The role of **transportation infrastructure** in the **development** of **international tourism** in Uzbekistan

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Abstract | This paper analyzes the impact of the transport infrastructure for destination development and shows how it plays into the conventional demand for tourism at the level of international trade. An efficient transportation system and an adequate infrastructure are essential for the development of the tourism sector. Having a good transportation infrastructure result in less transportation cost, lower trading costs, and reducing travel distance, all of which contribute to the development of international tourism. Based on panel data from 22 countries trading with Uzbekistan during 2003–2019, the study examines bilateral tourism flows including transport infrastructure among other classical factors affecting foreign tourism. We have applied a gravity model to international tourism flows in order to control the role of infrastructure in various data sets as well as disaggregating the data sets by countries and time. It is evident from the results that Uzbekistan's foreign inbound tourism is strongly influenced by both direct and indirect transport infrastructure development. According to the findings, Uzbekistan can develop its tourism sector by strategically developing its transport infrastructure.

Keywords | Transport infrastructure, tourism, gravity model, Uzbekistan

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1. Introduction

In the current context, tourism contributes to the growth and development of countries in two ways: first, by bringing economic benefits and values, and second by contributing to the development of regional identity, brand image and value (Estol & Font, 2016; Manzoor, Wei, Asif, Haq & Rehman, 2019). The tourism sector is considered to be the main driver of regional economic growth in most of the country (Abdurakhmanova et al., 2021; Karimov et al., 2022), and contributing to peace and understanding among people and cultures (Martins & Costa, 2021). Accordingly, the World Travel and Tourism Council (WTTC, 2021) stated that tourism contributes significantly to the growth of income and the creation of jobs, both directly and indirectly by generating approximately 334 million jobs or 10.6% of all jobs, and USD 9.2 trillion or 10.4% of the global GDP with international visitor spending accounting for 27.4% of global services exports and 6.8% of total exports in 2019. In this regard, the tourism sector has become a prominent and growing sector of the international trade in services.

As the tourism industry develops, transportation infrastructure becomes increasingly important (Khadaroo & Seetanah, 2008; Masson & Petiot, 2009). Tourism destinations are easily accessible through transport infrastructure, and business activity increases in the region, raising local living standards. A number of scholars have found that transport infrastructure can be instrumental in promoting the development of new tourism sites as well as enhancing existing tourism activities (Musa & Ndawayo, 2011; Currie & Falconer, 2014; Virkar & Mallya, 2018). Furthermore, numerous studies have shown the existence of a strong relationship between transportation infrastructure and tourism development (Khadaroo & Seetanah, 2008; Liu et al., 2017), thereby increasing tourism patterns (Nazneen, et al., 2019; Kanwal et al., 2019).

With tourism being a form of international trade, gravity models are employed to examine the factors explaining tourism flows (Fourie & Santana-Gallego, 2011; Morley et al., 2014; Gołembski & Majewska, 2018; Habibi, 2017; Ulucak et al., 2020). It can be said that there have been several models developed that represent tourism flows, but most of them have been limited relevance when it comes to transportation. Consequently, Khadaroo & Seetanah (2008)'s study brings to light the fact that efficient transportation is an important part of any successful tourism development program, particularly to investigate the role of transportation in country-level destination development. In addition to reducing transportation costs, a better transport infrastructure can also facilitate shortened distances between destinations and origins, which can stimulate the growth of international tourism.

In recent centuries, Uzbekistan has been attracted by thousands of traders and invaders due to its location at the crossroads of the ancient Silk Road (Allaberganov & Preko, 2020). Samarkand, Bukhara, Khiva, and Shakhrisabz cities, all of which lie on the ancient Silk Road route, give Uzbekistan the most clearly defined and prestigious tourism image in the entire region. It has been reported by the State Committee of Statistics that the number of foreign citizens visiting the Republic of Uzbekistan increased 3.2 times from 2.6 million tourists in 2017 to 8.3 million tourists in 2019. The heart of Central Asia, Uzbekistan, is home to many fascinating historical sites and attractive exotic locations (Abdurakhmanova et al., 2021). Therefore, in theory, Uzbekistan is ideally positioned to become a top tourism destination in the future. Since the mid-1990s, it must be said that the infrastructure of the country's roads has been considerably improved and expanded. However, providing quality transport infrastructure is still being one of most challenging issues in many parts of the country (Safarov & Janzakov, 2021). Therefore, the government is taking steps to encourage investors in developing infrastructure and tourism,

which is vital to the overall tourism industry's development. These developments make Uzbekistan an interesting case where the impact of transport infrastructure can be studied in relation to regional arrivals. The paper accomplishes this by expanding demand for transportation infrastructure into the international tourism function.

Due to tourism being a form of international trade, an analysis of the factors influencing tourism flows is carried out using a gravity model. We model all sample countries as both tourist origins and Uzbekistan. The impact of transportation infrastructure on international tourism is studied for a panel of 22 countries (selected according to data availability and trade importance with Uzbekistan) over 2003–2019. There are two separate panel sets of data: those of the Commonwealth of Independent States (CIS), namely Azerbaijan, Kazakhstan, Kyrgyzstan, Russia, Tajikistan, Turkmenistan and Belarus; those of non-CIS countries, namely Afghanistan, China, Germany, France, Iran, India, Italy, Israel, Japan, South Korea, Spain, Turkey, Ukraine, United Kingdom, USA and in order to facilitate comparison of the determinants between countries, with an emphasis on transport infrastructure. Using this analysis, we can compare tourism flows' sensitivity to different determinants based on destination regions. Tourism in non-CIS countries is presumed to be influenced by factors different from those influencing tourism in CIS countries (Mirzaev & Janzakov, 2020). The aim of this article is to examine the factors influencing international tourism flows, including transport infrastructure among other classical factors affecting foreign tourism to Uzbekistan (such as common border and distance from tourism origin countries).

There are six sections in this research. The introduction takes up section one. An overview of the literature is presented in section two. A description of the database is presented in section three. Section four explains the econometric model. The results of the research are presented and discussed in Section five. As a final section, the study's conclusion is given along with its policy implications.

2. Literature Review

As a theme related to transport infrastructure in Uzbekistan, the scope of this research is to investigate the impacts of transport infrastructure development, mainly of roads, railways, and air, as well as other classical factors on international tourism development. This chapter reviews the literature on transport infrastructure development and tourism context by dividing into several groups: i) An overview of the relationship between transport infrastructure and tourism; ii) Impact of road and rail transport on tourism development; iii) Importance of air transport to tourism destinations, and iv) Related empirical studies to the topic.

Transport infrastructure and tourism. Several researchers have argued that transport infrastructure influences a country's attractiveness as a tourist destination (Inskeep, 1991; Lim, 1997; Eilat & Einav, 2004; Khadaroo & Seetanah, 2008; Cho, 2010; Martins et al., 2017; Permatasari & Padilla, 2020). For example, transportation infrastructure, which is the key to providing transportation services, is an essential factor in this regard. The contribution of the transportation network to successful tourism development has been acknowledged by Kaul (1985) who states that transportation is an important factor for attracting new investors as well as making existing ones more profitable. Providing transportation has transformed dead tourist attractions into active and prosperous destinations with a multitude of visitors. A precondition of tourism's development is the provision of adequate transport infrastructure, according to Chew (1987), Abeyratne (1993) and Prideaux (2000). For instance, Kurihara and Wu (2016) and Li et al. (2019) concluded that high-speed rail service

positively contributed to the growth of tourism in Japan and China, as the rapid transport system enables individuals to move between tourist destinations more easily.

Tourists from developed countries are more likely to take advantage of highly developed transport infrastructures. While traveling, these tourists prefer to maintain a similar level of comfort to that at home (Cohen, 1979; Mo et al., 1993). The possibility that tourists will seek alternative destinations may increase if they are hindered from traveling to their preferred destinations by inefficient transport systems, such as uncompetitive prices or long and discomforting journeys. Especially for high-class tourists, tourism resorts have been mentioned as essential sources of tourism. Prideaux (2000) argues that for high-quality resorts to be built in a country, adequate infrastructure (including transportation) is crucial. It is clear from the discussion above that transportation infrastructure is one of the major factors contributing to the attractiveness of a destination. In contrast, there have been few empirical studies to date on the importance of transportation infrastructure to the tourism industry's development.

Many tourism studies indicate that transport infrastructure and tourism are primarily discussed from the standpoint of accessibility, that is, transport plays a crucial role in connecting tourist-producing areas with tourist destinations. The development of various transport modes has been analyzed by some authors over the history of tourism (Dickman, 1994) whereas others (Christie & Morrison, 1985) have applied an interdisciplinary approach, including transportation as only one component constituting tourism. The role of transportation in tourism flows has also been studied, but to a much lesser extent. As an example, Lundgren (1982) considers transportation as a geographical phenomenon and analyzes flows of travelers between rural and urban locations.

Road and rail transport. For the tourism industry to develop, access to tourism destinations through road and rail transport infrastructure is vital, both in developing and developed countries (Azarmi et al., 2018). When it comes to road transport, there are many advantages to road travel, including convenience, accessibility, luggage restrictions, flexibility, affordability, and a wide range of choices (Kanwal et al., 2020). As well as, when traveling long distances or across medium distances, rail transport may also be preferable due to its affordability and convenience. Essentially, the rail system offers tourists an alternative to driving in urban areas, which reduces traffic congestion and parking difficulties that can be encountered there (Bazin et al., 2011). Having insufficient transportation infrastructure will make it difficult to enjoy a location. Additionally, improved transport infrastructure reduces travel costs and time (Kanwal et al., 2019). Previous studies have shown that modes of transportation like trains, roads, and air can positively influence tourism demand (Masson & Petiot, 2009; Kurihara & Wu, 2016; Li et al., 2019). It is suggested by tourism researchers and scholars that tourists from developed countries with sophisticated transportation systems desire to experience the same facilities at home (Mo et al., 1993). Additionally, in cases of poor road and rail transportation infrastructure, high travel prices, and inconvenient travel conditions, even tourists who wish to visit will seek out alternative tourist destinations. Hence, better transport infrastructure is a necessary factor in predicting tourism activity (Khadaroo & Seetanah, 2008). Road and rail transport are potential factors in tourism development, based on the above discussion. The literature, however, does not include many research studies on the importance of road and rail transport in expanding tourism and, therefore, this study fills a gap.

Air transport. As one of the most efficient forms of transportation for promoting economic growth, air transport dominates due to its speed (Bieger & Wittmer, 2006), service quality (Spasojevic et al., 2018), high security and safety (Yang

& Zhang, 2019), and large generators of jobs (Benítez & Dogra, 2022). Specially, taking the plane is convenient way for tourists to travel long distances. In addition, it allows tourists to reach areas that are difficult to reach via alternative modes of transportation, such as islands and mountains (Yang & Zhang, 2019). The emergence of new business models (such as low-cost air carriers) and advancements in technology continue to reduce the costs associated with air transportation, spurring more international tourism (Teles & Sarmento, 2012). Air transport reduces travel time to tourism destinations, enabling tourists to spend more time at each destination (Yang & Stienmetz, 2018). Many studies have noted a significant relationship between air transport and tourism; for example, Costa et al. (2017) found that there was a high positive correlation between air traffic at Oporto airport and the number of international tourists visiting the northern region of Portugal. According to Tveteras and Roll (2014), the growth of non-stop flights could be key to a rise in Peruvian tourism. Similarly, Yang & Zhang (2019) concluded that connectivity between Chinese cities through air transport affected tourist flow significantly. The importance of air transport to tourism development cannot be understated, there can be no doubt that air travel is an important component of tourism development, particularly since the cost of air travel is declining. Using a model developed by Bieger and Wittmer (2006), policymakers in airline destinations can draw useful conclusions about the impact of air transport on tourism growth. Because of their heavy dependence on each other, they suggested that airlines and tourism destinations form a win–win relationship. It is still relevant to policymakers today and should be taken into serious consideration.

Empirical Studies. Several empirical studies have investigated the importance of transport infrastructure to the attractiveness of a destination based on the analysis of survey data. In particular, Kozak and Rimmington (1999) illustrated

this point in Turkey, while McElroy (2003) did so for 51 islands and emphasized the significance of government-financed infrastructure to the success of a destination. In addition to survey analysis, some studies estimate international tourism demand using an equation. In empirical work conducted by Eilat and Einav (2004), Naudé and Saayman (2005), panel data regression is used to examine factors affecting tourism flows within African countries. Among the classical factors, these authors also cite the availability of infrastructure. Nevertheless, they concentrate exclusively on the factor of tourism infrastructure. Eilat and Einav (2004) investigated factors that influence bilateral tourism over time using a gravity model. In their study, they found that several factors affect tourism, such as destination risk, exchange rates, price elasticities, common languages, and common borders. Using a gravity equation, Gil-Pareja et al. (2007) investigate how embassies and a common currency affect tourism. Gazoni et al. (2017) analyze the relationship between transport and tourism in Brazil, a cross-section of the results indicates a high correlation between transport supply and tourism demand using Principal Component Analysis, which was found to be the most appropriate for the study. The impact of mega events on international tourism was estimated using gravity model by Fourie and Santana-Gallego (2011). Neumayer (2010) applied a gravity model to analyze international tourism flow dynamics in light of visa restrictions. According to Vietze (2012), there is a significant impact of religious affiliation on tourist arrivals in the U.S. As well, Massidda and Etzo (2012) examine the influence of different determinants such as crime rates, cultural activities, spending, and price differences within the Italian domestic tourism sector.

The importance of efficient transport as part of a successful tourism development program is widely acknowledged, but studies of the impact of transportation in tourism development have been sparse. Past studies have investigated the rela-

tionship between tourism development and economic growth using different methodologies (Estol & Font, 2016; Calero & Turner, 2020; Cheng & Zhang, 2020; Navarro-Martínez et al., 2020). There has been relatively little attention given to the development of transportation infrastructure in relation to tourism (Nazneen et al., 2019). With respect to this important research gap, the purpose of the present study is twofold. First, it examines the relationship between transportation infrastructure and total tourists. Secondly, it analyzes the mechanisms underlying this relationship with several determinants. The findings of this study contribute significantly to the tourism literature. This study employs a gravity model to analyze the relationship between transport infrastructure and tourism determinate in international trade. In addition, this study explores how infrastructure development can enable tourism to thrive through both positive and negative means. Lastly, tourism policy implications can be drawn from the study for countries in Central Asia and CIS. Furthermore, in developing economies such as Uzbekistan, an analysis of the role of transport infrastructure using a gravity model has only been limited to the nonexistent. The aim of this study is to investigate such an issue by employing a panel data estimation technique of gravity model, with the expectation that the findings will contribute to existing literature and serve as a valuable reference for developing countries.

3. Data

The study examines bilateral tourism flows across countries influenced by a variety of variables based on panel data from 2003 to 2019. Therefore, we will divide the whole time-period into two phases, i.e., before and after an economic reform of Uzbekistan (currency rate, inflation rate, etc.) in 2016 (respectively 2003–2015 and 2016–2019) to test whether the results are influenced by the impact of transport infrastructure in gravity model. Further, we have disaggregated the data into two subgroups based on the countries in each group (CIS and non-CIS). Furthermore, we have chosen 22 countries:

- Those of seven CIS countries, namely Azerbaijan, Kazakhstan, Kyrgyzstan, Russia, Tajikistan, Turkmenistan, and Belarus.

- Those of fifteen non-CIS countries, namely Afghanistan, China, Germany, France, Iran, India, Italy, Israel, Japan, South Korea, Spain, Turkey, Ukraine, United Kingdom, USA.

Uzbekistan is a country in Central Asia with a total area of 449,000 km2 and a population of 32,981,716 in 2019 (Statistical Committee of Uzbekistan, 2021) that is located on the map shown in figure 1. Republic of Uzbekistan is divided into 12 administrative regions, 1 autonomous republic, and 1 independent city. In alphabetical order, these regions are: Andijan, Buxoro, Fergana, Jizzax, Namangan, Navoiy, Qashqadaryo, Samarkand, Sirdaryo, Surxondaryo, Tashkent, and Xorazm; along with the autonomous republic of Karakalpakstan and the independent city of Tashkent. The country's borders are with Kazakhstan in the north, Kyrgyzstan and Tajikistan in the east, Turkmenistan in the southeast, and Afghanistan in the south. There is a diversity of countries included in this study. Some are bordering, while others are far away. They have different economies and are at different stages of development. By analyzing Afghanistan and the USA together, for instance, the significance of the analysis and its conclusions can be reduced. It may also be difficult to provide development strategies for a country when different stages of economies are placed together in the same group. As the main reason for selecting these countries for the study, each is considered to have the highest numbers of international tourist flows as well as non-zero exports and imports to Uzbekistan. Moreover, unless we count CIS countries, the largest number of tourists are visited from the de-

veloped economies such as Germany, France, Italy, Israel, Japan, South Korea, United Kingdom, and USA, and increasing year by year. Many tourists come from China, India, Iran, Turkey, and Ukraine, as well as being Uzbekistan's top exporter and importer aside from the CIS countries.

Figure 1 | Map of Uzbekistan

Furthermore, as Uzbekistan is a double-landlocked country, it must integrate economically with neighboring countries, such as Kazakhstan, Turkmenistan, Kyrgyzstan, and Afghanistan. In fact, most tourists in 2019 came from Kazakhstan, Tajikistan, and Kyrgyzstan (Statistical Committee of Uzbekistan, 2021). Although not many tourists come from Afghanistan, it is a neighbor of Uzbekistan and probably one of the future's most important partners. Additionally, Uzbekistan government has also made agreements with Afghanistan and Pakistan governments for crossing their territory to be able to reach the sea and collaborate with China and South Asian countries via train and road (Yusufkhonov et al., 2022). In this regard, it may be possible in the future to increase volume of foreign trade and the number of tourists along the Afghanistan corridor. There are, however, still several issues that need to be solved, including different lack of finance and inadequacies in travel and commerce security.

Table 1 summarizes the dependent variable as well as key independent variables. To analyze the impact of the overall transport infrastructure on tourism, two different variables are included, specifically the length of roadways, railroad lines and waterways based on the country's size (roadrw), the total number of international destinations in international airports having non-stop passenger flights from Uzbekistan (air). It can be said that transportation infrastructure and tourism infrastructure played an important role together. In fact, it is more evident when considering developed continent destinations that have invested heavily in effective transport infrastructure to accommodate high levels of tourist traffic. Several factors contribute to tourism, including the distance between countries, the language spoken in the country, the transit route, and the level of infrastructure. Uzbekistan's transport infrastructure plays a particularly important role among the variables that were cited in literature as explanations of the ef-

fect of travel. In addition to the development of the existing infrastructure which consists of expanding motorways and expressways, there are a number of attractive factors for the destination country which include Uzbekistan's connectivity to the Central Asia network. Further, since Uzbekistan is a double-landlocked country, air transport is essential for the tourism sector. Indeed, there are many conveniences, reliability, and fast services offered by air transportation. As well as determining cost, these factors impact how the destination country is perceived to be attractive by tourists from the country of origin.

Table 1 | Summary of variables used in the model

Variable	Measure	Description	Data source
TA_{ij}	Tourism arrivals	Number of tourists arriving in Uzbekistan each year from country i;	World Tourism Organization
ROADRW	Transport infrastructure for roadways, railroad lines and waterways	Kilometers of roadways, railroad lines, and waterways in destination country (Uzbekistan)	Tourism Satellite Accounts (TSA)
AIR	Transport infrastructure for air transport	Number of international destinations having non-stop flights from Uzbekistan	Uzbekistan Airports JSC
TOURINF	Tourism infrastructure	Total number of hotel rooms in Uzbekistan	Tourism Satellite Accounts (TSA)
GDPUZB	Income per capita of Uzbekistan	Average per capita income of Uzbekistan (in US dollars)	World Bank
EXP_{ij}	Export from Uzbekistan to country i	The value of goods exported from Uzbekistan to country i	International Monetary Fund
DIS_{ij}	Distance	Distance between capital cities of the origin and destination countries, measured in kilometers (Uzbekistan)	Google Map
BOR_{ij}	Common border	Dummy that takes the value 1 if the origin and destination countries share borders, otherwise it takes the value 0.	Google Map
$LANG_{ij}$	Common Language	A language that are commonly understood between international tourists and local residents in Uzbekistan	Organization of Turkic States

Source: Own elaboration

We have also included the classical determinants of foreign inbound tourism in our gravity model, such as distance between the destinations and origin countries as determined by the length of the distance between the capital cities of these countries. As the distance increases, so does the airfare as well as the level of discomfort and the opportunity cost which could adversely affect arrivals. The distance between two countries (DIS) is measured in air kilometers. In view of the difficulty of collecting appropriate quantitative data (e.g., transportation costs, services, prices, and sales), these variables were chosen over others.

The empirically relevant variables that are included in the model are outlined in Table 2, which provides a descriptive statistic of those variables. In total, there are 255 observations and 8 variables, which are tourist arrivals as a dependent variable, and roads (including railway and waterway), air transport, Gross domestic Product of Uzbekistan, bilateral exports of Uzbekistan with the countries included in the study, distance between Uzbekistan and the origin countries are independent variables, furthermore, border and language dummies are added to the dataset. We get logarithmic form of all variables to get precise and accurate results. The standard deviation is a crucial measurement that may be used to analyze spread or dispersion. It provides an indication of how much, on average, the findings deviate from the mean. When the standard deviation of a set of numbers is large, it indicates that the data are dispersed in a less-than-reliable manner, but when it's low, it indicates that the numbers are tightly packed (more reliable). According to the results of Table 2, the standard deviation of several variables,

namely tourist arrivals, exports, border, and language dummies, have greater value compared to mean of those variables. According to the statements which are above-mentioned, it may create an unreliable result if we analyze. That is why all variables under the study are converted to logarithmic form to get reliable and precise results after empirical analysis.

Table 2 | Main descriptive statistics

Variable	Obs	Mean	Std. dev.	Min	Max
ta	255	8486.272	12106.11	239	74802
roadrw	255	43226.41	21728.69	18600	92600
air	255	49.59608	11.31778	34	69
gdpuzb	255	1524.559	742.9692	396.4	2615
exp	255	327.5035	637.0665	.1	5044.6
dis	255	4444.667	2361.232	1579	11537
bor	255	.0666667	.2499344	0	1
lang	255	.0666667	.2499344	0	1

Source: Computed by Stata 17.0

In particular, the rich set of data provides further opportunities for further disaggregation into tourism flows from different continents for comparing and analyzing in greater detail. As an example, this analysis can be used to compare tourist behavior with respect to transportation between countries on different continents. There is a hypothesis that the determinant of tourism flows to high-standard of living destinations may differ from those of low-standard of living destinations (Jenkins, 1980). Jenkins (1980) identifies that a lack of transport services may pose a problem for developing countries, which influence total tourism demand. There is no doubt that the relationship between trade and tourism arrivals can be highly positive. Most scholars agree with the idea that bigger countries are most likely to trade more (Kulendran & Wilson, 2000; Prideaux, 2000; Silva & Tenreyro, 2006; Khadaroo & Seetanah, 2008). On the other hand, the distance between country pairs tends to negatively correlate with tourism arrivals: farther distances between countries result in fewer tourists arriving.

4. Model

Based on panel data collected from 22 countries being the most active in terms of international tourism flows to and having non-zero exports and imports to Uzbekistan, the study examined bilateral tourism flows in 2003-2019. To study the impact of transport infrastructure in various data sets, a gravity model for international tourism flows will be applied by employing four sub-panels (divided by countries and time).

Using the gravity concept of Isard (1954) in international economics, we can express the general formula as follows:

$$F_{ij} = g\,\frac{m_i m_j}{d_{ij}^2},$$

This formula represents the gravitational force (trade flow) which F_{ij} is the gravitational force between two objects (countries) i and j; m_i and m_j indicate the countries' masses (economic sizes); d_{ij} is the distance between them; and g is the gravitational constant representing the other variables that influence cooperation between countries. It can be stated simply that the gravity theory of trade flows is the following: the distance between the countries affects the volume of trade between them in inverse proportion to the economy's size.

It is important to point out that one of the most successful empirical models in economics is gravity, which is remarkably effective at explaining the vast variations in economic relationships across space, both in terms of trade flows and factors of production. There is no doubt that gravity is at work in the vast empirical literature based on the good fit of the coefficient estimates and the relatively tight clustering of coefficient estimates, but without direct relevance to economic theory, some economists ignored it.

There is a widespread use of the gravity model framework in the economic literature in order to analyze patterns of international trade, capital flows, and tourist movements (Tinbergen, 1962;

Anderson & van Wincoop, 2003; Bergstrand & Egger, 2007; Gil-Pareja et al., 2007; Morley et al., 2014). It is generally accepted that bilateral trade between two countries has a tendency to increase with an upward trend in per capita income and to decline with the increase in transport costs as indicated by a measurement of the physical distance between them. Based on the theory, we can formulate a simple gravity model in which tourists traveling between two countries towards one another are determined by the economic size of the countries and their geographical distance from each other.

The regression specification in equation is written as a log-linear model:

$$tr_{it} = \beta_0 + \beta_1 relative_{it} + \beta_2 gdpf_{it} + \beta_3 room_{it} + \beta_4 dist_{it} + \beta_5 trans_{it} + \beta_6 nontrans_{it} + \varepsilon_{it}$$

A natural logarithm is represented by lowercase letters, which indicate that the variables are in natural logarithm form. It is implicitly assumed that the elasticity of tourists with respect to the different explanatory variables is constant over time when using a log-linear model. To identify the determinants of arrivals into the country, both static and dynamic techniques (generalized methods of moments) are employed. With panel data, dynamic relationships can be explored as well as unobserved cross-country heterogeneity.

Our specification, based on Silva and Tenreyro's (2006) gravity model, takes the following form:

$$lnTA_{ijt} = \beta + \alpha lnROADRW_{jt} + \delta lnAIR_{jt} + \gamma lnTOURINF_{jt} + \vartheta lnGDPUZB_{jt} + \eta lnEXP_{ij} + \varepsilon lnDIS_{ij} + \eta_i + \varphi_j + \mu_t + \varepsilon_{ijt}$$

in which TA_{ij} indicates the number of international tourists between countries i(origin) and j(destination); ROADRW and AIR are transport infrastructure for road, rail, water and air transports respectively while TOURINF is tourism infrastructure, GDPUZB is a measure of per capita income in Uzbekistan, EXP_{ij} is the value of goods exported from Uzbekistan to country i, DIS_{ij} is the geographic distance between countries i(origin)

and j(destination); the η_i, ϕ_j and μ_t coefficients represent the country fixed effects accounting for all time-invariant determinants in origin and destination country and the time fixed effects accounting for common shocks in a given year that might have an impact on international tourism across all countries, respectively. ϵ_{ijt} denotes an idiosyncratic error term that is consistent with zero mean and constant variance assumptions.

Particularly, the study was adopted by a panel data of transport infrastructure and other classic factors on international tourism growth. We specified ln_ta (log of international tourist arrivals as a dependent variable, and ln_roadrw (log of kilometers of roadways, railroad lines, and waterways, ln_air (log of number of international destinations having non-stop flights from Uzbekistan), ln_tourinf (log of total number of hotel rooms), ln_gdpuzb (log of average per capita income, ln_exp(log of the value of goods exported from Uzbekistan to country i, and ln_dis (log of distance between capital cities of the origin and destination countries) as independent variables.

Due to the fact that most gravity models are estimated using cross-sectional data, it is likely to produce biased results on the basis of a possible relationship between explanatory variables and unobservable country characteristics, as it does not take heterogeneity into consideration. It is possible to address these econometric concerns using panel data estimations by accounting for country and time fixed effects (Bergstrand & Egger, 2007).

5. Results and Discussion

The dataset includes 22 countries (Afghanistan, Azerbaijan, China, Germany, France, Italy, Israel, Iran, India, Japan, Kazakhstan, Kyrgyzstan, Russia, South Korea, Tajikistan, Turkey, Turkmenistan, United Kingdom, Ukraine, USA, Belarus, Belarus and Spain) all of these countries participa-

ting in as origin countries for Uzbekistan, and the period under study is 2003–2019.

The results of the estimation of a gravity model are presented in Table 3. Based on the results, several statistically significant relationships have been identified. An important point to emphasize is that the degree of fit of the variables to the model was highly satisfactory. There are two different panel models that are estimated here for various time periods: (1) the first panel model that covers the years 2003 to 2015, (2) and the second panel model covering the years 2016 to 2019. As can be seen in table 3, the results of these two estimations are presented.

Table 3 | Panel data estimation: period 2003–2015 and 2016–2019

Independent	Dependent (ln_ta) 2003-2015			Dependent (ln_ta) 2016-2019		
	Coeff.	T	P>|t|	Coeff.	T	P>|t|
ln_roadrw	0.3895723**	0.70	0.018	0.3938423**	0.71	0.017
ln_air	0.2864475*	2.63	0.014	0.4323524**	5.19	0.003
ln_tourinf	-	-	-	-	-	-
ln_gdpuzb	0.2358941**	-0.51	0.033	-	-	-
ln_exp	0.2936525**	11.85	0.000	0.3922594*	5.86	0.000
ln_dis	-0.864897**	-8.31	0.000	-0.8347981*	-3.51	0.001
bor	-	-	-	-	-	-
Lang	0.5148256**	2.88	0.004	0.3165871**	0.81	0.019
Constant	2.154752*	0.82	0.416	12.149568**	1.14	0.299
Obs. (n)	308			66		
R^2	0.8392			0.8558		
Adjusted R^2	0.8453			0.8279		

Note: *Significant at 5%. **Significant at 1%.
The blank "-" means that the estimate is not statistically significant.
Source: Computed by Stata 17.0

Though there are some estimates which is not statistically significant, the results of the study show number of interesting features. As a first point, it is noteworthy that the model fits the data reasonably well: their R2 is more than 0.8392, which means that nearly 84% of the observed variation in the data can be accounted for by the explanatory variables. According to our study, this figure is likely to increase as more variables are added to the model. Besides distance, it can be said that we also have added a dummy variable with a value of unity for those countries that are bordered with Uzbekistan (bor) as well as another dummy variable with a value of unity for those countries that have a common language (lang). Each of these factors can sometimes affect trade flows significantly, as evidenced by gravity model literature because these factors have the potential to lead to increases or decreases in the costs associated with international trade.

To discuss the results of the model further, it is necessary to examine the estimated coefficients and their corresponding t-tests in more detail. With regards to tourism arrivals first, the results

show that transportation infrastructure for road, rail and waterways, and tourism arrivals are positively associated: an increase of 1% in transportation infrastructure leads to an increase of 0.39% in tourism arrivals, and the result is statistically significant. It is interesting to note that the coefficients of air transport are different during the given years. In the period 2003-2015, the coefficient was approximately 0.29, but from 2016-2019, it increased to over 0.43. In other words, there is a positive correlation between air transport and tourism arrivals: an increase in transportation infrastructure may result in an increase of 0.43% in tourism arrivals between 2019 and 2019. It can be suggested that tourism and transport infrastructure can be affected by Uzbekistan's economic reform in 2016. In this regard, it is evident that transportation plays a significant role in determining the success of the tourism industry in Uzbekistan. Tourists will find it harder to visit a destination without a way to get to or travel within it (Prideaux, 2000). It is possible to increase the efficiency of tourism arrivals by developing a higher level of transport infrastructure. Due to the significant contribution made by tourism and transportation infrastructure to economic growth in Uzbekistan, the findings of this study are relevant to policy debates on how transportation infrastructure affects tourism-driven economic development. It is crucial for the development and expansion of the tourism industry that transportation facilities are developed (Massidda & Etzo, 2012). It is important to develop infrastructure for the tourism industry to grow, particularly transportation infrastructure.

Moreover, we found a significant positive correlation (0.347*) between the number of foreign tourists arriving in Uzbekistan and the GDP per capita of Uzbekistan during the period 2003-2016, which would confirm that there is a positive correlation between yearly tourism growth and GDP in Uzbekistan, which means that tourism offers great opportunities for emerging economies and developing countries. As a result, tourism-led growth

hypothesis, the development of a country's tourism industry will boost economic growth, which in turn will lead to further economic growth via multipliers and spillovers, is supported. Further, it is necessary to recognize that the variable determining the value of exports from Uzbekistan should play an important role. This variable was strongly correlated with the number of foreign tourists arriving in Uzbekistan both during the period 2003 to 2015 (0.293**) as well as during the period 2016 to 2019 (0.392**). The results support that there is a causal association between exports to origin countries and tourists arriving from those countries in relation to economic cycle. It was confirmed in the study that an increase in international inbound tourism to Uzbekistan enhanced the chance of trade relations being established and contributed to the growth of exports between trading partners (Kulendran & Wilson, 2000).

Meanwhile, the distance between the capital cities of the country of origin and destination was also examined, measured in kilometers. In line with expectations, there was a negative correlation. Overall, this was evident over all time periods examined, but was especially evident for the first sub-period (2003-2015), which showed a coefficient of −0.864**. During that time, distance and travel cost played an important role in determining destination country choice. An indirect measure of transport infrastructure development would be the lessening of the inverse dependency between tourist arrivals and geographic distance, making it possible to reduce geographic distance with good infrastructure. Specifically, reducing a cost and improving facilities of international airports can promote tourists to visit a destination and minimize difficulties related to geographic distance. With a case of Uzbekistan, the government should reduce basic fees and tariffs for aircrafts of foreign airlines and take steps to eliminate monopoly in the sphere of aviation (Khalikov et al., 2021).

In addition, three panel models were estimated for the entire period (2003-2019) and dis-

tinguishing between CIS and non-CIS countries (Table 4).

Several statistically significant relationships are revealed in Table 4. It is important to emphasize that the model fit the variables very well despite of statistically insignificant estimates. In the case of CIS member countries, the fit rate was 0.8819, while for non-CIS countries, it was 0.8326. Meanwhile, it should be noted that absence of association between the explanatory variables and the dependent variable is also a factor that can lead to interesting results. Based on the results of the study, the relationship between the variables in CIS countries gets slightly higher than in non-CIS Counties. Certainly, Uzbekistan's economy has become closely integrated with the CIS Countries. It must be said that there is high correlation between tourism arrivals and common languages for all countries including CIS and non-CIS countries with 0.47 coefficient. The following should be noted that the coefficients between air and other modes of transportation are quite distinctive when

it comes to CIS and non-CIS countries. Specifically, the coefficient of CIS countries for road, rail and waterways are higher compared to non-CIS countries (0.35 and 0.29 respectively), and vice versa for air transport (0.31 and 0.39 respectively). In fact, non-CIS countries are more likely to have access to air transport than CIS countries, while CIS countries are more likely to have access to roads, rails, and waterways. In fact, most of CIS countries are neighbors of Uzbekistan and it is possible to get by roads or railways for other CIS countries that is not a neighbor. Consequently, it is plausible that a common language is adversely affecting international tourist arrivals due to cultural proximity. It not only reduces tourism transaction costs, but also provides tourists with a sense of comfort and enthusiasm when they travel to destinations with a common language. Due to this, the promotion of the cultural heritage of the destination country should be part of any efforts designed to attract international tourists.

Table 4 | Panel data estimation for the CIS and not CIS member countries

Independent	Dependent (ln_ta) All Counties		Dependent (ln_ta) CIS member Countries		Dependent (ln_ta) Not CIS member Counties	
	Coeff.	T	Coeff.	T	Coeff.	T
ln_roadrw	0.3169853*	0.67	0.3496582**	0.36	0.2925691**	0.71
ln_air	0.36387411**	2.81	0.3138417*	5.68	0.3892462**	0.67
ln_tourinf	-	-	-	-	-	-
ln_gdpuzb	0.2522841**	1.48	0.2736854**	-0.36	0.2414259*	2.53
ln_exp	0.3335254**	13.58	0.3398547**	5.26	0.2989473*	13.18
ln_dis	-0.861557*	. -8.56	-	-	-0.622549**	-3.51
bor	-	-	-	-	-	-
lang	0.472139**	3.49	-	-	0.3241364*	7.41
Constant	4.925843*	3.84	22.425**	7.25	2.36958**	1.71
Obs. (n)	374		118		255	
R^2	0.8536		0.8819		0.8326	
Adjusted R^2	0.8498		0.8726		0.8328	

Note: *Significant at 5%. **Significant at 1%. The blank "-" means that the estimate is not statistically significant. Source: Computed by Stata 17.0

The gravity model analyzes flows between multiple origins and destinations, and can be applied to cross-sectional data (i.e., one time period). A panel data analysis is appropriate when the data span more than one time-period (Kulendran & Wilson,

2000). In consumer economics based modeling, origins and destinations are generally considered in pairs (and usually one pair at a time), but time series data is used for longer periods of time. It is important to allow for clustering by country pair

in gravity model contexts, as errors are likely to be correlated by country pair. For this purpose, a clustering variable must be specified that identifies each pair of countries independently of the direction of trade. Distance, for instance, is unique to each pair of countries, but it is the same in both directions.

It is interesting to note that a summary of the results reveals that transportation infrastructure may have played a significant role in tourism, along with tourism infrastructure and other classical determinants.

6. Conclusion

Our study has presented a new approach to modeling international tourism flows between Uzbekistan and other countries involved in international trade by including transport infrastructure as a driving factor of the intensity of tourism flows according to a methodology that has not been previously used. Considering the above points, it should be noted that the gravity model of Uzbekistan's tourism flows highlights the importance of transport infrastructure, especially transportation by road and rail, to the development of tourism in the country. As well as playing a direct role, the transport infrastructure also plays an indirect role. A decline in the inverse dependence between tourist arrivals and geographic distance is an indication of this in the direct sense. Essentially, in these circumstances, it is easier for the traveler to get to remote attractions offered by the destination country, as the distance between the origin and the destination is "shortened" by the development of transport infrastructure (reginal airports, railways and roadways). As a direct result, there has also been a high increase in the number of tourists arriving from non-CIS counties (China, Turkey, USA or South Korea). Indirectly, improvements in transportation infrastructure have been proven to have a positive effect on the growth of Uzbekistan exports. This growth is closely associated with foreign tourist arrivals of Uzbekistan. It can generally be said that the development of the transportation infrastructure is an important factor in promoting the growth of export, which is at the same time associated with the growth of foreign tourists.

In addition, we determined policy implications based on the study's results. In view of the strong positive relationship between the development of transportation infrastructure and the development of tourism, as well as the relationship between commodity exports and the development of tourism, it has been recommended that transportation policies be incorporated into tourism planning as part of the overall strategy. For tourism and transportation planning to be effective, it is essential that a broad range of concerns are included to enable policy makers to develop a sustainable and integrated transportation system from a social, economic, and environmental perspectives (Khadaroo & Seetanah, 2008). Therefore, in terms of policy implications, the Uzbekistan government should incorporate transport policies more directly into tourism planning, particularly since the country's infrastructure is less competitive than its neighbors. It may not be enough to invest in marketing efforts, tourism infrastructure, and liberalizing air access if they are not accompanied by an efficient transportation infrastructure supporting those efforts. Hence, there should be an explicit focus on strategic long-term planning and measurable requirements from the government and local policymakers. Importantly, current projects and work in progress look positive and are likely to increase the country's attractiveness to tourists. Moreover, as transportation infrastructure develops rapidly and tourist travel directions become more widespread (considering the modes of transportation, as well as other push and pull factors of destination countries and origin countries), it is essential to develop appropriate promotional strategies for markets that attract foreign tourists. Gravity models for

tourism may be useful in this matter since they include the transportation infrastructure that has not previously been considered when managing Uzbekistan's tourism.

The study has been conducted with the aim of focusing on the entire country of Uzbekistan and its transport infrastructure' role on tourism sector. In this regard, it is essential to acknowledge several limitations. Initially, one limitation is the diversity of countries that differ in their economies, stages of development and proximity, socio-economic realities, some bordering, others distant. There is a possibility that putting low-income countries as well as high-income countries together in the same analysis will remove any relevance to the analysis and its conclusions. Second, comparing different data sets can be a limitation of the study. Moreover, the processing of data through different realities on the same level may be less biased because of affecting the assumption of the results. Another limitation of the study is environmental pollution of transportations and the low level of road and safety, which leads to major economic and social problems as well as threats to tourism development. The study also can have a limitation by analyzing Uzbekistan as a whole. There may be differences between current conditions in different regions or in the main touristic cities. To gain a deeper understanding of the relationship between transport and tourism in Uzbekistan and the sector's development, it is important to conduct future research on transport and tourism in each country's regions and main touristic cities.

As a gravity model of tourism flows for Uzbekistan has been presented, further research should be conducted to validate the model under changing circumstances of the international economy, for example, by comparing results with gravity models from other countries. It is also important to mention that such modeling allows for a deeper examination of the often-underestimated relationship between exports and international tourism, which should be further explored.

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