based on panel data for the period 2009–2017 and focuses specifically on air transport and railway infrastructure.

The paper is structured as follows. The next section briefly describes trade and infrastructure development in Central Asia. Section 3 presents a literature review on the topic of infrastructure and trade relationship. Sections 4 outline the methodology and describe the data. Section five presents empirical results for transportation infrastructure impact on trade. The final section draws conclusions.

2. TRADE AND INFRASTRUCTURE DEVELOPMENT IN CENTRAL ASIA

With a population of over 67 million,[1] the Central Asian (CA) countries – Kazakhstan, the Kyrgyz Republic, Tajikistan, Uzbekistan, and Turkmenistan – are strategically located at the heart of Asia, connecting Asia with Europe. Despite this strategic location, which could be seen as a key factor for enhancing the international trade performance in the region, one of the main disadvantages of the international trade of Central Asian countries is that the countries are landlocked. This may imply high transport and logistical costs in comparison with maritime trade (Raballand 2003).

Table 1 presents a summary of CA countries (due to data inaccessibility Turkmenistan is excluded from analysis in this paper). The population in CA ranges from 6 million in the Kyrgyz Republic to over 30 million in Uzbekistan, with economies ranging from $7.5 billion GDP in Tajikistan to $179.3 billion in Kazakhstan.

Table 1: Selected Aggregate Indicators for Central Asian Countries, 2018

	Population (million)	**GDP** (billion US$)	**GDP per Capita** (const. 2011, PPP US$)	**Export** (billion US$)	**Import** (billion US$)
Kazakhstan	18.4	179.3	24,738.3	61.1	33.7
Kyrgyz Republic	6.4	8.1	3,446.9	1.8	4.9
Tajikistan	9.1	7.5	3,061.07	1.1	3.2
Uzbekistan	33.3	50.5	7,591.9	10.9	17.3

Source: WDI, Ministry of National Economy of the Republic of Kazakhstan Statistics Committee.

Figure 1 shows the export performance of Central Asian countries. While there was a reduction in the ratio of exports to gross domestic product (GDP) for the period 2009–2015, after 2015 there was a rising export trend with respect to GDP. The main trade partner countries of Central Asian countries are mostly located in Eurasia. According to Statistics Committee of Ministry of National Economy of the Kazakhstan (2019) he top export destinations of Kazakhstan are Italy ($11,734.3 million), the Russian Federation ($5,279.9 million), France ($3,839.2 million), the Netherlands (6,186.1 million), and the People's Republic of China (PRC) ($6,307.5 million).

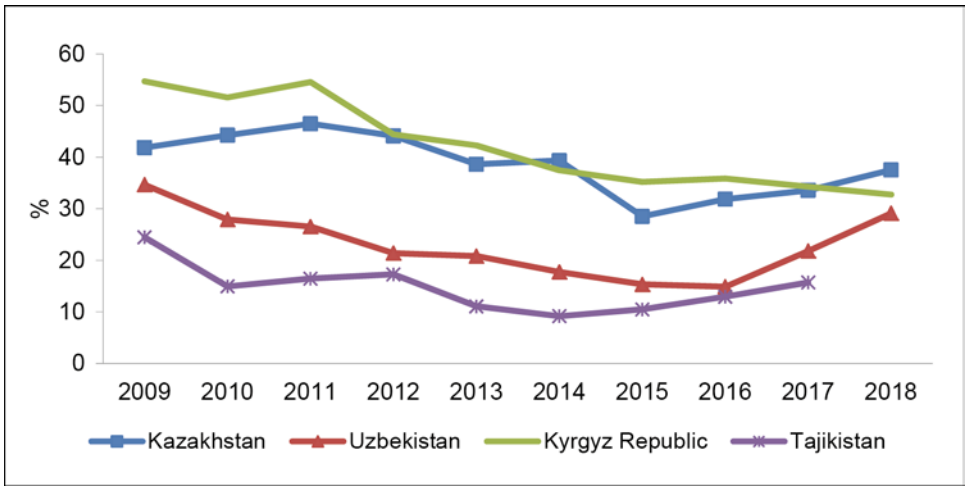
According to the National Statistical Committee of the Kyrgyz Republic, the main export partners of the Kyrgyz Republic in 2018 were Kazakhstan ($270.3 million), the United Kingdom ($669.9 million), the Russian Federation ($358.2 million), Turkey ($104.3 million), and Uzbekistan ($158.5 million).

The top export destinations of Tajikistan, according to the Agency on Statistics under the President of the Republic of Tajikistan in 2017, were Commonwealth of Independent States (CIS) countries (about 36% of total export) and other Asian countries (40.6% of total export).

According to the State Committee of the Republic of Uzbekistan on Statistics, the highest export destinations of Uzbekistan in 2017 were the PRC ($1,401.8 million), the Russian Federation ($1,527.346 million), Turkey ($833.514 million), Kazakhstan ($991.308 million), and Afghanistan ($507.912 million).

[1] Excluding the population of Turkmenistan.

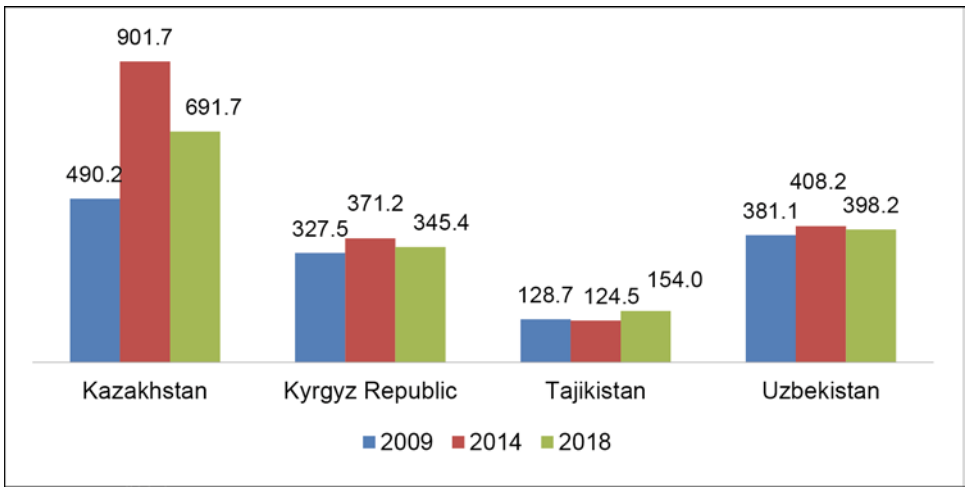
Figure 1: Exports of Goods and Services (% of GDP) **in Central Asia, 2009–2018**



Source: World Development Indicators (accessed on 20 January 2020).

Despite the changing ratios of exports with respect to GDP, the export value index shows the steady growth of export outputs in Central Asian countries since 2000 (see Figure 2). According to a World Trade Organization report (2019), the infrastructural constraints and digital gap are still challenging issues in regard to integration into global service exports. Hence, except for Tajikistan, for the 2000–2018 period the export volume rose at least three times. To maintain this upward export trend it is important to facilitate transport and minimize the cost of trade. Hence the trade cost is crucial in determining how much a country can trade (WTO Report 2019). Transport and logistical costs depend on the quality of transport infrastructure and the distance between trading countries. The cost of delivering goods and services from exporter to importers accounts for 28% and 19% of bilateral trade costs, respectively (Yi and Koopman 2019).

Figure 2: Export Value Index (2000 = 100) in Central Asia, 2009–2018



Source: World Development Indicators (accessed on 20 January 2020).

Table 2 provides details on the logistical performance of Central Asian countries for the years 2010 and 2016. The overall logistical performance index for all countries in CA decreased in the given period. There was a slight decrease in the competence and quality of logistical services and in the index of ease of arranging competitively priced shipments.

The other indicators vary across the countries. For example, in Kazakhstan and Tajikistan the performance of transport-related infrastructure and quality of trade improved, while in the Kyrgyz Republic and Uzbekistan this index fell.

The efficiency of the customs clearance process was the worst in the Kyrgyz Republic, but it had the minimum lead time to export (1 day); in contrast, in the other countries the customs clearance process tended to improve but the lead time to both import and export increased (this is very clearly seen in the cases of Tajikistan and Uzbekistan).

Table 2: Logistical Performance Index in Central Asian Countries (1 = low to 5 = high)

	Kazakhstan		Kyrgyz Republic		Tajikistan		Uzbekistan	
	2010	2016	2010	2016	2010	2016	2010	2016
Overall	2.83	2.75	2.62	2.15	2.35	2.06	2.79	2.40
Competence and quality of logistical services	2.6	2.56	2.37	1.96	2.25	2.11	2.5	2.38
Ease of arranging competitively priced shipments	3.29	2.75	3.18	2.10	2.42	2.11	2.79	2.36
Quality of trade and transport-related infrastructure	2.66	2.76	2.09	1.96	2	2.13	2.54	2.44
Efficiency of customs clearance process	2.38	2.51	2.44	1.8	1.9	1.93	2.2	2.31
Lead time to import, median case (days)	–	3	–	2**	2*	14**	2	20
Lead time to export, median case (days)	2*	3	2	1**	7	14**	1.41	18

Notes: * data for 2012 and ** data for 2014 are given.

Source: World Development Indicators (accessed on 20 January 2020).

In Table 3 the overall performance of infrastructure in Central Asian countries for 2018 is presented. According to these data, the best performer in the region was Kazakhstan, but its infrastructure index was still not very high and was around the average. Among 141 countries, Kazakhstan ranked 67 with an index of overall infrastructure of 68.3 points.

The Kyrgyz Republic was the worst performer in Central Asia in 2018 in terms of infrastructure, ranking 103rd. The overall infrastructure scored 55.8 points, while the transport infrastructure scored much lower at around 32 points. The quality of roads and efficiency of train and airport services were well below the average, showing that hard infrastructure is underdeveloped in the Kyrgyz Republic.

As mentioned earlier, the infrastructure- and transportation-related costs account for one third of trade costs, hence the poor performance in infrastructure, transportation, and logistics in Central Asia may significantly reduce trade. Investment in physical or hard infrastructure is vital to enhance trade facilitation in the region.

Table 3: Infrastructure Indicators for Central Asian Countries, 2018

		Infrastructure 0–100	Transport Infrastructure 0–100	Road Connectivity 0–100 (best)	Quality of Road Infrastructure 1–7 (best)
Kazakhstan	Value	–	–	79.3	3.6
	Score	68.3	48.7	79.3	43.2
	Rank	67	73	56	93
Kyrgyz Republic	Value	–	–	59.6	3.1
	Score	55.8	32.1	59.6	34.2
	Rank	103	129	110	113
Tajikistan	Value	–	–	35.8	4.5
	Score	60.6	39.6	35.8	58.2
	Rank	91	111	137	50
		Railroad Density km/1,000 km^2	**Efficiency of Train Services 1–7 (best)**	**Airport Connectivity Score**	**Efficiency of Air Transport Services 1–7 (best)**
Kazakhstan	Value	5.9	4.2	33,808.6	4.3
	Score	14.9	53.4	46.4	54.9
	Rank	66	33	72	89
Kyrgyz Republic	Value	2.2	2.8	8,251.2	3.0
	Score	5.5	30.1	30.0	33.4
	Rank	86	77	104	133
Tajikistan	Value	4.5	4.1	4,195.6	4.5
	Score	11.2	51.0	23.8	57.9
	Rank	72	37	121	76

Source: The Global Competitiveness Report 2019, World Economic Forum.

3. LITERATURE REVIEW

Trade is one of the important drivers of economic growth, and infrastructure development has a key role to play in facilitating trade performance (Stone and Strutt 2010). Hence, a high-quality hard infrastructure, such as a developed railways network, roads, and airports, supports trade by reducing the cost of transportation (WTO Report 2019).

In a theoretical framework the impact of infrastructure on trade has been reflected through the inclusion of transportation costs. Thus, Bougheas, Demetriades, and Morgenroth (1999), following the Dornbusch-Fischer-Samuelson model, argue that infrastructure reduces the cost of transportation and accelerates trade. Moreover, accumulation of the stock of infrastructure is argued to be dependent on the geography and endowments of countries. Although their theoretical approach was not able to explicitly indicate the distribution of costs and benefits between two trade partner countries, the benefits of infrastructure in terms of enhancing trade are noted for all countries participating in trade. Therefore, one may expect increasing infrastructure to have a positive impact on international trade.

Empirical literature generally confirms this positive relationship (Cigu, Agheorghiesei, and Toader 2019). Portugal-Perez and Wilson (2012) argued in the case of developing countries that the export performance of these countries improves along with the hard and soft infrastructure. Therefore, not only investment into the physical infrastructure but also regulatory reforms oriented towards the development of soft infrastructure are important for enhancing trade opportunities.

The importance of infrastructure may differ by type. Most studies argue that investments in road construction lead to higher economic performance and may also increase private investment (Matas, Raymond, and Ruiz 2018). Some other studies focusing on railroad infrastructure mention that it has widespread welfare effects (Xu 2016; Yoshino and Abidhadjaev 2016). Donaldson (2018) found that railroads in India decreased trade costs and interregional price gaps and increased trade and real income.

The other aspect of infrastructure effects is that not only access to infrastructure but also its quality can have a large impact. In this regard, Iimi (2011), using firm-level enterprise survey data for Europe and Central Asia, examined whether the quality of infrastructure services has an impact on firm costs. Findings indicate that the quality of electricity services is important for firms' competitiveness and has a significant impact on firm costs. Therefore, interruptions of the infrastructure service supply may result in losses of sales and impose supplementary backup costs on enterprises. Analogously, Francois and Manchin (2013) stated that both the level of infrastructure development and institutional quality are the main determinants of exports.

There is rich literature on the impact of hard and soft infrastructure on international trade and economic growth in developing countries, while there are a limited number of empirical studies on Central Asian countries. Mostly these countries have been investigated within the context of international trade in the Asian or Eurasian context.

Among them, Shepherd and Wilson (2007) investigated the impacts of infrastructure on trade using the gravity model among 27 countries in Europe and Central Asia. Findings highlighted the importance of improving road networks. According to their findings, a feasible road upgrade may increase trade by up to 50%, and this value exceeds the effect of tariff reductions. Grigoriou (2007) and Raballand (2003) investigated the impacts of infrastructure and landlockedness on Central Asian countries by using the gravity model approach. Empirical results indicated that the number of border crossings substantially increases the transport cost burden, which in turn may negatively affect trade. Thus, being landlocked reduces international trade by around 80%, in comparison to maritime transport. Tanabe, Shibasaki, and Kato (2016) studied the expected impacts of improvements in border crossings on international trade in Central Asia and stated that improvements of border crossing services lead not only to a reduction of transportation but are also positively correlated with the international trade flow in Central Asian countries, implying that improvements of transportation services are a prerequisite for regional trade growth. Another study by Yii et al. (2018) examined the importance of transportation infrastructure for ASEAN and Central Asian countries within the One Belt One Road initiative. Findings of this study confirmed the positive relationship between transportation infrastructure and GDP growth, suggesting further expansion and upgrading of infrastructure, especially in terms of railway networks.

Thus, infrastructure development is expected to reduce transportation costs and increase trade flows. Although this argument is confirmed by most empirical studies, there is a lack of research in the context of Central Asian countries. The landlocked position of these countries provides reasonable arguments for the need to develop infrastructure. However, the current empirical literature does not sufficiently clarify this relationship in Central Asian countries. This study aims to fill this gap.

4. METHODOLOGY

4.1 Model Specification

The traditional gravity model of trade flows is based on Newton's law of gravitation. The law states that the force of gravitational attraction between two material points is proportional to both masses and inversely proportional to the square of the distance between them (Rohrlich 1989). Tinbergen was the first to use this law for explaining international trade flows (Anderson 2011). The trade flows (X_{ij}) between countries of origin and destinations are directly proportional to the supply of factors of production (Y_i) at origin i, and to the demand for goods and labor (E_j) in destination j, but indirectly proportional to the distance (d_{ij}) between these countries, as given below in the equation (Anderson 2011):

$$X_{ij} = Y_i E_j / d_{ij}^2 \tag{1}$$

The log-linearized form of this model is widely used to empirically assess the factors causing bilateral trade flows (Ismail and Mahyideen 2018; Wessel 2019; Grigoriou 2007; Raballand 2003; Shepherd and Wilson 2007; Francois and Manchin 2013; Martínez-Zarzoso and Nowak-Lehmann 2003; Kepaptsoglou, Karlaftis, and Tsamboulas 2010; Sohn 2005; Martínez-Zarzoso 2003; Dascal, Mattas, and Tzouvelekas 2002; Query 2020; Ramasamy and Yeung 2019; Kohl 2019). However, estimating the log-linearized gravity model in the presence of zero trade values leads to a loss of information from these observations and a reduction of the sample size (Wessel 2019). To deal with this problem, Silva and Tenreyro (2006) suggest using the Poisson pseudo-maximum-likelihood (PPML) estimation method. They have argued that standard techniques used to estimate the gravity model are inappropriate for two reasons. Firstly, nonlinear transformation of the model in the presence of heteroskedasticity yields inconsistent estimates, and secondly truncation of the sample, due to the elimination of zero trade values during log-linearization of the model (Silva and Tenreyro 2006). They assessed the PPML method and found that in the presence of heteroskedasticity the results bias severely. For this reason, they propose using the PPML technique not only to deal with zeros in trade data but also to cope with the heteroskedasticty issue.

Following the literature, we have used the gravity model to investigate the impact of infrastructure on the international trade flow of Central Asian countries, and to estimate the PPML regression, the trade gravity model of Anderson and Van Wincoop (2003) was augmented as follows:

$$\begin{aligned} X_{ijt} = \exp\big[& \beta_0 + \beta_1 LnGDP_{jt} + \beta_2 LnGDP_{jt} + \beta_3 LnDist_{ijt} \\ & + \beta_4 INFRA_{it} + \beta_5 INFRA_{jt} + \beta_6 Controls_{ijt} \\ & + \beta_7 MRT_{jt}\big] * \delta_t * \varepsilon_{ijt} \end{aligned} \tag{1}$$

$$\begin{aligned} M_{ijt} = \exp\big[& \beta_0 + \beta_1 LnGDP_{jt} + \beta_2 LnGDP_{jt} + \beta_3 LnDist_{ijt} \\ & + \beta_4 INFRA_{it} + \beta_5 INFRA_{jt} + \beta_6 Controls_{ijt} \\ & + \beta_7 MRT_{jt}\big] * \delta_t * \varepsilon_{ijt} \end{aligned} \tag{2}$$

where the bilateral trade flows, the export $\boldsymbol{X_{ijt}}$, and import $\boldsymbol{M_{ijt}}$ enter into the equation in levels, not in logarithmic form, as proposed by Silva and Tenreyro (2006). The interpretation of the results of this model is the same with OLS, and coefficients are interpreted as elasticity (Wessel 2019). To estimate this model we have used the *ppml* command with cluster-robust standard errors in STATA (Santos Silva and Tenreyro 2010).

The *i*- in Equations (1) and (2) represents the countries of origin in Central Asia – Kazakhstan, the Kyrgyz Republic, and Tajikistan; *j*- represents the trading destination countries – Azerbaijan, Belgium, Bulgaria, the PRC, the Czech Republic, France, Germany, India, Iran, Italy, the Republic of Korea, Latvia, Lithuania, Mongolia, the Netherlands, the Russian Federation, Switzerland, Turkey, the United Kingdom, the United States, and Ukraine. GDP_{jt}, GDP_{it}, and $LnDist_{ijt}$ are the gravity variables. $Infra_{ijt}$ indicates the infrastructure variable, and $Controls_{ijt}$ is the vector of the exogenous variable. To control the time-specific effects that may affect all countries in the same way, δ_t is included, which is the dummy variable, taking the value "1" for the period from 2009 to 2017. To take into account the unobservable barriers faced between trading countries, we followed Rasoulinezhad, Taghizadeh-Hesary, and Yoshino (2020), and calculated MRT as the GDP for weighted distance between exporter and importer countries.

4.2 Data

The annual data on the bilateral trade of Central Asian countries, the export $\boldsymbol{X_{ijt}}$, and import $\boldsymbol{M_{ijt}}$ are gathered for the 2009–2017 period from statistical agencies of each country: the Ministry of National Economy of the Republic of Kazakhstan Statistics Committee, the National Statistical Committee of the Kyrgyz Republic, and the Agency on Statistics under the President of the Republic of Tajikistan. The trade flows used in analysis are the level of export and import of Central Asian countries (origin, *i*-th country) with their trading partners (destination, j-th country) in current thousand US dollars.

The road, railway, and air transport infrastructure indicators are used as approximations of hard infrastructure quantity and quality. Differentiating between the quality and quantity of infrastructure might have different implications for trade flows and this distinction may provide additional insights (Wessel 2019). The quantity data on transport infrastructure were collected from the World Development Indicators (WDI). These indicators include: for railways – rail lines (*total route in km*), passengers carried (*million passengers per km*), goods transported (*million tons per km*); for air transport – passengers carried, freight (*million tons per km*), registered carried departures worldwide. Also, air transport quantity data were gathered from the Global Competitiveness Report, as the number of available millions airline seat per kilometers in a week.

Following Wessel (2019), the transport infrastructure quality data were taken from the Global Competitiveness Report (GCR) of the World Economic Forum. These are the quality of road, railroad, and air transport infrastructure. These indicators take values from 1 to 7, with 7 being the most desirable outcome (Schwab 2018).

One of the main limitations faced when collecting data from several sources is that in assessing the quality of infrastructure with GCR data, there are no available data on Uzbekistan. For this reason, data are collected only for Kazakhstan, the Kyrgyz Republic, and Tajikistan and their trading partners and estimation results in preceding sections are presented only for these countries. The other problem was collecting data on road infrastructure, as due to the lack of data on roads in the WDI, in this study, the road infrastructure indicators presented only qualitative data from GCR.

To disentangle the differentiating impact of infrastructure on export with respect to countries of origin and destination, the infrastructure variable presented destination ($\mathrm{INFRA_{jt}}$) and origin ($\mathrm{INFRA_{it}}$) countries, separately.

To properly estimate the impact of infrastructure on exports, it is necessary to include exogenous variables that influence trade, in order to minimize the omitted variable bias. This occurs when the model leaves out relevant variables, which in turn affects the estimation results. The first variables are from Anderson and Van Wincoop's (2003) gravity model, namely the GDP of countries of origin and destination, and the distance between these countries. $\mathrm{GDP_{it}}$ and $\mathrm{GDP_{jt}}$ are the level of gross domestic product in the country of origin and destination in year t, respectively; the data for these two variables are collected from the WDI as constant thousand US dollars. Following the literature, the level of GDP in the country of destination is expected to be positively correlated with the trade outflow from Central Asia. Hence, the relative growth in income of foreigners increases the demand for domestic goods. For this reason, β_2 is expected to be greater than zero.

The variable $\mathrm{DIST_{ijt}}$ represents the distance between the capital cities of countries of origin (*i*-th country) and destination (*j*-th country) and is collected from the CEPII (Centre d'Etudes Prospectives et d'Informations Internationales) in kilometers (Mayer and Zignago 2011). This variable included capturing the cost of transportation of goods and services. It is expected that the variable $\mathrm{DIST_{ijt}}$ will have a negative impact on trade flows, thus trading with remote areas increases logistical costs, and thus the cost of exporting.

The variable $\mathrm{ENDW_{ijt}}$ is the difference in GDP per capita (data taken from the WDI in US dollars) between countries of origin and destination in year t and refers to relative endowment. It refers to the income gap between countries of origin and destination, and is expected to be negatively correlated with exports and imports, showing that economies with a similar income level are more likely to trade with each other (Ismail and Mahyideen 2018). The dummy variable $Border_{ij}$ shows the existence of common border between Central Asian countries and their trading partner countries.

4.3 Descriptive Statistics

According to the descriptive statistics given below, the average exports of Central Asian countries amount to around $896 million and imports to $709 million. The average overall transport infrastructure quality is 3.36 points. The other quality infrastructure variables show that the quality of infrastructure in Central Asia is lower than that of their trading partner countries. The railway indicators at origin (Central Asian countries) show that the rail network covers on average about 5,921.636 km, and that passenger turnover is much less than that of their trade partners countries.

The air transport infrastructure indicators show that far fewer passengers are carried by air transport in Central Asian countries (2 million passengers) than in their trade partner countries (73 million passengers). The same pattern is seen for air transport freight, the number of registered departures, and available airline seats. The distance between countries of origin and destinations is about 4,000 kilometers. There is a significant difference in GDP per capita and GDP in countries of export and import, and relative endowment amounts to around $19,000.

Table 4: Descriptive Statistics

Variables	Mean	Min.	Max.	Obs.	Data Sources
Dependent variables					
Export (*thousand US dollars)*	896,179.5	0	1.65E+07	504	Statistics committees of Kazakhstan, Kyrgyz Republic, Tajikistan
Import (*thousand US dollars)*	709,074	162	1.80E+07	504	
Control variables					
GDP, *Central Asian counties* (*thousand US dollars)*	7.40E+07	4,794,358	1.96E+08	504	WDI
GDP, *trading partner countries* (*thousand US dollars)*	1.82E+09	4,794,358	1.73E+10	504	WDI
GDP per capita, *Central Asian counties* (*US dollars)*	4,671.149	719.2083	10,867.74	504	WDI
GDP per capita, *trading partner countries* (*US dollars)*	24194.07	719.2083	77,684.06	504	WDI
Endowment	–19,522.92	–76,613.7	9,842.879	504	WDI
Border *(1 = existence of common border)*	0.1071429	0	1	504	WDI
Distance *(km)*	3910.808	524.7949	10,909.58	504	CEPII
MRT	2.430873	2.004078	2.814007	504	WDI, CEPII
Quality infrastructure variables					
• Overall transport infrastructure quality *(Central Asian counties)*	3.366032	2.47	4.25	504	GCR
• Overall transport infrastructure quality *(trading partner countries)*	4.85746	1.9	6.8	504	GCR
• Road quality *(Central Asian counties)*	2.796825	2.3	4.1	504	GCR
• Road quality *(trading partner countries)*	4.405952	1.4	6.6	504	GCR
• Railways quality *(Central Asian counties)*	3.330556	2.3	4.4	504	GCR
• Railways quality *(trading partner countries)*	4.505357	2	6.8	504	GCR
• Air transportation quality *(Central Asian counties)*	3.583532	2.7	4.3	504	GCR
• Air transportation quality *(trading partner countries)*	5.022421	2.7	6.6	504	GCR
Quantity infrastructure variables					
Railways					
• Rail lines, *Central Asian counties* (total route-km)	6,365.715	417	16,040.3	504	WDI
• Passengers carried, *Central Asian counties* (million passengers-km)	7,211.815	16	19,241.2	504	WDI
• Passengers carried, *trading partner countries* million passengers-km)	93,828.97	16	1,149,835	504	WDI
• Goods transported, *Central Asian counties* (million tons-km)	87,247.96	165	235,845.5	504	WDI
Air transportation					
• Passengers carried, Central Asian counties	2,204,136	309,488	6,903,190	504	WDI
• Passengers carried, trading partner countries	7.35E+07	69445	8.49E+08	504	WDI
• Freight, Central Asian counties (million tons-km)	18.67025	0.02165	58.19901	504	WDI
• Freight, trading partner countries (million tons-km)	4,304.978	0.02165	41,591.55	504	WDI
• Departures, Central Asian counties	30,162.14	4,135	83,048	504	WDI
• Departures, trading partner countries	764,768.8	4,135	1.01E+07	504	WDI
• Available airline seat km/week, millions (Central Asian counties)	127.3121	19.2	306.1	504	GCR
• Available airline seat km/week, millions (trading partner countries)	4,470.692	7.5	328,852.2	504	GCR

Source: Authors' calculations.

5. EMPIRICAL RESULTS

5.1 Infrastructure Quality Regressions

The PPML quality infrastructure regression outputs with robust clustered standard errors are presented in Table 5. It should be noted that in this table, only the estimated coefficient results for quality infrastructure variables are presented (to see detailed regression estimation results see Table 1, Table 2, and Table 3 in the Annex). According to empirical results, the control variables have the expected and significant impact on the bilateral trade of Central Asia. Hence, there is a significant impact of trading partner GDP on bilateral trade flow, while the relative endowment variable has a significant negative impact on exports and imports. This means that with a rise in income gaps between trading countries, the volume of bilateral trade would decrease. This finding is in line with Ismail and Mahyideen (2018) and, as expected, endowment is negatively correlated with exports and imports of Central Asian economies (see Annex Tables 1–9), showing that economies with a similar income level are more likely to trade with each other.

The variable indicating the distance between capitals of trade origin and destination countries shows that with increased distances from trading partners the volume of exports and imports reduces, meaning that longer distances may have implications for transportation costs related to distance. Hence, the variables indicating the common border with Central Asian countries show that Central Asian economies are more likely to trade with their border trading partners, and this is true both for export and import.

The estimated coefficients for the main variable of interest, the quality of infrastructure, are presented in Table 5. According to these empirical outputs, there is a positive correlation between the infrastructure development and bilateral trade of Central Asia. Hence, an improvement in the overall transport infrastructure quality in the countries of origin (Kazakhstan, the Kyrgyz Republic, Tajikistan) for 1% increases exports by 9.15%, while imports increase by 5.12%, whereas an improvement in the quality of railway and air transportation leads to increases in exports and imports of 5.16% and 7.83%, respectively.

To disentangle the heterogeneity of the infrastructure quality of Central Asian economies and its impact on bilateral trade, the total sample was further estimated by country subsamples, because, as previously indicated, the best performer in the region in terms of infrastructure quality is Kazakhstan and pulling it out of the total sample and estimating separately would give more insight into the impact of infrastructure.

The empirical results for the Kazakhstan sample show that there is a highly significant correlation between the infrastructure quality improvement in Kazakhstan and the bilateral trade flows of Kazakhstan with its trading partners (see Table 5). Accordingly, an increase in the quality of the overall transportation infrastructure, and road, railway, and air transportation would lead to increases in exports of 8.85%, 3.68%, 10.24%, and 27.58%, respectively, while the imports of Kazakhstan would increase by 5.12%, 2.29%, 5.16%, and 7.83%, respectively.

Table 5: Estimated Infrastructure Quality Coefficients

	Export			Import		
	Total Sample	***Kazakhstan Sample***	***Kyrgyz Republic and Tajikistan Sample***	***Total Sample***	***Kazakhstan Sample***	***Kyrgyz Republic and Tajikistan Sample***
Overall transport infrastructure quality						
• Central Asian countries	9.1548*** (2.6935)	8.8505** (4.3564)	–12.3176*** (4.6624)	5.1272*** (1.0964)	2.6579* (1.3827)	2.0912 (3.9725)
• Trading partner countries	0.9970 (2.6201)	–2.4537 (1.9662)	–0.5289 (1.4642)	0.2821 (0.6162)	–0.2263 (0.5320)	–1.6915 (1.4282)
Road quality						
• Central Asian countries	0.3991 (0.8347)	3.6869*** (1.0981)	–5.8953*** (2.2511)	2.2934*** (0.8729)	2.3869*** (0.6610)	0.2465 (0.6380)
• Trading partner countries	0.8254 (1.3537)	–1.0423 (1.8364)	–0.7135 (1.1513)	–2.4772*** (0.7734)	–2.0612** (0.8252)	–3.6267*** (0.6842)
Railways quality						
• Central Asian countries	11.6415*** (4.2365)	10.2477*** (3.5469)	–4.9584*** (1.8988)	5.1661*** (1.1685)	3.1620* (1.7083)	1.6756 (2.1499)
• Trading partner countries	–0.7735 (1.7001)	–1.6816 (1.4025)	2.8344 (2.3460)	–0.4602 (0.6437)	0.2016 (0.8659)	–1.4371 (1.1836)
Air transportation quality						
• Central Asian countries	7.9561*** (1.6998)	27.5892*** (7.6030)	–5.3418*** (1.8945)	7.8394*** (2.0216)	10.5932*** (3.3306)	1.4335 (2.0766)
• Trading partner countries	–0.1672 (2.9318)	–3.2173* (1.7030)	–0.4058 (1.8279)	–0.5899 (1.0177)	–0.5280 (1.2256)	–2.8185* (1.6818)
N	504	207	297	423	207	216

Note: dependent variable – *exports*; all infrastructure variables presented in logarithmic form. Clustered standard errors presented in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$.

Source: Authors' calculations.

However, for the Kyrgyz Republic and Tajikistan joint sample, we have opposing results. According to empirical outputs, there is a significant but negative impact of infrastructure quality improvement on the trade flows of the Kyrgyz Republic and Tajikistan. This might be explained by the fact that over the analysis period the quality of air transport, roads, and railway saw no significant improvement (see Figures 1, 2, and 3 in the Annex), meaning that hard infrastructure in these countries is underdeveloped and negatively correlated with increasing trade flows.

The other variable of interest presented in Table 5 is the infrastructure quality of trading partners of Central Asian economies and its impact on the bilateral flow between these countries. The empirical results indicate that in general there is no impact of improvement in overall transport infrastructure quality in the trading partner countries on the bilateral flows with Central Asia. This may indicate the particular importance of improving domestic infrastructure to facilitate the trade of Central Asia.

5.2 Infrastructure Quantity Regressions

5.2.1 Air Transport Infrastructure Regression Results

Table 6 presents regression results on the impact of the air transportation infrastructure quantity on bilateral trade. The four indicators are presented as proxy variables for air transportation quantity infrastructure: air transport freight, air transport passengers carried, number of air transport departures, and available airline seat kilometers/

millions/week. All these quantity air transport variables for Central Asian countries are statistically significant and positively correlated with bilateral flows. Thus, increases in the number of passengers carried, registered departures worldwide, available airline seats, and freight carried from Central Asia would increase exports by 1.78%, 1.19%, 3.03%, and 1.15%, respectively, and increase imports (except for the passengers carried variable) by 1.15%, 1.55%, and 0.45%, respectively.

As for the Kazakhstan subsample estimation results, there is a highly significant and positive correlation between the increase in quantity infrastructure measurement of air transportation and its bilateral trade flows. For the Tajikistan and Kyrgyz Republic subsample there are contradictive outputs. There is a negative relation between the number of passengers carried, available airline seats, and freight transported and the export of these countries, and a positive relation with the number of registered departures worldwide; and no impact on imports. Also, there is no significant evidence seen for the impact of air transport infrastructure development in the trading partner countries on the bilateral flows of Central Asia.

Table 6: Quantity Regression Results, Air Transportation

	Export			Import		
	Total Sample	***Kazakhstan Sample***	***Kyrgyz Republic and Tajikistan Sample***	***Total Sample***	***Kazakhstan Sample***	***Kyrgyz Republic and Tajikistan Sample***
Passengers carried						
• Central Asian countries	1.7877*** (0.3132)	0.5190*** (0.1274)	–1.2135*** (0.3494)	–1.0443*** (0.1294)	0.2273*** (0.0656)	0.1768 (0.5076)
• Trading partner countries	–0.5891 (0.4866)	–0.5178 (0.5207)	1.9430*** (0.3891)	1.0605*** (0.1930)	–0.2091 (0.1938)	1.0551* (0.5930)
Freight						
• Central Asian countries	1.1511*** (0.2608)	0.5649*** (0.1582)	–0.4007*** (0.1471)	0.4509*** (0.1076)	0.2198*** (0.0792)	0.0677 (0.0985)
• Trading partner countries	–0.1390 (0.2961)	–0.1996 (0.2905)	0.3146** (0.1553)	0.2124 (0.1334)	0.0324 (0.0975)	0.5509 (0.3532)
Number of departures worldwide						
• Central Asian countries	1.9507*** (0.3650)	0.4517*** (0.1136)	1.0759** (0.4648)	1.1506*** (0.2454)	0.2057*** (0.0771)	–0.1669 (0.1821)
• Trading partner countries	–0.9901 (0.7015)	–0.9658 (0.6982)	1.3111*** (0.4210)	0.3837 (0.3133)	–0.1621 (0.1862)	2.2970*** (0.6553)
Available seats						
• Central Asian countries	3.0331*** (0.4643)	1.3975*** (0.4004)	–0.5704* (0.3377)	1.5535*** (0.2888)	0.4799** (0.2144)	–0.0081 (0.2956)
• Trading partner countries	–0.2274 (0.5363)	–0.1592 (0.6271)	1.7660*** (0.6702)	0.5143* (0.2754)	0.0962 (0.2544)	1.6470** (0.7513)
N	504	207	297	423	207	216

Note: dependent variable – *exports*; all infrastructure variables presented in logarithmic form. Clustered standard errors presented in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$.

Source: Authors' calculations.

5.2.2 Railway Infrastructure Regression Results

Table 7 shows the results for the railway quantity infrastructure impact on the bilateral trade of Central Asian countries. Three indicators were used as proxies for railway infrastructure: total route of rail lines, the goods, and the number of passengers carried by railways.

According to the empirical results, the development of quantity infrastructure of railways leads to an increase in the bilateral flows of Central Asia. There is a significant positive impact of total railroad increment, the number of passengers carried, and goods transported by railway on the export and import of Central Asia. As a result, an increase in the quantity of railway infrastructure for 1% may increase exports by up to 1.38% and imports by 0.73%.

Along with these empirical outputs the subsample division of regressions indicates that the highest impact of railway infrastructure development is seen for Kazakhstan. Thus, a 1% total railroad increment leads to increases in exports and imports of 15.69% and 6.30%, respectively, while the number of passengers carried by railways increases exports and imports, respectively, by 2.97% and 1.29%. And a 1% increase in goods transported by railways will lead to a 6.70% and 2.69% increase in the exports and imports of Kazakhstan, respectively.

For the Kyrgyz Republic and Tajikistan there is no significant impact of railway development on imports. And there is a negative correlation between the rail network developments and trade performance of these countries. However, as explained in the preceding section, this may be due to the stagnation of the rail networks in Tajikistan and the Kyrgyz Republic, hence no significant increment in the total route of railways is seen for the analysis period. A significant negative impact on trade may imply the importance of improving and increasing the rail networks in these countries. However, there is a positive impact of goods transported and passengers carried by railways on exports and imports, which may suggest that active improvement of train routes may lead to positive trade spillover effects.

Table 7: Quantity Regression Results, Railways

	Export			Import		
	Total Sample	***Kazakhstan Sample***	***Kyrgyz Republic, Tajikistan Sample***	***Total Sample***	***Kazakhstan Sample***	***Kyrgyz Republic, Tajikistan Sample***
Rail lines *(Central Asia)*	1.3835*** (0.2047)	15.6965*** (3.6217)	–5.2802** (2.0541)	0.7377*** (0.1437)	6.3012*** (2.4178)	1.6535 (2.5227)
Passengers carried						
• Central Asia	0.8373*** (0.1023)	2.9798*** (0.6557)	1.4059*** (0.4651)	0.4203*** (0.0843)	1.2953*** (0.3854)	–0.5538 (0.6865)
• Trading partners	0.0533 (0.1677)	–0.0003 (0.1630)	0.4129 (0.6361)	–0.0730 (0.2376)	0.1795 (0.3637)	–0.2356 (0.2951)
Goods transported *(Central Asia)*	0.8516*** (0.1183)	6.7045*** (1.5470)	1.3466*** (0.3923)	0.4578*** (0.0961)	2.6915*** (1.0327)	–0.4458 (0.5425)
N	504	207	297	423	207	216

Note: dependent variable – *exports*; all infrastructure variables presented in logarithmic form. Clustered standard errors presented in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$.

Source: Authors' calculations.

6. CONCLUSION

The objective of this paper was to examine the impact of infrastructure on trade in the case of three Central Asian countries. Infrastructure was measured by quality and quantity indicators. The latter was assessed by road, air transport and railroad proxies. Overall empirical results indicate that both the quality and quantity of infrastructure in Central Asia have positive impacts on trade flows – export and import flows increase with improved infrastructure. However, estimations by country subsamples show that this

effect varies by country. A significant positive relationship between infrastructure and trade flows is confirmed in the case of Kazakhstan. On the other hand, the Kyrgyz Republic and Tajikistan joint sample demonstrated no impact or even in some cases a negative relationship. This diverging result can be ascribed to the differences between countries in the development of infrastructure over the period of analysis. In the recent decades railroad and air transportation networks in these two countries have not demonstrated significant development. Moreover, infrastructure investments in the Kyrgyz Republic and Tajikistan have been mainly in road construction, while in our analysis of infrastructure quantity, road infrastructure was not taken into consideration due to data limitations.

Indeed, this can be mentioned as the main limitation of this study. Because of the limited data available on paved roads or improved roads, it did not focus on the road infrastructure impact, although this remains one of the important methods of transportation. However, given the general view of road transportation as a costly type of transportation, the focus on railway and air transport can be seen as analyzing perspectives on less costly or alternative options for infrastructure development. Further studies using a micro-level data set may provide additional evidence on the welfare effects of infrastructure projects in Central Asia.

The main findings of the study have several policy implications for Central Asian countries. First, it underlines the fact that facilitation of regional trade should be based on regional infrastructure development projects that are not limited to single country perspectives. The development of infrastructure within one country without the support of international cooperation with other countries in the region is limited in terms of bringing expected region-wide benefits. Second, deliberate government policy is needed, taking into consideration the cost-efficient effects of different types of transportation, because not all types of transportation will have the same effect on facilitation of trade. Railways may have a long-term sustainable impact whilst being very costly to construct, while road construction may have a direct effect in the short term, but necessitates constant investments for maintenance. Third, physical infrastructure itself may not have sufficient impact on trade if it is not supported by conducive customs services and border management. Therefore, policy regarding the development of infrastructure should be associated with other policy aspects of regional economic integration.

REFERENCES

Agency on Statistics under President of the Republic of Tajikistan, www.stat.tj.

Anderson, J. E. (2011). The gravity model. Annual Review of Economics, 3(1), 133–160.

Anderson, J. E., and Van Wincoop, E. (2003). Gravity with gravitas: A solution to the border puzzle. American Economic Review, 93(1), 170–192.

Bougheas, S., Demetriades, P. O., and Morgenroth, E. L. (1999). Infrastructure, transport costs and trade. Journal of International Economics, 47(1), 169–189.

Cigu, E., Agheorghiesei, D. T., and Toader, E. (2019). Transport infrastructure development, public performance and long-run economic growth: A case study for the Eu-28 countries. Sustainability, 11(1), 67.

Dadabaev, T. (2018). Japanese and Chinese infrastructure development strategies in Central Asia. Japanese Journal of Political Science, 19(3), 542–561.

Dascal, D., Mattas, K., and Tzouvelekas, V. (2002). An analysis of EU wine trade: A gravity model approach. International Advances in Economic Research, 8(2), 135–147.

Donaldson, D. (2018). Railroads of the Raj: Estimating the impact of transportation infrastructure. American Economic Review, 108(4–5), 899–934.

Francois, J., and Manchin, M. (2013). Institutions, infrastructure, and trade. World Development, 46, 165–175.

Grigoriou, C. (2007). Landlockedness, infrastructure and trade: New estimates for central Asian countries. The World Bank https://doi.org/10.1596/1813-9450-4335.

Iimi, A. (2011). Effects of improving infrastructure quality on business costs: Evidence from firm-level data in Eastern Europe and Central Asia. The Developing Economies, 49(2), 121–147.

Ismail, N. W., and Mahyideen, J. M. (2018). The impact of infrastructure on trade and economic growth in selected economies in Asia. Financing Infrastructure in Asia and the Pacific: Capturing Impacts and New Sources, Asian Development Bank Institute, Japan, pp. 259–296.

Karymshakov, K., and Sulaimanova, B. (2019). Measuring the Impact and Financing of Infrastructure in the Kyrgyz Republic. Asian Development Bank Institute Working Paper No 988.

Kepaptsoglou, K., Karlaftis, M. G., and Tsamboulas, D. (2010). The gravity model specification for modeling international trade flows and free trade agreement effects: A 10-year review of empirical studies. The Open Economics Journal, 3(1), 1–13.

Kohl, T. (2019). The Belt and Road Initiative's effect on supply-chain trade: Evidence from structural gravity equations. Cambridge Journal of Regions, Economy and Society, 12(1), 77–104.

Martínez-Zarzoso, I. (2003). Gravity model: An application to trade between regional blocs. Atlantic Economic Journal, 31(2), 174–187.

Martínez-Zarzoso, I., and Nowak-Lehmann, F. (2003). Augmented gravity model: An empirical application to Mercosur-European Union trade flows. Journal of Applied Economics, 6(2), 291–316.

Matas, A., Raymond, J. L., and Ruiz, A. (2018). Regional infrastructure investment and efficiency. Regional Studies, 52(12), 1684–1694.

Mayer, T., and Zignago, S. (2011). Notes on CEPII's distances measures: The GeoDist database (accessed at 20 November 2019).

Ministry of National Economy of the Republic of Kazakhstan Statistics Committee, www.stat.gov.kz.

Ministry of National Economy of the Republic of Kazakhstan Statistics Committee (2019) Foreign Trade of the Republic of Kazakhstan / Statistical Book, editor Aydapkelov N.S., p. 268, Nur-Sultan // Внешняя торговля Республики Казахстан/ Статистический сборник (2019) Министерство национальной экономики Республики Казахстан Комитет по статистике, редактор Айдапкелов Н.С., 268 стр, Нур-Султан.

National Statistical Committee of Kyrgyz Republic, www.stat.kg.

Portugal-Perez, A., and Wilson, J. S. (2012). Export performance and trade facilitation reform: Hard and soft infrastructure. World Development, 40(7), 1295–1307.

Query, J. (2020). Differing trade elasticities for intra-and international distances: A gravity approach. DOI: 10.1111/roie.12475.

Raballand, G. (2003). Determinants of the negative impact of being landlocked on trade: An empirical investigation through the Central Asian case. Comparative Economic Studies, 45(4), 520–536.

Ramasamy, B., and Yeung, M. C. (2019). China's one belt one road initiative: The impact of trade facilitation versus physical infrastructure on exports. The World Economy, 42(6), 1673–1694.

Rasoulinezhad, E., Taghizadeh-Hesary, F., and Yoshino, N. (2020). Assessment of the trade integration pattern between the Russian Federation and East/Southeast Asian economies using the panel gravity framework. Asian Economic Papers, 19(1), 1–14.

Rohrlich, F. (1989). From paradox to reality: Our basic concepts of the physical world. Cambridge University Press.

Santos Silva, J. M. C., and Tenreyro, S. (2010). On the existence of the maximum likelihood estimates in Poisson regression. Economics Letters, 107, 310–312.

Schwab, K. (2018). The global competitiveness report 2018. In World Economic Forum.

Shepherd, B., and Wilson, J. S. (2007). Road infrastructure in Europe and Central Asia: Does network quality affect trade? The World Bank.

Silva, J. S., and Tenreyro, S. (2006). The log of gravity. The Review of Economics and statistics, 88(4), 641–658.

Sohn, C. H. (2005). Does the gravity model explain South Korea's trade flows?. The Japanese Economic Review, 56(4), 417–430.

Stone, S., and Strutt, A. (2010). Transport infrastructure and trade facilitation in the Greater Mekong Subregion. Trade Facilitation and Regional Cooperation in Asia, 156.

Tanabe, S., Shibasaki, R., and Kato, H. (2016). Impact assessment model of international transportation infrastructure development: Focusing on trade and freight traffic in Central Asia. Asian Transport Studies, 4(1), 159–177.

The Global Competitiveness Report (2019) edited by Klaus Schwab, World Economic Forum, Switzerland.

The State Committee of the Republic of Uzbekistan on Statistics, www.stat.uz.

Wessel, J. (2019). Evaluating the transport-mode-specific trade effects of different transport infrastructure types. Transport Policy, 78, 42–57.

World Development Indicators data, www.data.worldbank.org/country.

Yi, X., and Koopman, R. (2019) World Trade Report: The future of services trade, World Trade Organization, WTO Publications, Geneva.

Yii, K. J., Bee, K. Y., Cheam, W. Y., Chong, Y. L., and Lee, C. M. (2018). Is transportation infrastructure important to the One Belt One Road (OBOR) Initiative? Empirical evidence from the selected Asian countries. Sustainability, 10(11), 4131.

Xu, H. (2016). Domestic railroad infrastructure and exports: Evidence from the silk route. China Economic Review, 41, 129–147.

Yoshino, N., and Abidhadjaev, U. (2016). Impact of infrastructure investment on tax: Estimating spillover effects of the Kyushu High-Speed Rail Line in Japan on regional tax revenue (No. 574). Asian Development Bank Institute, Tokyo.

ANNEX

Annex Table 1: Quality Infrastructure Regression Outputs (Total Sample)

	Export				Import			
	Overall Transport Infrastructure Quality	***Road Quality***	***Railways Quality***	***Air Transportation Quality***	***Overall Transport Infrastructure Quality***	***Road Quality***	***Railways Quality***	***Air Transportation Quality***
GDP *(Trading partner countries)*	1.1427* (0.6348)	1.4814 (0.9126)	1.3049* (0.6747)	1.4007 (1.0422)	0.2300 (0.3326)	0.6628*** (0.1832)	0.1634 (0.2526)	0.1765 (0.2534)
Distance	–0.0006* (0.0003)	–0.0006* (0.0003)	–0.0006* (0.0003)	–0.0006 (0.0004)	–0.0001 (0.0003)	0.0000 (0.0002)	–0.0001 (0.0002)	–0.0000 (0.0002)
Endowment	0.0260 (0.2956)	0.5159*** (0.1517)	–0.2445 (0.2280)	0.2684* (0.1372)	–0.0874 (0.1639)	0.2772** (0.1220)	–0.2903 (0.2008)	–0.1632 (0.1611)
Border (1 = common border)	0.9419 (0.6405)	0.7148 (0.7800)	1.0635** (0.4435)	0.7955 (0.8250)	1.2041*** (0.4365)	1.2964*** (0.4965)	1.3838*** (0.4423)	1.5346*** (0.5123)
MRT	–6.6124 (4.2882)	–9.7508 (7.0663)	–7.6021 (4.9897)	–8.4945 (7.9353)	3.7851 (3.2234)	–0.0598 (2.0392)	4.3339* (2.4122)	3.5087 (2.4240)
Infrastructure variables:								
Overall transport infrastructure quality (Central Asian countries)	9.1548*** (2.6935)				5.1272*** (1.0964)			
Overall transport infrastructure quality (trading partner countries)	0.9970 (2.6201)				0.2821 (0.6162)			
Road quality (Central Asian countries)		0.3991 (0.8347)				2.2934*** (0.8729)		
Road quality (trading partner countries)		0.8254 (1.3537)				–2.4772*** (0.7734)		
Railways quality (Central Asian countries)			11.6415*** (4.2365)				5.1661*** (1.1685)	
Railways quality (trading partner countries)			–0.7735 (1.7001)				–0.4602 (0.6437)	
Air transportation quality (Central Asian countries)				7.9561*** (1.6998)				7.8394*** (2.0216)
Air transportation quality (trading partner countries)				–0.1672 (2.9318)				–0.5899 (1.0177)
Constant	–4.8338 (3.1719)	8.9317*** (2.8162)	–6.3942 (5.2176)	–1.7219 (4.5491)	–7.8906** (3.7408)	0.7742 (2.3310)	–7.1786** (3.2593)	–8.8780** (4.4505)
Years dummy	+	+	+	+	+	+	+	+
R2	0.4796	0.3412	0.5854	0.4382	0.7797	0.8077	0.8877	0.8276
N	504	504	504	504	423	423	423	423

Note: dependent variable – *exports*; all explanatory variables presented in logarithmic form. Clustered standard errors presented in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$.

Source: Authors' calculations.

Annex Table 2: Quality Infrastructure Regression Outputs (Kazakhstan Sample)

	Export				Import			
	Overall Transport Infrastructure Quality	***Road Quality***	***Railways Quality***	***Air Transportation Quality***	***Overall Transport Infrastructure Quality***	***Road Quality***	***Railways Quality***	***Air Transportation Quality***
GDP *(Trading partner countries)*	1.7238*** (0.6197)	1.9528 (1.4160)	1.7572*** (0.6242)	2.1223*** (0.6936)	–0.4011* (0.2102)	0.4709 (0.3880)	–0.4695** (0.2153)	–0.3253 (0.3140)
Distance	–0.0009*** (0.0003)	–0.0009 (0.0006)	–0.0009*** (0.0003)	–0.0010*** (0.0003)	0.0002* (0.0001)	–0.0000 (0.0001)	0.0002** (0.0001)	0.0002 (0.0002)
Endowment	–0.7752** (0.3506)	–0.5002** (0.2402)	–0.6767** (0.3408)	–0.7565*** (0.2524)	–0.3843* (0.2232)	–0.3315** (0.1567)	–0.3373 (0.2409)	–0.3935** (0.1529)
Border (1 = common border)	1.1756** (0.5534)	1.0584 (0.7705)	1.5887*** (0.6090)	1.2608** (0.4952)	1.4788*** (0.4480)	1.2412*** (0.4609)	1.4656*** (0.4666)	1.4801*** (0.4651)
MRT	–10.7407** (4.2502)	–12.6953 (9.9165)	–11.6162** (4.8219)	–14.5717*** (5.2993)	8.8142*** (2.4291)	1.3897 (3.6937)	9.3497*** (2.2183)	8.0794** (3.3374)
Infrastructure variables:								
Overall transport infrastructure quality (Central Asian countries)	8.8505** (4.3564)				2.6579* (1.3827)			
Overall transport infrastructure quality (trading partner countries)	–2.4537 (1.9662)				–0.2263 (0.5320)			
Road quality (Central Asian countries)		3.6869*** (1.0981)				2.3869*** (0.6610)		
Road quality (trading partner countries)		–1.0423 (1.8364)				–2.0612** (0.8252)		
Railways quality (Central Asian countries)			10.2477*** (3.5469)				3.1620* (1.7083)	
Railways quality (trading partner countries)			–1.6816 (1.4025)				0.2016 (0.8659)	
Air transportation quality (Central Asian countries)				27.5892*** (7.6030)				10.5932*** (3.3306)
Air transportation quality (trading partner countries)				–3.2173* (1.7030)				–0.5280 (1.2256)
Constant	0.0768 (5.8927)	6.9892** (3.1633)	–1.7292 (4.4313)	–22.3627** (9.4656)	–4.8144 (4.0231)	0.8158 (3.0974)	–6.2008 (4.0432)	–14.8024** (6.9830)
Years dummy	+	+	+	+	+	+	+	+
R2	0.5635	0.5348	0.5996	0.6835	0.9539	0.9566	0.9540	0.9525
N	207	207	207	207	207	207	207	207

Note: dependent variable – *exports*; all explanatory variables presented in logarithmic form. Clustered standard errors presented in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$.

Source: Authors' calculations.

Annex Table 3: Quality Infrastructure Regression Outputs (Kyrgyz Republic and Tajikistan Sample)

	Export				Import			
	Overall Transport Infrastructure Quality	***Road Quality***	***Railways Quality***	***Air Transportation Quality***	***Overall Transport Infrastructure Quality***	***Road Quality***	***Railways Quality***	***Air Transportation Quality***
GDP *(Trading partner countries)*	0.8010 (3.0196)	0.8822 (2.9000)	0.7352 (2.0141)	1.1023 (2.9369)	0.9046 (0.8368)	0.9356*** (0.1554)	0.7802 (0.6439)	0.7441* (0.4208)
Distance	–0.0017 (0.0033)	–0.0016 (0.0031)	–0.0017 (0.0022)	–0.0019 (0.0031)	–0.0007 (0.0010)	–0.0003* (0.0001)	–0.0005 (0.0008)	–0.0004 (0.0005)
Endowment	–2.1624 (2.1076)	–2.2042 (1.9168)	–1.5415 (1.1548)	–2.2909 (1.9950)	–0.7728* (0.4612)	–0.4923** (0.2338)	–0.6036 (0.5285)	–0.5984 (0.4415)
Border (1 = common border)	1.0920 (3.2789)	1.1279 (3.0555)	0.4832 (1.9077)	1.1697 (2.9843)	0.2025 (0.7866)	1.2936*** (0.4564)	0.3171 (0.8611)	0.4252 (0.7660)
MRT	–6.1249 (26.5600)	–6.6690 (25.4533)	–5.4507 (17.3494)	–8.4960 (25.6004)	2.8353 (9.0712)	0.0756 (1.7469)	4.0624 (6.8582)	3.1965 (4.5691)
Infrastructure variables:								
Overall transport infrastructure quality (Central Asian countries)	–12.3176*** (4.6624)				2.0912 (3.9725)			
Overall transport infrastructure quality (trading partner countries)	–0.5289 (1.4642)				–1.6915 (1.4282)			
Road quality (Central Asian countries)		– 5.8953*** (2.2511)				0.2465 (0.6380)		
Road quality (trading partner countries)		–0.7135 (1.1513)				– 3.6267*** (0.6842)		
Railways quality (Central Asian countries)			– 4.9584*** (1.8988)				1.6756 (2.1499)	
Railways quality (trading partner countries)			2.8344 (2.3460)				–1.4371 (1.1836)	
Air transportation quality (Central Asian countries)				–5.3418*** (1.8945)				1.4335 (2.0766)
Air transportation quality (trading partner countries)				–0.4058 (1.8279)				–2.8185* (1.6818)
Constant	22.7844 (14.9926)	15.1851 (12.1862)	11.2835 (8.4297)	16.3725 (13.0976)	–13.2603 (11.6972)	–3.5977 (2.4926)	–13.7344 (11.9776)	–9.0673 (10.1671)
Years	+	+	+	+	+	+	+	+
R2	0.3855	0.4335	0.5494	0.4846	0.7243	0.8733	0.7186	0.7417
N	297	297	297	297	216	216	216	216

Note: dependent variable – *exports*; all explanatory variables presented in logarithmic form. Clustered standard errors presented in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$.

Source: Authors' calculations.

Annex Table 4: Railways Quantity Infrastructure Regression Outputs (Total Sample)

	Export			Import		
	Rail Lines	***Passengers Carried***	***Goods Transported***	***Rail Lines***	***Passengers Carried***	***Goods Transported***
GDP *(Trading partner countries)*	1.0951** (0.4787)	0.9638 (0.7383)	1.0984** (0.4748)	0.1386 (0.2938)	0.3035 (0.5164)	0.1607 (0.3068)
Distance	–0.0006** (0.0003)	–0.0006 (0.0004)	–0.0006** (0.0003)	–0.0001 (0.0002)	–0.0002 (0.0003)	–0.0001 (0.0003)
Endowment	–0.4370*** (0.1659)	–0.4695*** (0.1538)	–0.4503*** (0.1670)	–0.3039* (0.1818)	–0.2506* (0.1424)	–0.2863 (0.1807)
Border (1 = common border)	1.1782** (0.5794)	1.1557** (0.5605)	1.1861** (0.5836)	1.2072*** (0.4275)	1.1638*** (0.4305)	1.1776*** (0.4354)
MRT	–6.0819* (3.6958)	–5.5070 (4.4460)	–6.1168* (3.6559)	4.9125* (2.8953)	4.4473 (2.7517)	4.7626 (2.9944)
Infrastructure variables:						
Rail lines *(Central Asian countries)*	1.3835*** (0.2047)			0.7377*** (0.1437)		
Passengers carried, *(Central Asian countries)*		0.8373*** (0.1023)			0.4203*** (0.0843)	
Passengers carried *(Trading partner countries)*		0.0533 (0.1677)			–0.0730 (0.2376)	
Goods transported *(Central Asian countries)*			0.8516*** (0.1183)			0.4578*** (0.0961)
Constant	–4.1669 (3.9974)	1.4460 (4.2229)	–1.3099 (3.7420)	–8.4785** (4.1711)	–6.6794 (6.6727)	–7.0315* (4.0886)
Years	+	+	+	+	+	+
R2	0.5617	0.5623	0.5617	0.9004	0.8965	0.8953
N	504	504	504	423	423	423

Note: dependent variable – *exports*; all explanatory variables presented in logarithmic form. Clustered standard errors presented in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$.

Source: Authors' calculations.

Annex Table 5: Railways Quantity Infrastructure Regression Outputs (Kazakhstan Sample)

	Export			Import		
	Rail Lines	***Passengers Carried***	***Goods Transported***	***Rail Lines***	***Passengers Carried***	***Goods Transported***
GDP *(Trading partner countries)*	1.4038*** (0.4557)	1.4046** (0.6893)	1.4038*** (0.4557)	–0.4266** (0.2165)	–0.8896 (0.8686)	–0.4266** (0.2165)
Distance	–0.0008*** (0.0003)	–0.0008** (0.0004)	–0.0008*** (0.0003)	0.0002* (0.0001)	0.0004 (0.0004)	0.0002* (0.0001)
Endowment	–0.4286** (0.1680)	–0.4285*** (0.1526)	–0.4286** (0.1680)	–0.3555* (0.1912)	–0.4214*** (0.1425)	–0.3555* (0.1912)
Border (1 = common border)	1.2276** (0.6038)	1.2278** (0.5795)	1.2276** (0.6038)	1.4811*** (0.4490)	1.4610*** (0.4671)	1.4811*** (0.4490)
MRT	–8.6841*** (3.2262)	–8.6877** (3.9011)	–8.6841*** (3.2262)	9.0120*** (2.5449)	10.8864*** (3.2395)	9.0120*** (2.5449)
Infrastructure variables:						
Rail lines *(Central Asian countries)*	15.6965*** (3.6217)			6.3012*** (2.4178)		
Passengers carried *(Central Asian countries)*		2.9798*** (0.6557)			1.2953*** (0.3854)	
Passengers carried *(Trading partner countries)*		–0.0003 (0.1630)			0.1795 (0.3637)	
Goods transported *(Central Asian countries)*			6.7045*** (1.5470)			2.6915*** (1.0327)
Constant	– 140.6180*** (34.8129)	–19.1800** (7.4698)	–72.2973*** (19.1800)	–61.8290** (24.1519)	–11.8994 (7.5597)	–34.4023** (13.7881)
Years	+	+	+	+	+	+
R2	0.4920	0.4920	0.4920	0.9538	0.9536	0.9538
N	207	207	207	207	207	207

Note: dependent variable – *exports*; all explanatory variables presented in logarithmic form. Clustered standard errors presented in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$.

Source: Authors' calculations.

Annex Table 6: Railways Quantity Infrastructure Regression Outputs (Tajikistan and Kyrgyz Republic Sample)

	Export			Import		
	Rail Lines	***Passengers Carried***	***Goods Transported***	***Rail Lines***	***Passengers Carried***	***Goods Transported***
GDP *(Trading partner countries)*	1.2159 (2.9170)	0.4125 (2.2662)	0.6609 (2.5770)	0.7632 (0.9683)	1.0777 (0.7055)	0.8554 (1.0755)
Distance	–0.0021 (0.0032)	–0.0016 (0.0026)	–0.0015 (0.0028)	–0.0006 (0.0011)	–0.0007 (0.0008)	–0.0007 (0.0013)
Endowment	–2.3218 (1.8478)	–2.1221 (1.5829)	–1.9457 (1.8639)	–0.4916 (0.5716)	–0.4182 (0.4695)	–0.5696 (0.5288)
Border (1 = common border)	1.1692 (2.8395)	0.8158 (2.5325)	0.9398 (2.7665)	0.3281 (0.9029)	0.1921 (0.9050)	0.2313 (0.8811)
MRT	–9.3983 (25.3003)	–6.6933 (21.9452)	–4.9533 (22.7270)	3.1039 (8.8661)	3.6858 (7.6266)	2.9427 (11.1795)
Infrastructure variables:						
Rail lines *(Central Asian countries)*	–5.2802** (2.0541)			1.6535 (2.5227)		
Passengers carried *(Central Asian countries)*		1.4059*** (0.4651)			–0.5538 (0.6865)	
Passengers carried *(Trading partner countries)*		0.4129 (0.6361)			–0.2356 (0.2951)	
Goods transported *(Central Asian countries)*			1.3466*** (0.3923)			–0.4458 (0.5425)
Constant	42.4490** (19.6853)	8.5631 (14.3204)	0.0880 (9.6736)	–20.9602 (16.0361)	–13.5604 (18.1695)	–9.2274 (13.3907)
Years	+	+	+	+	+	+
R2	0.5579	0.5052	0.3766	0.6977	0.7070	0.7286
N	297	297	297	216	216	216

Note: dependent variable – *exports*; all explanatory variables presented in logarithmic form. Clustered standard errors presented in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$.

Source: Authors' calculations.

Annex Table 7: Air Transport Quantity Infrastructure Regression Outputs (Total Sample)

	Export				Import			
	Passengers Carried	***Freight***	***Number of Departures Worldwide***	***Available Seats***	***Passengers Carried***	***Freight***	***Number of Departures Worldwide***	***Available Seats***
GDP *(Trading partner countries)*	1.6147** (0.6592)	1.3105** (0.6573)	1.7100*** (0.5899)	1.2594* (0.7029)	0.3359 (0.3623)	–0.1921 (0.3532)	–0.0222 (0.4024)	–0.1899 (0.2202)
Distance	–0.0005** (0.0002)	–0.0006** (0.0003)	–0.0003 (0.0003)	–0.0005** (0.0002)	–0.0001 (0.0003)	–0.0000 (0.0002)	–0.0002 (0.0003)	–0.0002 (0.0003)
Endowment	–0.1695 (0.1974)	–0.3536* (0.2051)	–0.1399 (0.2109)	–0.3834** (0.1686)	–0.1569 (0.1693)	–0.1228 (0.1623)	–0.1438 (0.1578)	–0.2622 (0.1655)
Border (1 = common border)	1.0899** (0.5146)	1.1222** (0.4623)	1.3329*** (0.4367)	1.2064** (0.5014)	1.2545*** (0.4454)	1.1351*** (0.4188)	1.0536** (0.4577)	1.0606*** (0.4054)
MRT	–5.1993 (3.3739)	–6.1421* (3.3728)	–3.4706 (3.4095)	–5.6912* (3.3978)	3.7474 (3.1612)	5.2192* (3.0054)	3.0692 (3.0597)	3.6357 (2.8617)
Infrastructure variables:								
Passengers carried *(Central Asian countries)*	1.7877*** (0.3132)				1.0605*** (0.1930)			
Passengers carried *(Trading partner countries)*	–0.5891 (0.4866)				–0.1113 (0.2046)			
Freight *(Central Asian countries)*		1.1511*** (0.2608)				0.4509*** (0.1076)		
Freight *(Trading partner countries)*		–0.1390 (0.2961)				0.2124 (0.1334)		
Number of departures worldwide *(Central Asian countries)*			1.9507*** (0.3650)				1.1506*** (0.2454)	
Number of departures worldwide *(Trading partner countries)*			–0.9901 (0.7015)				0.3837 (0.3133)	
Available seats *(Central Asian countries)*				3.0331*** (0.4643)				1.5535*** (0.2888)
Available seats *(Trading partner countries)*				–0.2274 (0.5363)				0.5143* (0.2754)
Constant	–20.9411*** (6.4010)	1.7692 (9.4222)	–19.8919*** (7.2111)	–10.1437 (9.8053)	–16.3985*** (4.6860)	1.3404 (3.5765)	–10.2918** (4.5003)	–3.0503 (4.8800)
Years	+	+	+	+	+	+	+	+
R2	0.5987	0.5876	0.6586	0.5699	0.8221	0.8834	0.7952	0.8926
N	504	504	504	504	423	423	423	423

Note: dependent variable – *exports*; all explanatory variables presented in logarithmic form. Clustered standard errors presented in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$.

Source: Authors' calculations.

Annex Table 8: Air Transport Quantity Infrastructure Regression Outputs (Kazakhstan Sample)

	Export				Import			
	Passengers Carried	***Freight***	***Number of Departures Worldwide***	***Available Seats***	***Passengers Carried***	***Freight***	***Number of Departures Worldwide***	***Available Seats***
GDP *(Trading partner countries)*	1.8104** (0.7372)	1.6461** (0.6481)	1.8561*** (0.6297)	1.5011* (0.7733)	–0.2668 (0.2771)	–0.4733** (0.2219)	–0.3548* (0.2050)	–0.4685** (0.2169)
Distance	–0.0007** (0.0003)	–0.0008*** (0.0003)	–0.0004 (0.0003)	–0.0007*** (0.0002)	0.0002** (0.0001)	0.0002* (0.0001)	0.0003* (0.0002)	0.0002 (0.0002)
Endowment	–0.3629* (0.2032)	–0.5390** (0.2381)	–0.3551 (0.2163)	–0.4303** (0.1732)	–0.3154 (0.2165)	–0.3391* (0.1959)	–0.3338* (0.1955)	–0.3563* (0.1905)
Border (1 = common border)	1.2795** (0.5752)	1.3431*** (0.4954)	1.5816*** (0.5415)	1.2681** (0.5473)	1.5237*** (0.4434)	1.4617*** (0.4327)	1.5430*** (0.4461)	1.4372*** (0.4019)
MRT	–7.5046** (3.4668)	–8.2896** (3.2587)	–5.0003 (4.2173)	–8.2152*** (2.9904)	9.3262*** (2.4096)	9.0397*** (2.5080)	9.5687*** (2.7920)	8.6804*** (2.9090)
Infrastructure variables:								
Passengers carried *(Central Asian countries)*	0.5190*** (0.1274)				0.2273*** (0.0656)			
Passengers carried *(Trading partner countries)*	–0.5178 (0.5207)				–0.2091 (0.1938)			
Freight *(Central Asian countries)*		0.5649*** (0.1582)				0.2198*** (0.0792)		
Freight *(Trading partner countries)*		–0.1996 (0.2905)				0.0324 (0.0975)		
Number of departures worldwide *(Central Asian countries)*			0.4517*** (0.1136)				0.2057*** (0.0771)	
Number of departures worldwide *(Trading partner countries)*			–0.9658 (0.6982)				–0.1621 (0.1862)	
Available seats *(Central Asian countries)*				1.3975*** (0.4004)				0.4799** (0.2144)
Available seats *(Trading partner countries)*				–0.1592 (0.6271)				0.0962 (0.2544)
Constant	–0.6635 (6.4582)	3.2333 (9.1709)	–2.6645 (7.2264)	0.1543 (11.4972)	–5.4340 (3.3324)	–1.5122 (4.3167)	–4.6707 (4.1192)	–2.8665 (5.4222)
Years	+	+	+	+	+	+	+	+
R2	0.5672	0.5366	0.6522	0.5017	0.9529	0.9548	0.9535	0.9543
N	207	207	207	207	207	207	207	207

Note: dependent variable – *exports*; all explanatory variables presented in logarithmic form. Clustered standard errors presented in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$.

Source: Authors' calculations.

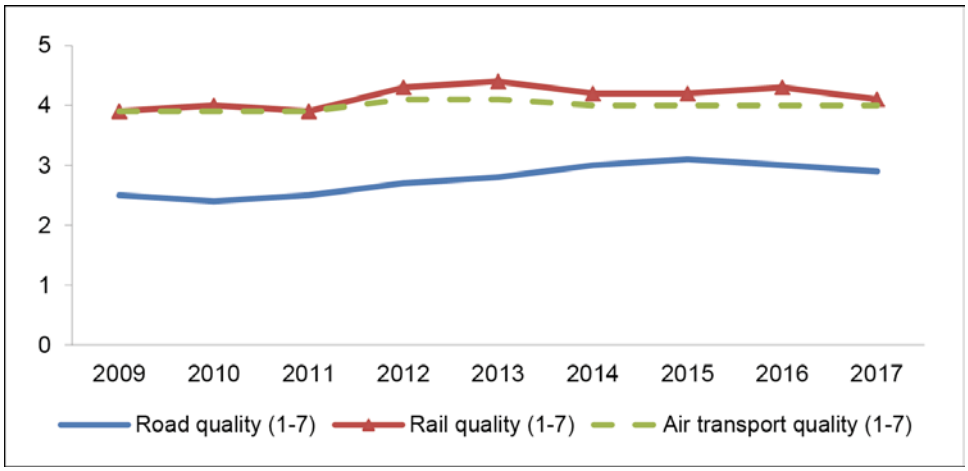
Annex Table 9: Air Transport Quantity Infrastructure Regression Outputs (Kyrgyz Republic and Tajikistan sample)

	Export				Import			
	Passengers Carried	***Freight***	***Number of Departures Worldwide***	***Available Seats***	***Passengers Carried***	***Freight***	***Number of Departures Worldwide***	***Available Seats***
GDP *(Trading partner countries)*	–1.6725 (1.5375)	0.2204 (2.4286)	–0.9891 (1.9392)	–0.7419 (1.3829)	–0.3736 (1.1828)	–0.2688 (1.0069)	–1.4878** (0.6830)	–0.6187* (0.3342)
Distance	–0.0013 (0.0015)	–0.0015 (0.0026)	–0.0011 (0.0019)	–0.0020 (0.0017)	–0.0006 (0.0009)	–0.0004 (0.0008)	–0.0007** (0.0003)	–0.0010 (0.0008)
Endowment	–2.3851** (1.0894)	–1.8832 (1.7403)	–2.0281 (1.3702)	–2.4058* (1.3411)	–0.7810 (0.4978)	–0.4453 (0.4005)	–0.8414** (0.3876)	–0.7432* (0.4411)
Border (1 = common border)	0.9057 (2.2018)	1.2657 (2.4762)	0.5404 (2.1633)	1.6783 (2.4065)	0.0456 (0.8050)	0.1910 (0.6875)	0.1396 (0.4904)	0.4981 (0.7352)
MRT	–0.0421 (12.9525)	–5.0242 (21.3791)	–0.1514 (15.5567)	–7.9210 (14.4878)	5.1988 (9.4480)	7.3226 (9.0827)	4.6969 (3.7729)	1.1518 (6.9825)
Infrastructure variables:								
Passengers carried *(Central Asian countries)*	–1.2135*** (0.3494)				0.1768 (0.5076)			
Passengers carried *(Trading partner countries)*	1.9430*** (0.3891)				1.0551* (0.5930)			
Freight *(Central Asian countries)*		–0.4007*** (0.1471)				0.0677 (0.0985)		
Freight *(Trading partner countries)*		0.3146** (0.1553)				0.5509 (0.3532)		
Number of departures worldwide *(Central Asian countries)*			1.0759** (0.4648)				–0.1669 (0.1821)	
Number of departures worldwide *(Trading partner countries)*			1.3111*** (0.4210)				2.2970*** (0.6553)	
Available seats *(Central Asian countries)*				–0.5704* (0.3377)				–0.0081 (0.2956)
Available seats *(Trading partner countries)*				1.7660*** (0.6702)				1.6470** (0.7513)
Constant	25.5183*** (8.9235)	16.4462 (10.7928)	2.7162 (6.0687)	35.3142** (14.2643)	–13.9919 (10.8134)	-5.0408 (9.4694)	3.1060 (5.9365)	11.2074 (15.6781)
Years	+	+	+	+	+	+	+	+
R2	0.4724	0.4109	0.4069	0.3535	0.7684	0.8068	0.8452	0.8709
N	297	297	297	297	216	216	216	216

Note: dependent variable – *exports*; all explanatory variables presented in logarithmic form. Clustered standard errors presented in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$.

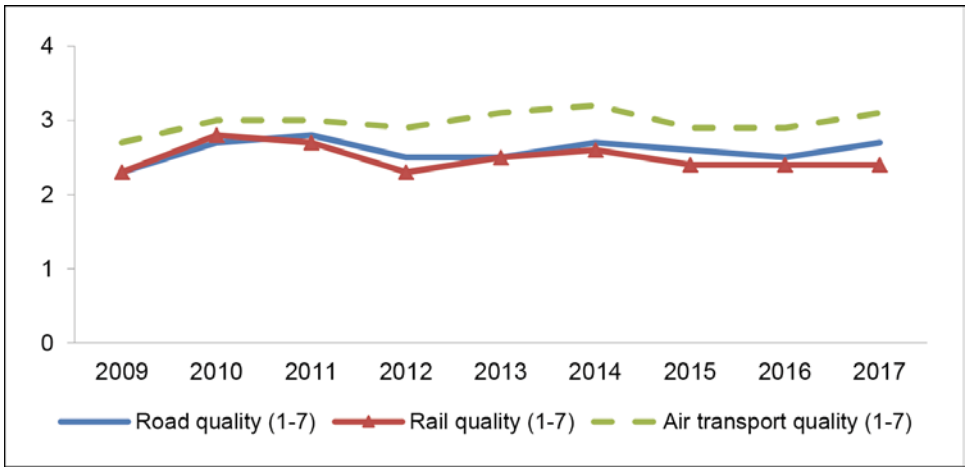
Source: Authors' calculations.

Figure A1: The Transport Quality of Kazakhstan



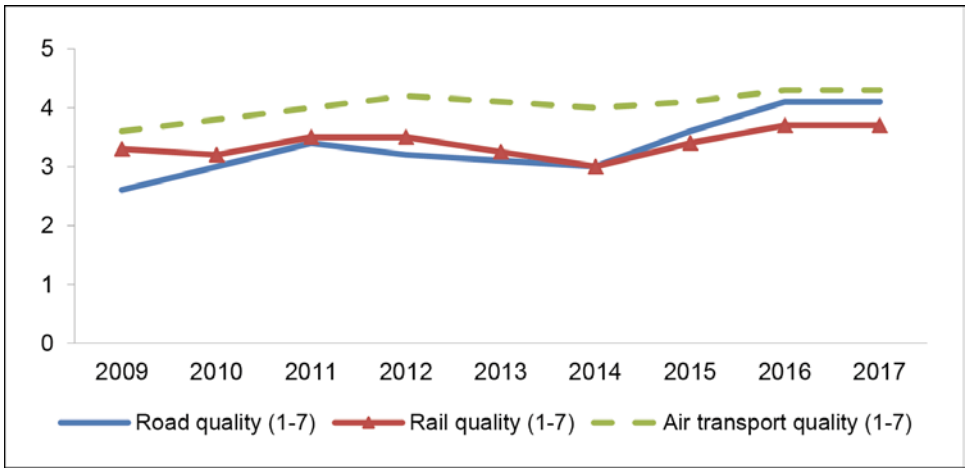
Source: Data collected from GCR.

Figure A2: The Transport Quality of Kyrgyz Republic



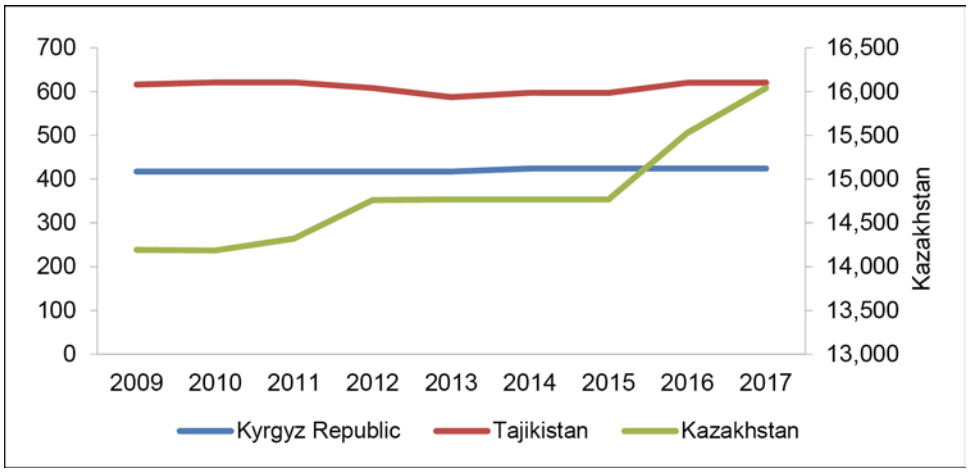
Source: Data collected from GCR.

Figure A3: The Transport Quality of Tajikistan



Source: Data collected from GCR.

Figure A4: Total Route of Rail Lines
(total route-km)



Source: WDI.