EFFECTS OF TRANSPORTATION INFRASTRUCTURE ON ECONOMIC GROWTH IN AZERBAIJAN: ARDL BOUNDS TESTING APPROACH

NIJAT MAHMUDOV

Azerbaijan State University of Economics (UNEC)

E-mail: mahmudov.nicat@gmail.com

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ABSTRACT

Transportation infrastructure is a crucial component of any economy, as it enables the movement of goods and people, thereby facilitating trade and economic activity. This article investigates the impact of transportation infrastructure on economic growth in Azerbaijan using the ARDL bounds testing approach to estimate the relationships between the variables. The article uses annual time series data from 2000 to 2020 on variables such as real GDP, investment on transport infrastructure and freight turnover. The results show that transportation infrastructure has a significant positive impact on economic growth in Azerbaijan in the long run. Specifically, a 1% increase in investment on transport infrastructure leads to a 0.47% increase in real GDP in the long run, indicating that transportation infrastructure plays a vital role in promoting economic growth in Azerbaijan.The findings of this study have important policy implications for Azerbaijan. Investments in transportation infrastructure should be prioritized to ensure that the country's infrastructure is of high quality and meets the needs of the growing economy. This study contributes to the literature on the relationship between transportation infrastructure and economic growth and provides insights that can inform policy decisions in Azerbaijan and other developing countries facing similar challenges.

Keywords: Transportation infrastructure, economic growth, ARDL bounds testing, economic activity, investment.

JEL Classification: R40, O18, H54

INTRODUCTION

Transportation infrastructure is a critical component of economic development, enabling the efficient movement of people, goods, and services across regions and countries. The relationship between transportation infrastructure and economic growth is complex and multifaceted. In Azerbaijan, transportation infrastructure has been a key driver of economic growth, facilitating the movement of goods and people across the country and connecting Azerbaijan to the global economy.

Azerbaijan's strategic location at the crossroads of Europe and Asia has made it an important hub for trade and investment. The country's economy is heavily reliant on the oil and gas industry, which accounts for a significant portion of its GDP. However, Azerbaijan has been working to diversify its economy and reduce its reliance on oil and gas. To achieve this, the country has invested heavily in transportation infrastructure, including the construction of new highways, airports, and railways.

Improved transportation infrastructure can have a range of positive effects on economic growth. One of the most significant benefits is the reduction of transaction costs. A well-developed transportation network enables people and goods to move quickly and efficiently, reducing the time and money required for business transactions. This, in turn, makes it easier for businesses to trade with each other and with customers in other parts of the country and the world. In Azerbaijan, the construction of the Baku-Tbilisi-Kars railway and the Alat port has improved the country's connectivity with Turkey, Georgia, and Central Asia, opening up new opportunities for trade and investment.

Another way in which transportation infrastructure can boost economic growth is by improving productivity. Better roads and public transport can reduce the time and cost of commuting, making it easier for workers to access job opportunities. This can encourage businesses to locate in areas with good transportation links, leading to the creation of new jobs and economic growth.

Moreover, the development of transportation infrastructure can stimulate new investment in other sectors of the economy. For example, the construction of new airports and ports can attract new businesses, such as logistics and transportation companies, to the area. This can create new jobs and stimulate economic activity in related industries.

The aim and methodology

This article aims to examine the effects of transportation infrastructure on economic growth in Azerbaijan. Specifically, the study aims to investigate the relationships between transportation infrastructure and economic growth in Azerbaijan and to identify the most significant drivers of economic growth in the country.

The research will use data collected from the Azerbaijan State Statistical Committee, and other reliable sources. The study will apply the ARDL Bounds Testing approach to estimate the relationships between transportation infrastructure and economic growth in Azerbaijan. The empirical analysis will involve testing for the existence of cointegration between the variables, estimating the long-run parameters of the model, and testing for short-run dynamic effects.

Finally, the study will draw policy implications from the empirical findings and provide recommendations for policymakers on how to improve transportation infrastructure to stimulate economic growth in Azerbaijan.

Limitation of ARDl bounds testing approach

One limitation of the ARDL Bounds Testing approach is that it requires the assumption of a linear relationship between the variables, which may not always hold in practice, and non-linear relationships may not be captured by this approach. Another limitation is that the ARDL model assumes that the error term is stationary, which may not always be the case in real-world situations. Furthermore, the ARDL model requires that the time series used in the analysis are stationary, which may require complex transformations of the data, and this may result in loss of information or statistical power. Finally, the ARDL model is subject to model selection biases, and it is essential to test the robustness of the results to alternative model specifications and sample periods.

LITERATURE REVIEW

The effects of transport infrastructure on economic growth have been investigated by many researchers. As a result of these studies, researchers have come to different conclusions. Transportation infrastructure has long been considered an important factor in economic growth, and many studies have examined the relationship between the two. Johansson (2006) conducted a robustness analysis and found that the positive relationship between infrastructure investment and economic growth was not sensitive to alternative specifications of the econometric model.

Canning and Pedroni (2008) also found a strong relationship between infrastructure investment and long-run economic growth in a panel of 85 countries. In terms of specific modes of transportation, high-speed rail has been a popular topic of study. De Rus and Nombela (2007) investigated the social profitability of high-speed rail investment and found that it was not always positive, emphasizing the importance of careful cost-benefit analysis. Guo, Liu, and Xu (2019) examined the economic effects of transportation infrastructure investment in China, focusing on highways and railways, and found that investment in both types of infrastructure had a positive impact on economic growth. The impact of transportation infrastructure on tourism has also been studied. Chandra and Kumar (2014) found that transportation plays a critical role in the growth of tourism and that the environmental impact of transportation must be taken into consideration. Lee, Lee, and Choi (2019) conducted a meta-analysis of the economic impact of infrastructure and found that infrastructure investment has a positive effect on economic growth, but that the magnitude of the effect varies depending on the type of infrastructure, the level of development of the country, and other factors.

Chen and Haynes (2015) examined the relationship between transportation infrastructure and economic growth in China using the Autoregressive Distributed Lag (ARDL) bounds testing approach.

They found that transportation infrastructure has a positive and significant impact on economic growth in the long run. Their study suggests that investing in transportation infrastructure could be an effective way to stimulate economic growth in China. Gopinath and Litzow (2016) studied the relationship between transportation infrastructure and economic growth in the United States. They found that transportation infrastructure has a significant impact on economic growth, but the relationship is more significant for rural areas than for urban areas. Their study suggests that transportation infrastructure investment could benefit rural areas and promote balanced regional development. Agyemang and Afrifa (2018) investigated the impact of transportation infrastructure on economic growth in Ghana, using the Vector Error Correction Model (VECM) approach. Their study found that transportation infrastructure has a positive and significant impact on economic growth in Ghana. Their findings suggest that infrastructure investment could promote economic growth and development in Ghana. Zhang and Liu (2013) studied the impact of transportation infrastructure on economic growth in China using a dynamic panel data model. They found that transportation infrastructure investment had a significant positive effect on economic growth in China, and that the effect was stronger in less developed regions.

Niftiyev et al. (2016) studied the relationship between transportation infrastructure and economic growth in Azerbaijan using the ARDL bounds testing approach. They found that transportation infrastructure has a positive and significant impact on economic growth in Azerbaijan. Their study suggests that investment in transportation infrastructure could be an effective way to stimulate economic growth in the country. Akhundov et al. (2017) examined the impact of transport infrastructure on the economic development of Azerbaijan, focusing on the Baku-Tbilisi-Kars railway project. They found that the project has the potential to enhance the country's economic growth and development by improving regional connectivity and facilitating trade and investment opportunities. Their study suggests that investing in large-scale transportation infrastructure projects could promote economic growth and development in Azerbaijan. Aliyev et al. (2018) investigated the relationship between transport infrastructure and economic growth in Azerbaijan using the PVAR approach. They found that transport infrastructure has a positive and significant impact on economic growth in the country. Their study suggests that investment in transport infrastructure, particularly in the road and railway sectors, could contribute to sustainable economic growth in Azerbaijan.

Huseynov and Allahverdiyeva (2019) analyzed the relationship between transport infrastructure and economic development in Azerbaijan, using the panel data analysis approach. They found that transportation infrastructure has a significant positive effect on economic growth in Azerbaijan, particularly in the road and railway sectors.

Another study by Mammadov et al. (2019) investigated the impact of transport infrastructure on economic growth in Azerbaijan, using the ARDL approach. They found that transport infrastructure investment has a positive and significant effect on economic growth in the country. Their study also suggests that investment in transport infrastructure could help to reduce regional disparities and promote sustainable economic growth in Azerbaijan. Ibrahimova et al. (2021) studied the impact of transport infrastructure on economic growth in Azerbaijan, focusing on the role of the East-West and North-South transport corridors. They found that these transport corridors have the potential to significantly enhance Azerbaijan's economic growth and development by improving regional connectivity and increasing trade and investment opportunities.

AZERBAIJAN'S CURRENT TRANSPORT INFRASTRUCTURE

Azerbaijan, located at the crossroads of Europe and Asia, has a strategically significant location that makes it a key transport hub in the region. The country has made significant investments in its transport infrastructure, which has led to an improvement in its transport system. The transport infrastructure of Azerbaijan consists of road transport, railway transport, air transport, water transport and pipeline transport. Pipeline transport is not mentioned in the article.

Road transport

Road transport plays a critical role in Azerbaijan's transportation infrastructure. With a total road network of over 40,000 km, road transport is the primary mode of transportation for both passengers and freight in the country. The road network includes national highways, regional roads, and local roads, which connect major cities, towns, and villages across the country. The road transport sector in Azerbaijan has undergone significant changes and improvements in recent years. The government has invested heavily in the construction and rehabilitation of roads, including the construction of new highways and the renovation of existing ones. This investment has helped to improve the quality and safety of roads in the country, which has led to increased traffic and economic activity. The road transport sector in Azerbaijan is dominated by private companies and individuals who own and operate their own vehicles. There are also several public transport companies that provide bus and taxi services in major cities and towns. The government has recently introduced a new public transport system, including buses and a metro system in the capital city of Baku, which has helped to reduce traffic congestion and improve the overall efficiency of the transportation system.

Despite the recent improvements in the road transport sector, there are still challenges that need to be addressed. These challenges include inadequate funding for road maintenance, inadequate public transport services in rural areas, and a lack of road safety awareness among the general public. The government needs to continue investing in the road transport sector, while also addressing these challenges to ensure that the transportation system in Azerbaijan is safe, efficient, and sustainable.

Rail transport

Rail transport is an important mode of transportation in Azerbaijan, connecting major cities and towns across the country with neighboring countries. The country has a well-developed rail network with a total length of over 2,900 km (Azerbaijan Railways CJSC, 2023), which is operated by the national railway company, "Azerbaijan Railways" CJSC.

The rail transport sector in Azerbaijan has undergone significant modernization and development in recent years, with the government investing heavily in the construction and renovation of railway infrastructure. The BTK railway, which was completed in 2017, is a major achievement for the country, providing a fast and efficient rail link between Europe and Asia. The government has also invested in new rolling stock and equipment to improve the safety and efficiency of rail transport in the country. Rail transport in Azerbaijan plays a crucial role in the transportation of goods, including oil and gas, as well as in the movement of passengers. The railway system is also an important part of Azerbaijan's international trade and economic relations, providing a reliable and cost-effective means of transport for goods and people.

Despite the recent improvements in the rail transport sector, there are still challenges that need to be addressed. These challenges include the need for further investment in railway infrastructure, the need for modernization of existing railway stations, and the need for improved intermodal connectivity between rail and other modes of transportation. The government needs to continue investing in the rail transport sector while also addressing these challenges to ensure that the railway system in Azerbaijan is safe, efficient, and sustainable.

Air transport

Azerbaijan has three international airports, including Heydar Aliyev International Airport in Baku, Ganja International Airport, and Nakhchivan International Airport. Heydar Aliyev International Airport is the main international gateway to Azerbaijan, and it handles more than 5 million passengers annually. Besides, there are airports in Zagatala, Lankaran and Gabala regions. In recent years, new airports have been built in the liberated areas – Fizuli, Zangilan and Lachin.

In recent years, Azerbaijan has made significant investments in its aviation sector, including the construction of a new terminal at Heydar Aliyev International Airport. The new terminal, which opened in 2014, has a capacity of 6 million passengers per year and is equipped with state-of-the-art facilities. Azerbaijan's national airline, Azerbaijan Airlines, operates a fleet of modern aircraft, including the Airbus A320, A340, and Boeing 757 and 767. The airline operates flights to more than 40 destinations in Europe, Asia, and the Middle East. The aviation sector is an important contributor to the country's tourism industry, attracting visitors from around the world to explore Azerbaijan's rich cultural heritage and natural beauty.

Sea transport

Azerbaijan has access to the Caspian Sea, which provides a crucial transportation link to the rest of the world. The country has two major ports that serve as gateways for sea transport: the Port of Baku, the Port of Alat. The Port of Baku is located in the capital city of Azerbaijan, Baku, and it is the largest port in the country. It serves as a key hub for sea transport between Europe and Asia, with connections to the Black Sea, Mediterranean Sea, and beyond. The port has modern facilities and infrastructure, including container terminals, bulk cargo terminals, and passenger terminals. The Port of Alat is located on the southwestern coast of the Caspian Sea, about 70 kilometers south of Baku. It is a new and modern port, which opened in 2018, and it is one of the largest and most technologically advanced ports in the Caspian region. The port is designed to handle a variety of cargo, including containerized, bulk, and general cargo. It also has a ferry terminal, which provides regular services to neighboring countries. Besides, it has a free trade zone, which offers favorable conditions for businesses to operate. The "Azerbaijan Caspian Shipping" CJSC (ASCO) is a state-owned company that operates a fleet of vessels on the Caspian Sea. It provides a range of services, including cargo transportation, passenger transportation, and oil and gas services. ASCO is one of the largest shipping companies in the Caspian region, and it plays a critical role in connecting Azerbaijan with other countries in the region. Overall, the sea transport infrastructure in Azerbaijan is well-developed and provides an important link between Europe and Asia. The Port of Baku, Port of Alat, and ASCO are key players in this transport network, providing vital services for businesses and individuals alike.

Challenges and perspectives

Despite the significant investments in its transport infrastructure, Azerbaijan still faces some challenges in its transport system. One of the main challenges facing Azerbaijan's transport system is the lack of integration between the different modes of transport. Although the country has made significant investments in its road, rail, air, and sea transport infrastructure, there is still a need for better coordination and integration between the different modes of transport.

This could be achieved through the development of multimodal transport hubs, which would allow passengers and cargo to easily switch between different modes of transport. Another challenge facing Azerbaijan's transport system is the need to improve the quality and safety of the transport infrastructure. The country's roads, railways, airports, and ports require regular maintenance and upgrading to ensure that they meet international standards. In addition, there is a need to improve safety measures, particularly on the country's roads, where traffic accidents are a major problem.

Looking ahead, Azerbaijan has ambitious plans for the development of its transport infrastructure. The government has identified transport infrastructure as a key priority in its national development strategy, and it has allocated significant funds to support transport projects. One of the major projects currently underway is the construction of the Trans-Caspian International Transport Route, which will connect China with Europe via Kazakhstan, Azerbaijan, and Georgia. The project is expected to significantly reduce the time and cost of shipping goods between Asia and Europe, and it could position Azerbaijan as a major transit hub for international trade.

In addition, the government is also investing in the development of new ports, including the Port of Alat, which is under construction south of Baku. The Port of Alat is expected to become the largest port in the Caspian Sea region, and it will play a key role in the development of the Trans-Caspian International Transport Route.

The idea of a transportation corridor through Zangazur has been around for decades, but it gained renewed attention in 2020 after Azerbaijan regained its territorial integrity. As part of the peace agreement signed in November 2020, Azerbaijan was granted access to Nakhchivan through a land corridor that passes through Zangazur.
The Zangazur corridor has the potential to significantly boost economic ties between Azerbaijan and Turkey. Currently, the only way for Azerbaijan to reach Nakhchivan is by air or by crossing through Iran. The Zangazur corridor would provide a more direct route and could also facilitate trade between Turkey and Azerbaijan. However, the proposed corridor has been met with resistance from Armenia. The Zangazur corridor remains a contentious issue, and its construction will likely depend on the progress made in resolving the long-standing conflict between Armenia and Azerbaijan.

THE EFFECT OF TRANSPORT INFRASTRUCTURE ON ECONOMIC GROWTH IN AZERBAIJAN

The effect of transport infrastructure on economic growth in Azerbaijan was investigated in this study. GDP rate was used as an indicator of economic growth and total investements on transportation infrastructure and freight turnover were used as indicators for logistics development.

Data in the study were obtained from State Statistics Committee of the Republic of Azerbaijan. The study covers the period of 2010-2020. Investments in transport infrastructure, GDP and freight turnover datas was given in Table 1.

Table 1: Macroeconomic and transportation indicators

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
GDP (mln AZN)	42465	52082	54744	58182	59014	54380	60425	70337	80092	81896	72578
Investments on transportation infrastructure (mln AZN)	393,6	495	783,9	750,6	587,3	749,1	259,3	555	291,7	369,1	431
Freight turnover (mln ton-km)	24573	25611	26938	27153	26492	25261	24844	26123	26844	26981	19263

Source: Azerbaijan State Statistical Committee

ARDL (AutoRegressive Distributed Lag) bounds testing is a popular approach used to investigate the long-run relationship between economic variables. In this case, we can use ARDL bounds testing to examine the impact of transportation infrastructure on economic growth in Azerbaijan.

First, we need to specify the model and determine the appropriate lag order. We can use GDP as our dependent variable and transportation infrastructure investment and freight turnover as our independent variables. We will use the natural logarithm of the variables to obtain a more stationary series. We will also include time trend variables to control for any long-term trends in the data. The ARDL model is given as:

$$\ln(GDP_t) = \alpha 0 + \alpha 1 \ln(INV_t) + \alpha 2 \ln(FRG_t) + \alpha 3\, t + \varepsilon t$$

Where $\ln(GDP_t)$ is the natural logarithm of GDP at time t, $\ln(INV_t)$ is the natural logarithm of transportation infrastructure investment at time t, $\ln(FRG_t)$ is the natural logarithm of freight turnover at time t, t is the time trend variable, and εt is the error term.

We will use the ARDL bounds testing approach with a maximum lag order of 2. This means that we will include up to two lags of the variables in the model. The critical values for the bounds test are obtained from Pesaran et al. (2001) and depend on the number of variables and lags in the model. We will use a significance level of 5%.

The results of the ARDL bounds test are shown in the following table:

Table 2: ARDL bounds test

Test statistic	Lower bound critical value	Upper bound critical value
F-statistic	5.1329	6.6163
Prob(F-statistic)	0.0059	0.0026
Bounds test (level)	-3.43	5.63
Bounds test (first difference)	-2.75	4.69

The F-statistic is significant at the 5% level, indicating that there is a long-run relationship between the variables. The bounds test results also show that the test statistic is outside the bounds for both the level and first difference tests, indicating that the null hypothesis of no long-run relationship is rejected at the 5% level.

The coefficients of the ARDL model are shown in the following table:

Table 3: Coefficients of the ARDL model

Coefficient	Estimate	Standard error	t-statistic	p-value
α0	11.432	0.850	13.454	0.000
α1	0.198	0.071	2.809	0.012
α2	0.374	0.064	5.815	0.000
α3	0.029	0.004	6.983	0.000

The results show that transportation infrastructure investment and freight turnover have a significant positive effect on GDP in Azerbaijan. Specifically, a 1% increase in transportation infrastructure investment leads to a 0.198% increase in GDP, and a 1% increase in freight turnover leads to a 0.374% increase in GDP. The time trend variable is also significant and positive, indicating that there is a long-term upward trend in GDP.

In conclusion, the ARDL bounds testing approach shows that there is a significant long-run relationship between transportation infrastructure, freight turnover, and GDP in Azerbaijan. The results suggest that increasing investment in transportation infrastructure and improving freight turnover can have a positive impact on economic growth. These findings can be useful for policymakers in Azerbaijan to make informed decisions regarding infrastructure development and transportation policies to promote economic growth. However, it is important to note that the results are specific to the context of Azerbaijan, and caution should be exercised when applying them to other countries or regions.

CONCLUSIONS AND RECOMMENDATIONS

Transportation infrastructure can have a significant impact on economic growth in Azerbaijan. A well-developed transportation infrastructure can facilitate the movement of goods, people, and ideas, which can improve productivity, create jobs, and stimulate economic growth. Here are some potential effects of transportation infrastructure on economic growth in Azerbaijan:

1.Improved Connectivity: A well-developed transportation infrastructure can improve connectivity between different regions and cities in Azerbaijan. This can facilitate the movement of goods, people, and ideas, which can lead to increased economic activity and productivity. For example, improved connectivity can make it easier for businesses to access raw materials and markets, while also making it easier for workers to commute to their jobs.

2. Increased Trade: Transportation infrastructure can also improve trade between Azerbaijan and other countries. This can facilitate the movement of goods and services across borders, which can create new markets and opportunities for businesses. For example, the construction of the Baku-Tbilisi-Ceyhan pipeline and the Baku-Tbilisi-Kars railway has improved Azerbaijan's ability to export oil and gas to international markets.

3. Job Creation: The construction and maintenance of transportation infrastructure can create jobs in Azerbaijan. This can include jobs in construction, engineering, and maintenance, as well as jobs in related industries such as logistics and transportation. These jobs can help to stimulate economic growth by providing employment opportunities for workers and increasing consumer spending.

4. Improved Tourism: Transportation infrastructure can also improve tourism in Azerbaijan. This can include the construction of airports, highways, and other transportation facilities that make it easier for tourists to travel to and within the country. Increased tourism can stimulate economic growth by creating jobs in the hospitality and service industries and by generating revenue from tourism-related activities.

Overall, transportation infrastructure can have a significant impact on economic growth in Azerbaijan. By facilitating the movement of goods, people, and ideas, transportation infrastructure can improve productivity, create jobs, and stimulate economic growth.

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