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Does Logistics Infrastructure Affect Economic Boost? Empirical Evidence from Turkey

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Abstract

In this research we investigated the relationship between infrastructure of logistics services and economic boost in Turkey. For investment decisions, it is important to know how infrastructure investment impact economic development. Turkey is developing economy and it has been investing in logistic infrastructure extensively since 20 years so we examined the relationship for Turkey. For this purpose, we used methods of Johansen (1988) cointegration test and Granger (1969) causality test. Our data is yearly and covers the years 1984-2020. We used airfreight, total fleet, number of container transport, length of railways, railways freight, divided road, motorways, and government infrastructure expenditure to represent infrastructure of logistics services. In addition, we used EXIM (total trade), export, import, GDP, and GDP per capita to represent economic boost. Contrast to general expectations we couldn't find clear evidence that shows infrastructure of logistics services cause of economic boost in Turkey.

Keywords: *Logistics, Logistics Infrastructure, Economic Growth, Time Series, Turkish Economy.*
JEL Codes: *F43, C22, H54, L91, E01.*

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Özet

Lojistik Alt Yapısı Ekonomik Büyümeyi Etkiliyor Mu? Türkiye'den Ampirik Deliller

Bu araştırmada, Türkiye'deki lojistik hizmetlerin altyapısı ile ekonomik büyüme arasındaki ilişkiyi inceledik. Yatırım kararları için altyapı yatırımlarının ekonomik kalkınmayı nasıl etkilediğini bilmek önemlidir. Türkiye ekonomisi gelişmekte oluğu için ve bu ülekde lojistik altyapıya 20 yıldan beri yoğun bir şekilde yatırım yapıldığından, bu ilişkiyi Türkiye için inceledik. Bu amaçla Johansen (1988) eşbütünleşme testi ve Granger (1969) nedensellik testi yöntemlerini kullandık. Verilerimiz yıllık olup 1984-2020 yıllarını kapsamaktadır. Lojistik hizmetlerin altyapısını temsil etmek için hava taşımacılığı, toplam filo, konteyner taşımacılığı sayısı, demiryollarının uzunluğu, demiryolları navlun, bölünmüş yol, otoyollar ve devlet altyapı harcamalarını kullandık. Ek olarak, ekonomik artışı temsil etmek için EXIM (toplam ticaret), ihracat, ithalat, GSYİH ve kişi başına GSYİH'yı kullandık. Genel beklentilerin aksine, Türkiye'de lojistik hizmet altyapısının ekonomik canlanmaya neden olduğunu gösteren net bir kanıt bulamadık.

Anahtar Kelimeler: *Lojistik Altyapısı, Zaman Serileri, Türkiye Ekonomisi.*
JEL Kodları: *F43, C22, H54, L91, E01.*

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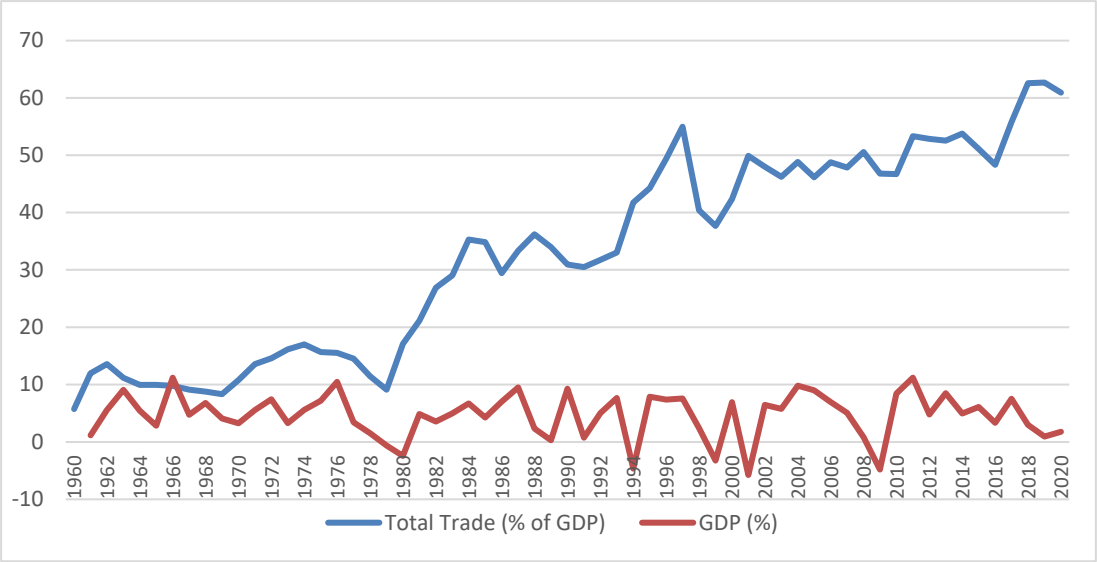
1. Introduction

1980 was a radical breaking point for many economies including the Turkish economy. After that year, Turkey started to adopt outward-oriented/open economy policies. Outward-oriented economic policies meant a change in Turkey's economic relationships with the rest of the world. This type of relationship requires the capacity to perform high quality and efficient operations in the context of logistics, the integration of different modes and communication infrastructure that enables accurate information flow. Although the failure to fulfill this requirement was not a problem until the beginning of the 2000s, it has become a problem for Turkey as well as for many countries that have adopted outward-oriented economic policies since the beginning of the 2000s.

The opening of economies to foreign markets causes the growth of international trade volume. In such a case, it becomes important for the markets to ensure the quality, reliability, fulfillment of logistics services on time and all these at the most affordable cost (Shkurenko & Savchenko, 2019). Because of economic activities, involve large amounts of freight mobility when countries adopted outward-oriented economy policies, the efficiency of logistics services become a prerequisite for the efficiency of economic activities.

It will make easier to understand the effects of open economy policies if we look how the share of international trade in total economic activities changes. In addition, the change in the share of foreign trade in total economic activities also give an idea about the increase in demand for logistics services. Figure 1 shows that the share of international trade in total economic activities differed 6% to 17% between 1960 and 1980. This ratio has started to increase after 1980, has reached the level of 61% today. Moreover, this increase has occurred even though the rate of increase in total economic activities constantly fluctuated within a certain range (almost under 10%).

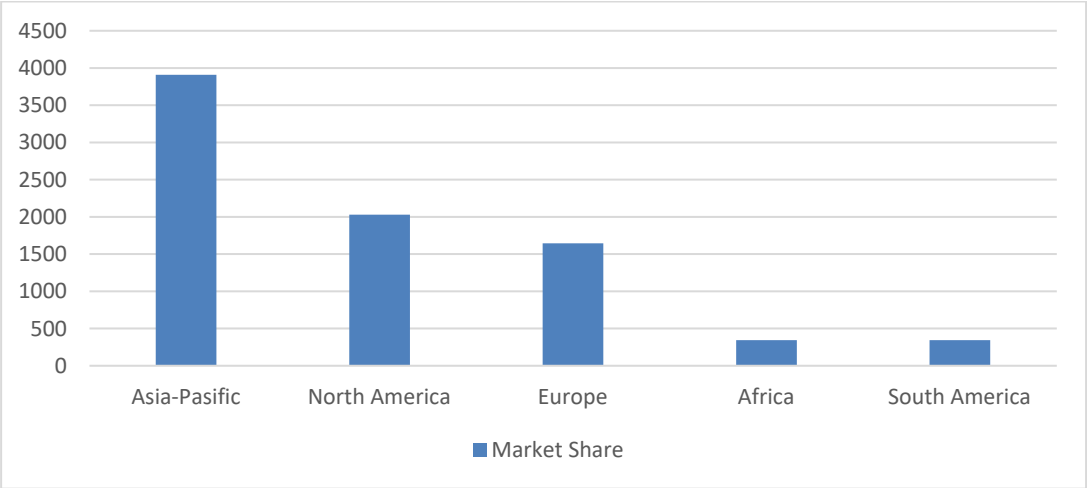
Figure 1. GDP Growth Rate and International Trade of Turkey (1960-2020)



Source: [World Bank, World Bank National Accounts Data 2021]

The increase in trade volume has caused significant structural changes in Turkey like the rest of the world. One of the most important of these changes has occurred in logistics industry. The changes in this special area, which can be accepted as logistics infrastructure, have been determined to a significant extent by the volumetric and structural changes in international trade. For this reason, it couldn't be seen a coincidence that many developing countries, including Turkey, have started to establish and develop their logistics infrastructures after the 1980s and especially after 2000s. It must be noted that the logistics infrastructure, which is heavily influenced by international trade, has also indirectly affected by the changing international division of labor, value chains, manufacturing networks and consumer products with shorter lifetimes (Varnavskii, 2021).

Figure 2. Size of the Global Logistics Market in 2020, by Region (in Billion $)



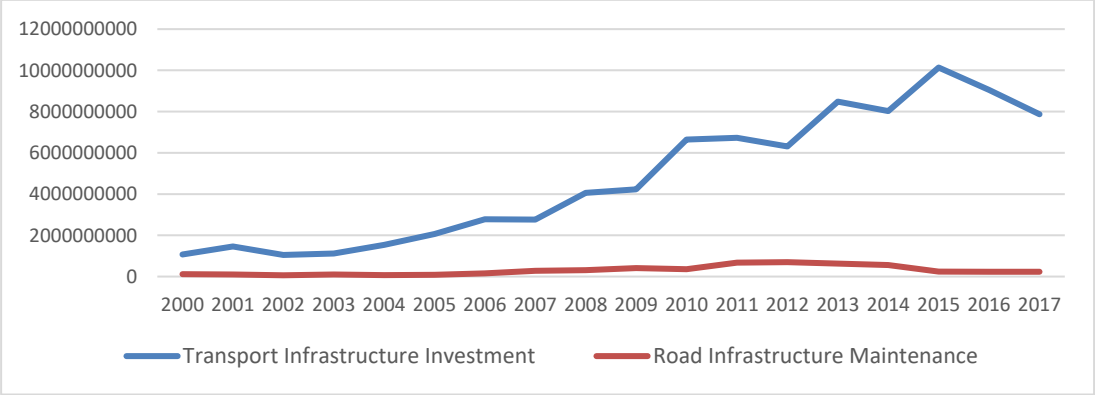
Source: (Statista.com, 2021)

Many countries of the world have turned their motivation to transform and develop their logistics sectors to keep up with the increasing trend in trade volume and to reduce logistics costs per unit. Upgrading efforts on logistics infrastructure have been observed in developing countries especially located in Asia. The region has gotten fabulously large amounts of investments from the rest of the world for the last

several decades. As a result, Asia-Pacific has been regarded as the world's manufacturing center by many people today. Just like we observe manufacturing, agglomeration of logistics activities at the region. Figure 2 shows the market share of continents. Asia-Pacific is well ahead among the reported continents.

If we look at the logistics upgrading from the viewpoint of the parties which bear the costs, orientation and efforts are divided into two categories. The first is, the vehicles used in logistics operations and the second is the physical area where the operations are carried out. The vehicles such as containers, trucks, tow trucks, lifts and warehouses used in logistics operations are those that usually covered by the private sector. The physical area, on the other hand, contains large investments that are usually covered by the public sector, such as logistics centers (villages), highways, railways, sea and airports, bridges, and crossings.

Figure. 3. Investment on Transport and Maintenance of Infrastructure in Turkey (Euro)



Source: [International Transport Forum 2021]

Turkey is one of the countries that intensively has started to renew and build its logistics infrastructure as required by today's logistics sector since the beginning of the 2000s. Figure 3 shows the development of investments in transportation infrastructure and maintenance expenditures corresponding to the physical space of

the logistics sector. It is clear that Turkey has an increasing trend in transportation infrastructure investments in Figure 2 between 2002 and 2016.

If the logistics sector has not developed to cope with the increasing integration of national economies with the world through international trade; costs, competitiveness of countries, productivity and efficiency of the workforce would inevitably be affected. Therefore, it is not possible to consider about improvement on the economic performance independently from the investments and the transformation in the logistics sector especially in developing countries (Varnavskii, 2021). Due to this reason, this paper aims to draw attention to the causal relationship between logistics infrastructure investments and economic performance in Turkey. To observe this, in estimations we used the data between 1984-2020 and we applied the Vector Autoregressive (VAR) and Vector Error Correction Model (VECM) methods. Eight different variables have been used to represent the logistics infrastructure (including land, sea, rail, and air freight). Economic activities have been represented by international trade volume, exports, imports, GDP and per capita.

After this introduction, the study will continue with the literature examining the relations between economic development and logistics development. In the third chapter, the econometric method and data set used in the study will be introduced. In the fourth chapter, the empirical findings will be reported. Lastly, the fifth chapter will be the conclusion section where the findings are discussed.

2. Literature Review

Most of the studies indicate that improvements in transport infrastructure support economies of countries in literature. It is obvious that there is relationship among logistic infrastructure, economic growth and international trade. However, there is no certain agreement on the direction of causality between those factors. Endogenous growth theory states that the economic growth depends on investment in endogenous factors such as education and transport (Romer, 1987). On the other hand, Wagner's

Law says that investment in infrastructure is an outcome of economic growth (Wagner & Weber, 1977).

Impacts of infrastructure on economic performance is separated into two categories. The first is indirect effects which impact on development of industries and production process. The second one is about efficiency of using resources. Accordingly, infrastructure can diminish operational costs, upgrade usage of production factors and, develop effectiveness (Das, 2017). In addition, there are both country specific and multiple country models studies. Also, it can be easily realized from literature that most of country specific studies are about developing countries. However, as it was stated in the comprehensive study of Miller and Tsoukis (2001) which covers 44 countries in Europe, Asia, Middle East, and Latin America whether developed or not, investment in motorways, seaports and airports, improves the distribution of goods and services. Therefore, output increases.

Studies on developed countries is uncommon when it comes to investigating transport infrastructure and economic growth relation. For example, (Berechman, et al., 2006) investigated relationship between transportation and its spillover effect with economic growth for the US between 1990-2000 time periods. The researchers highlighted the time lag between investment and economic output. As a result, they found that transportation investments have strong effects on economic growth regardless of time and space. Similarly, (Lau & Sin, 1997) examined private and public capitals (including transportation infrastructure investments) on economic growth. They used Johansen cointegration method and data set over the period 1925-1989 for the US. They found that private and public capitals move together with economic growth in the long run. The other example is Sweden. (Berndt & Hansson, 1991) investigated the impact of the public infrastructure on total economic activities of private sector between 1960-1988 in Sweden. According to econometric analysis depending on annual data set, they propounded that expenditure on public infrastructure decreases costs of private sector in Sweden.

Developed countries frequently have been discussed in multiple country studies. And, those studies have focused on the OECD member countries. To illustrate, (Égert, et al., 2009) discussed transportation issue for OECD countries in a period time between 1960 and 2005. The researchers, using both time series and cross section method, investigated how transportation investment including roads, railways, electricity, and telephone line investment effects economic performance for 24 OECD countries. They found that transportation investment substantially affects economic growth both in the short and long run. (Hayaloglu , 2015) used the infrastructure term in a broad sense. In this sense infrastructure included logistics infrastructure of all modes. Hayaloglu studied with panel data method on impact of infrastructure for economies of OECD. Time period of the study is 1995-2011. To represent logistic infrastructure, Hayaloglu used railway transport, road transport, air transport, and communication infrastructure. Hayaloglu found that there is clear relationship between economic activity and logistics infrastructure. Kabaklarlı, et al. (2018) investigates the relationship between infrastructure and economic growth by 17 OECD countries and Russia's data for the years from 1995 to 2015. Panel methods and common correlated effect estimator was applied as methodology. According to the results, there is a positive and significant long-run impact of transportation infrastructure on economic growth for the selected countries. Another important part of literature, which uses multiple countries data set, examines the impact of transport infrastructure development on the improvement of international trade.

One of the most referred studies is (Munim & Schramm, 2018). They investigated the impact of infrastructure quality on oversea trade for 91 countries. The countries which put together in data set were divided as developed and developing countries. According to the results of empirical analysis, they found that quality of infrastructure is more important for developing countries rather than developed ones so more qualified infrastructure results more oversea trade for developing countries. Contrast to Munim and Schramm (2018), (Alberto & Wilson, 2012) divided logistics infrastructure into two categories as soft and hard infrastructure. They defined

information and communication technologies as soft and physical infrastructure like road, port, and railways as hard infrastructure. Their data set covers 100 countries and over the period of 2004-2007. They concluded their investigation by expressing that there is a significant relationship between logistics infrastructure and trade. Değer and Doğanay (2015) examined the relationship between economic growth and investment in physical infrastructure using panel data method for the period of 1994-2013 by using data of 136 countries. The results indicated that energy infrastructure is positive and significant determinant of economic growth for all income groups except low-income countries. On the other hand, transport infrastructure has a significant but very low impact on economic growth in low-income countries. Lastly, for all countries the relationship between growth and telecommunication infrastructure was significant and positive. (Sharipbekova & Raimbekov, 2018) examined relationship logistics industry and economic growth for Commonwealth of Independent States Countries (CIS). Telecommunication and transport were used to stand for logistics industry while GDP, industry production and trade used to stand for economic growth by the researchers. By performing factor analysis, they found out that logistics industry has a key role in terms of total economic activities for CIS countries.

Most of studies discussing developing countries have focused on Asian countries, and especially China. For instance, (Li, et al., 2015) performed quantitative analysis to investigate the relationship between logistics and economic growth using 2000-2009 data in Xushou, China. Freight volume was used for proxy of logistics. Researchers found out that there is not a linear interaction between logistics and economic growth. Strength of the relationship changed between two different periods of time. Economic growth overtook logistics between 2000 and 2007 so the author concluded that logistics push economic growth. When it comes to between 2007 and 2009, logistics overtook economic growth. In conclusion researchers put forward that relationship between logistics and economic growth is U-quadric rather than linear. (Huang & Peng, 2014) analyzed port logistics efficiency and economic performance using correlation method for Zhejiang, China. Researchers found that the correlation

coefficient of port logistics and economic performance is extremely high. They concluded that there is a strong relationship between port logistics and economic performance in Zhejiang, China. (Zou & Smith, 2015) implemented a logistic model to investigate interaction between regional logistics improvement and economic boost in Sichuan, China. They used data over 2000-2013 and freight volume to represent logistics improvement. They found out that regional logistics improvement has a long run relationship with economic boost in Sichuan, China. (Liu, 2009) studied logistics infrastructure issue on China. Liu used GDP to represent economic performance and number of workers, investment, equipment's of transportation and operating income to represent logistic sector. After the analysis, Liu found that there is an important impact of logistic sector on total economic performance in China. Similar results have been found by (Yang & Jianguo, 2011), (Chu, 2012) and (Li & Qi, 2015).

Input-output analysis has been used for executing the relationship between logistics and economic activities as well as panel data and time series methods in China. We can exemplify that research with (Qian & Yang, 2013). They performed this method to Chizhou, China. They investigated the relationship between logistic parks and economy of Chizhou. Using input-output model, they found that logistics parks clearly affect Chizhou's economy positively. (Chu & Liu, 2013) examined the relationship between logistics and economic development using 1990-2010 data for Henan province, China. According to the result of econometric analysis, they found that there is a strong relationship from logistic to economic development for Henan province. Similar province studies on provinces of China resulted in similar results like (Mody & Wang, 1997), (Démurger , 2001) and (Chu Z. , 2012).

There have been multiple country studies covering Asian countries as well as country specific studies. For example, (Arnold, 2009) investigated how transport infrastructure and logistics industry affect the trade volume between East and South Asia. His analysis dates back to three decades. According to the author, sea transportation is the main transportation mode for trade between East and South Asia.

However, road and railways gained an important role for trade between East and South Asia in the last there decades. This improvement can provide more trade volume between noncontiguous countries in Asia. As a result, Arnold put forward that importance of transport infrastructure and logistics industry have not changed in the part of continents for the last 30 years. (Tang & Abosedra, 2019) studied on 23 Asian country economies. They aimed to determine how logistics affects economic growth, using panel data analysis. Using data over the period between 2010 and 2016, they suggested that logistics can be the key explanatory variable for development gap in the investigated countries. Thus, they put forward that logistics have a clear impact on economic growth and development. (Ismail & Mahyideen, 2015) investigated the impact of logistic infrastructure on some economic variables like trade and GDP on certain Asian economies such as India, Singapore, Thailand, and Vietnam. The researchers found that there is a reciprocal relationship between logistics infrastructure and selected economic variables. According to the results, logistics infrastructure results in good economic performance without any doubt. (Reza, 2013) used sea, air and rail transported volume of goods to represent logistic activities and GDP to represent economic development of Indonesia. He found that there is a reciprocal relationship between logistics and economic development. That is, logistics activities derive economic development while economic development derive logistics activities in Indonesia. The other study used input-output analysis is (Oruangke, 2018). Oruangke investigated how logistics sector affects Thailand's economy using data set, which covers from 1975 to 2010. After the analysis Oruangke put forward that logistics sector has clearly a positive effect on Thailand's economy.

In the studies generally investment or expenditure of transport infrastructure represents logistics investment. All investment and expenditure are proxy indicators of logistics efficiency. In addition, researchers used Logistic Performance Index to represent logistics efficiency. For instance, (Hoekman & Nicita, 2011) studied the relationship between logistics and trade. They used logistics variables produced by World Bank like Logistic Performance Index and Doing Business. Logistic

Performance Index which calculated by sub-indexes including infrastructure quality. The researchers concluded their research by saying that there is an important association between logistics and trade. According to their estimation, trade would increase if logistic performance rose in underdeveloped countries. (Sánchez, et al., 2014) investigated the impact of increasing logistic performance index on economic development. They used Logistic Performance Index to represent efficiency of logistics industry and used natural endowments, economic openness and institutional framework to represent economic development. According to their empirical result, they put forward high logistic performance index substantially cause economic development. Similar results were suggested by (Coto-Millán, et al., 2013), (Civelek, et al., 2015), (D'Aleo & Sergi, 2017) and (Hausman, et al., 2013).

African continent and its countries is another salient area where logistics studies have agglomerated. For example, (Hailu & Zenaselassie, 2016) investigated the impact of logistics on economic growth with panel data analysis for 19 African countries. They used data set from 2007 to 2014. They used Logistic Performance Index to stand for logistics industry. According to the results, they revealed that logistic upgrading can motivate economic performance. (Sharapiyeva, et al., 2019) revealed interaction between logistics and macroeconomic performance for 37 landlocked African economies. Structural Equation Model was preferred by the authors to analyze the data. And they used sub-indexes of Logistic Performance Index to represent efficiency of logistics industry. As a result, output of the econometric analysis showed that the efficiency of logistics industry has a significant impact on macroeconomic performance for 37 landlocked African economies. (Richard, 2020) Performed simple regression to investigate the relationship between logistics and economic boost in Tanzania. For this purpose, Richard used GDP to represent total economic activities and World Bank's logistic indicators to represent logistics. After estimations, he concluded that logistics affects economic growth of Tanzania positively. (Kayode, et al., 2013) examined how investment of transport infrastructure affects economic performance of Nigeria in 1997-2009. According to the results, the

researchers stated that the growth performance of Nigeria economy is significantly affected by investment of transport infrastructure. (Boopen, 2006) looked for an answer for impact of transport infrastructure on economic growth using panel data and cross section method for African countries and developing countries. After estimation, Boopen put forward that transport infrastructure encourage economic growth in both African and other developing countries. Similar results were found by Calderón and Servén (2012).

There are few academic papers on the investigation of causal relationship between logistics infrastructure and the economic growth in Turkey. The early paper is Kuştepeli, et al. (2012). Kuştepeli, et al. (2012) could not find any significant relationship between investment in highways, economic development and international trade of Turkey between 1970-2005. In the study, they applied causality tests and cointegration analysis. But later, the studies have put forward a significant interaction between logistics infrastructure and the economic growth. (Kuzu & Emrah , 2014) is one of the most referred papers for Turkish economy. Researchers examined the long run relationship between economic growth and developments of the logistics sector in Turkey. They used variables covering 2005-2013, Engle Granger Cointegration test and Granger Causality test applied as methodology. According to the results two variables (GDP growth and turnover index of transportation and logistics) are cointegrated. Moreover, Granger causality has been found from economic growth to logistics development in the long run. Saatçioğlu and Karaca (2018) investigates the relationship between transport infrastructure and regional economic growth in Turkey. Turkey was divided to 26 different sub-regions in the study. Cross-sectional and panel data regression analyses were applied, using data for the 26 regions over the period of 2004-2014. According to the results, transport infrastructure has a positive and statistically significant impact on regional economic growth in Turkey. Kara and Ciğercioğlu (2018) examines the long run relationship between transport infrastructure (length of highways) and economic growth in Turkey for the periods between 1988-2015. As methodology, Johansen co-

integration test and VAR analysis are used. The results indicate that in the long run, transport infrastructure has positive and significant impact on economic growth.

There is some shortcoming in the studies focused on Turkey. Firstly, concrete results of infrastructure investments emerge 15-20 years later. So, if studies aim to specify effects of logistics infrastructure investments, then data sets which cover 8 or 10 years are not suitable for that goal. The data should cover longer periods. In addition, time length should be meaningful for that period. For example, Kuştepeli, et al. (2012) used period from 1970 to 2005. However, Turkey's most important infrastructure investment of transportation have intensified after 2005. And all infrastructure investment of transportation does not target to upgrade economic performance. Perceptive of social state can be another reason behind infrastructure investment of transportation. Just like in other countries, studies focusing on Turkey accept GDP (or its growth rate) as economic performance indicator. But this point of view is narrow, to accept GDP as economic performance indicator. Because the concept of economic performance is multidimensional notion, which covers other macroeconomic variables like export, import etc. In this regard, we aim to clarify the causal relationship by using more comprehensive dataset of Turkey. We hope to find valuable implications for further research.

3. Methodology

To examine the causal relevance between logistics infrastructure development and economic boost in Turkey, we perform [Johansen 1988] cointegration and [Granger 1969] causality test. The tests work on VAR model. To perform a VAR model, used time series shouldn't have unit root. We used ADF [Dickey and Fuller 1981], PP [Phillips and Perron 1988] and KPSS [Kwiatkowski et al. 1992] unit root tests to control unit root in the series. A VAR model investigate causal relevance between selected variables. In this research we use the VAR model as following:

$$\Delta LEB_t = c_1 + \sum_{i=1}^{L} \alpha_{1i} \Delta LEB_{t-1} + \sum_{j=1}^{L} \beta_{1j} \Delta LLS_{t-j} + \varepsilon_{1t} \quad (1)$$

$$\Delta LLS_t = c_2 + \sum_{i=1}^{L} \alpha_{2i} \Delta LEB_{t-1} + \sum_{j=1}^{L} \beta_{2j} \Delta LLS_{t-j} + \varepsilon_{1t} \quad (2)$$

"ΔLEB" represents logarithmic difference of economic boost, "ΔLLS" represents logaritmic difference of logistics services in the VAR model. "c" is constant, "L" is optimal lag order according to Akaike information criterion and Schwarz information criterion. α and β are coefficients representing economic boost and logistics services respectively. And ε_t is error term.

We investigate long term relationship between variables using [Johansen 1988] cointegration test. Because two or more variables have unit root individually, a linear combination of them may be cointegrated. [Johansen 1988] cointegration test, tests number of cointegration vectors and consider all relationships between variable when trying to detect number of cointegration vector so the number of cointegration vectors doesn't change when transposition of dependent and independent variable. While specifying number of cointegration vectors, [Johansen 1988] cointegration test propose two likelihood ratio statistics. These are trace and maximum eigenvalue statistics. The variables are regarded as cointegrated if these test statistics are greater than critical values. Trace and maximum eigenvalue statistics are calculated as following.

$$\lambda_{trace} = -T \sum_{i=r+1}^{n} \ln (1 - \hat{\lambda}_i)$$

$$\lambda_{max\,eigen.} = -T \ln (1 - \hat{\lambda}_i)$$

"n" represents number of variables "T" is time, that is represents number of observations and "$\hat{\lambda}$" represents value of ordered eigenvalue.

According to test results if cointegration is detected for two variables, VECM (Vector Error Correction Model) can be used for causal relationship. Fort this purpose we can transform above (1) and (2) equation to (3) and (4) as follow:

$$\Delta LEB_t = c_1 + \sum_{i=1}^{L} \alpha_{1i} \Delta LEB_{t-1} + \sum_{j=1}^{L} \beta_{1j} \Delta LLS_{t-j} + \gamma_1 ECT_{t-1} + \varepsilon_{1t} \quad (3)$$

$$\Delta LLS_t = c_2 + \sum_{i=1}^{L} \alpha_{2i} \Delta LEB_{t-1} + \sum_{j=1}^{L} \beta_{2j} \Delta LLS_{t-j} + \gamma_2 ECT_{t-1} + \varepsilon_{1t} \quad (4)$$

On the other hand, Granger causality test works based on assumption which accepts all coefficients (in this case α and β) are zero. The null hypothesis includes the coefficients. In our equation, if null hypothesis including β_1 is rejected it means there is one-way Granger causality from logistics services to economic boost. If null hypothesis including α_2 is rejected, it means there is one-way Granger causality from economic boost to logistics services.

Our data covers period from 1984-2020. As we expressed above, two different kind of data is used in this paper. One of them is economic boost variables consisting of GDP, export, import, per capita and total trade (EXIM). The other variables are air freight, total fleet, number of container transport, length of railways, railways freight, divided road, motorways, and infrastructure. These variables are used to represent infrastructure of logistic services. We took all these data from World Bank, UNCTAD, Turkish Statistical Institute and General Directorate Highways. Table 1 and Table 2 show descriptive statistics and unit of infrastructure of logistic services and economic boost respectively.

Table 1. Logistics Indicators

Variables	Unit	Mean	Median	Max.	Min.
Air Freight	Tonne	1364151	880133	4090168	121568
Total Fleet	Tonne in Thousand	7910.824	7877.980	10669.76	4088.392
Number Container Transport	TEU*	5769470	1953214	87619739	106815
Length of Railways	Kilometer	9006	8682	10378	8400
Railways Freight	Tonne-KM	9783425	9152000	15427907	7224000
Divided Road	Kilometer	10786.59	6040.430	26646	1437
Motorways	Kilometer	1545.432	1674	3523	77
Infrastructure	Turkish Lira	18.76	20.66	23.12	11.47

**Twenty-Foot Equivalent Units*

Source: Turkish Statistical Institute (for Air Freight, Length of Railways, Railways Freight, Divided Road, Motorways) and General Directorate Highways (for Infrastructure) and UNCTAD (for Total Fleet)

Table 2. Economic Indicators

Variables	Unit	Mean	Median	Max.	Min.
EXIM	Thousand USD	2.20E+11	1.16E+11	5.05E+11	2.12E+10
Export	Thousand USD	1.04E+11	6.03E+10	2.49E+11	9.36E+09
Import	Thousand USD	1.16E+11	6.16E+10	2.75E+11	1.18E+10
GDP	Thousand USD	4.37E+11	2.76E+11	9.58E+11	6.00E+10
Per Capita	USD	6132.408	4499.738	12614.78	1246.824

Source: World Bank 2021.

4. Empirical Evidence

This chapter evaluates the empirical results. First, we make logarithmic transformation and execute unit root tests for used variables. Table 3 and table 4 reports ADF, PP and KPSS unit root test results at level I (0) and first difference I (1). All infrastructure of logistic service and economic boost variables have unit root at level except for KPSS test. It means that all variables are not stationary at level, but all variables are stationary at first difference.

Table 3. Results of Unit Root Tests for Infrastructure of Logistic Services

	I(0)			I(1)		
	ADF	**PP**	**KPSS**	**ADF**	**PP**	**KPSS**
Air Freight	-1.1802	-0.6305	0.1678**	-5.0909***	-4.7601***	0.0949
Total Fleet	0.8601	-2.2261	0.1546**	-5.2235***	-5.2134***	0.0867
Container Transport	-1.2038	-1.1561	0.7080**	-9.6322***	-15.606***	0.2653
Length of Railways	-1.2451	-1.4014	0.1721**	-4.9439***	-4.1111***	0.0751
Railways Freight	-2.7818	-2.6305	0.1633**	-6.5639***	-8.4489***	0.1025
Divided Road	-1.3903	-0.8008	0.1097***	-3.5364**	-3.5364**	0.1455
Motorways	-1.4445	-2.5749	0.1653**	-3.3128**	-3.3083**	0.1086
Infrastructure	0.149047	0.192816	0.1879**	-5.7793***	-5.8211***	0.1077

Note: **p<0.1, **p<0.05, ***p<0.01*

Source: Own work

Table 4. Results of Unit Root Tests for Economic Boost Variables

	I(0)			I(1)		
	ADF	**PP**	**KPSS**	**ADF**	**PP**	**KPSS**
EXIM	-0.7928	-0.7140	0.1465**	-6.2404***	-6.2404***	0.0780
Export	-0.2357	0.0309	0.1699**	-5.4297***	-5.3636***	0.1200
Import	-1.5795	-1.5957	0.1260**	-6.9221***	-6.9221***	0.0708
GDP	-1.1358	-1.1591	0.1225*	-6.4338***	-6.4338***	0.0741
Per Capita	-1.1329	-1.1669	0.1193*	-6.4100***	-6.4100***	0.0766

Note: *p<0.1, **p<0.05, ***p<0.01

Source: Own work

Second step is to examine cointegration test using infrastructure of logistic services and economic boost variables. Null hypothesis at Johansen cointegration test is no cointegration ($r = 0$) and at most one cointegration ($r \leq 1$). Statistical significance level was determined at %1, %5 and %10 level. According to Table 5 there are several important cointegration among infrastructure of logistic services and economic boost variables.

Table 5. Johansen (1988) Cointegration Test Results

	H_0	EXIM		Export		Import		GDP		Per Capita	
Variables		Trace	Max-Eigen	Trace	Max-Eigen	Trace	Max-Eigen	Trace	Max-Eigen	Trace	Max-Eigen
Air Freight	$r = 0$	22.03**	17.73**	19.72	16.34**	15.23	12.30	15.77	13.00	15.78	12.96
	$r \leq 1$	4.30	4.30	3.38	3.38	2.92	2.92	2.77	2.77	2.81	2.81
Total Fleet	$r = 0$	10.96	8.40	16.21	11.86	12.80	9.19	9.53	7.12	8.52	6.09
	$r \leq 1$	2.56	2.56	4.35	4.35	3.60	3.60	2.41	2.41	2.42	2.42
Con. Trans.	$r = 0$	17.15**	13.58	20.33***	15.74**	14.76*	12.11	13.39*	9.74	17.56	11.68
	$r \leq 1$	3.57	3.57	4.59**	4.59	2.64	2.64	3.64	3.64	5.87	5.87
Length of Railways	$r = 0$	35.50***	29.63***	10.34	6.01	20.17	15.09	15.52	8.60	13.01	9.94
	$r \leq 1$	5.86	5.86	4.33**	4.33**	5.08	5.08	6.92	6.92	3.07*	3.07*
Railways Freight	$r = 0$	12.64	11.73	12.41	8.99	11.14	10.72	27.97***	23.88***	13.47	8.28
	$r \leq 1$	0.91	0.91	3.41	3.41	0.42	0.42	4.08	4.08	5.18	5.18
Divided Road	$r = 0$	20.77***	17.38**	25.69***	17.42**	22.69**	15.34*	22.55	20.29**	39.21***	33.26***
	$r \leq 1$	3.39	3.39	8.27	8.27	7.35	7.35	2.25	2.25	5.95	5.95
Motoways	$r = 0$	6.88	5.89	6.97	6.16	22.36***	19.78***	19.35***	17.53***	23.57**	17.67**
	$r \leq 1$	0.98	0.98	0.80	0.80	2.57	2.57	1.82	1.82	5.90	5.90
Infra.	$r = 0$	6.22	6.20	6.49	6.42	6.26	6.09	4.71	4.42	4.76	4.50
	$r \leq 1$	0.02	0.02	0.07	0.07	0.16	0.16	0.29	0.29	0.26	0.26

*Note: *p<0.1,**p<0.05, ***p<0.01*
Source: Own work.

Firstly, divided road is cointegrated with almost whole economic boost variables. Similarly, motorways are cointegrated with import, per capita and GDP. Railway's freight is cointegrated with GDP at %1 significance level while length of railways is cointegrated with EXIM at %1 and with export at %5 significance level. When we consider land transport is consist of road and railway transportation, the results reveal that road transportation come into prominence in Turkey's land transportation.

Railway's transportation has weak long run relationships with economic boost variables. On the other hand, air freight has long run relationships with EXIM and export at %5 significance level. But have not cointegration with GDP and per capita. Finally, container transportation is cointegrated with EXIM and Export at %5 significance level and with import and GDP at %10 significance level.

After cointegration tests, we examine causality test between infrastructure of logistic services and economic boost variables. Causality tests are performed to all pair of variables. But VECM is performed to only cointegrated pair of variables. Causality test results are reported based on transportation modes. We use single variable to stand for air transportation, it is air freight. According to cointegration results air freight has long run relationship with EXIM and export. But as it can be clearly seen at table 6, air freight is not cause of EXIM, export, import, GDP and per capita and vice versa.

Table 6. Causality Test Results for Air Transport Infrastructure

Air Freight	$\Delta LogEXIM$	$\Delta LogExports$	$\Delta LogImport$	$\Delta LogGDP$	$\Delta LogPerCapita$
Δ *LogAir Freight does not cause of the variable*	0.004776	1.391263	0.212926	0.073776	0.052489
The variable does not cause of Δ *LogAir Freight*	0.437399	4.26E-06	0.028945	0.473687	0.520756

*Note: *p<0.1, **p<0.05, ***p<0.01*
Source: Own work

When it comes to maritime transportation, we use two different variables. Those are total fleet and container transport. As we saw (Table 5), total fleet has not long run relationship with economic boost variables, but container transportation has long run relationship with some economic boost variables. According to Table 7, however, in just same way as air transportation, there is no causality from maritime transportation to economic boost variables and vice versa.

Table 7. Causality Test Results for Maritime Transport Infrastructure

Total Fleet	$\Delta LogEXIM$	$\Delta LogExports$	$\Delta LogImport$	$\Delta LogGDP$	$\Delta LogPerCapita$
$\Delta\ LogTotalFleet\ does\ not\ cause\ of$ the variable	0.668326	0.197948	0.656791	0.334906	0.332284
The variable does not cause of $\Delta\ LogTotalFleet$	0.026024	0.088694	0.121675	0.068662	0.051790
Container Transport					
$\Delta\ LogCont.Tans.\ does\ not\ cause\ of$ the variable	1.688966	1.605476	2.224266	0.570942	0.541555
The variable does not cause of $\Delta\ LogCont.Tans.$	9.68E-05	0.257794	0.143437	0.131336	0.050729

*Note: *p<0.1, **p<0.05, ***p<0.01*
Source: Own work

In terms of causality, length of railways is not different from previous infrastructure of logistic services variables. That is, there is not causality from length of railways to economic boost variables and vice versa. However, there is causality from railway freight to GDP at %5 and %10 significance level while from GDP to railway freight at %1 significance level. With this output, we can easily say railway freight is associated with macroeconomic performance.

Table 8. Causality Test Results for Railway Transport Infrastructure

Length of Railways	$\Delta LogEXIM$	$\Delta LogExp.$	$\Delta LogImp.$	$\Delta LogGDP$	$\Delta LogPerCap.$
$\Delta\ LogLng\ of\ Rlw.\ does\ not\ cause\ of$ the variable	0.357576	0.020928	1.835236	0.745394	0.989793
The variable does not cause of $\Delta\ LogLogLng\ of\ Rlw.$	1.919491	0.944815	0.560452	0.010290	0.738595
	GDP				
Railways Freight **(VECM)**	ΔV		ΔL		
ECT	-0.514**		-1.617***		
ΔL_{t-1}	0.214		0.877**		
ΔL_{t-2}	0.304		1.162***		
ΔL_{t-3}	0.601**		0.916**		
ΔL_{t-4}	0.434*		0.621		
ΔV_{t-1}	-0.083		-0.375*		
ΔV_{t-2}	-0.094		-0.238		
ΔV_{t-3}	-0.320***		-0.266		
ΔV_{t-4}	-0.130		-0.686		

*Note: *p<0.1, **p<0.05, ***p<0.01*
Source: Own work

As we said before, the highest cointegration was determined between land transportation and economic boost variables. Table 9 shows causality test results between land transportation and economic boost variables.

Table 9. Causality Test Results for Land Transport Infrastructure

	EXIM		Export		Import		GDP		Per Capita	
***Divided Road* (VECM)**	ΔV	ΔL	ΔV	ΔL	ΔV	ΔL	ΔV	ΔL	ΔV	ΔL
ECT	-0.576**	-0.166*	-0.356*	0.189**	-0.643**	0.105	-0.672**	0.107	-1.143**	0.225
ΔL_{t-1}	0.536	0.555***	0.096	0.480**	0.987	0.638***	0.428	0.476**	-0.379	0.653**
ΔL_{t-2}	0.877**	0.122	0.988**	0.136	1.019*	0.103	-0.219	-0.011	-0.219	0.240
ΔL_{t-3}	-	-	-	-	-	-	-	-	-0.745	-0.018
ΔL_{t-4}	-	-	-	-	-	-	-	-	-0.023	0.296
ΔV_{t-1}	0.257	-0.012	0.374*	-0.020	0.128	-0.012	0.170	-0.015	0.562*	-0.075
ΔV_{t-2}	0.155	-0.035	0.059	-0.010	0.045	-0.042	0.194	-0.013	0.498*	-0.082
ΔV_{t-3}	-	-	-	-	-	-	-	-	0.369	-0.068
ΔV_{t-4}	-	-	-	-	-	-	-	-	-0.111	-0.130*
***Motorways* (VECM)**	ΔV	ΔL	ΔV	ΔL	ΔV	ΔL	ΔV	ΔL	ΔV	ΔL
ECT	-0.071**	-0.112***	-0.070**	-0.114***	-0.083*	-0.111***	-0.074*	-0.106***	-0.067**	-0.093***
ΔL_{t-1}	-0.140	0.170	-0.199	0.177	-0.106	0.163	-0.173	0.152	-0.192	0.151
ΔL_{t-2}	0.113	0.223	0.170	0.232	0.109	0.220	0.008	0.202	-0.027	0.189
ΔV_{t-1}	0.023	-0.141	0.178	-0.246	-0.121	-0.067	-0.066	-0.048	-0.096	-0.036
ΔV_{t-2}	0.069	-0.099	-0.065	-0.162	-0.003	-0.053	0.094	-0.003	0.068	0.009

*Note: *p<0.1, **p<0.05, ***p<0.01*
Source: Own work

As seen in Table 9, there is causality from divided rood to EXIM and, export at %5 significance level and to import at %10 significance level. On the other there is not causality from economic boost variables to divided road. Similarly, there is not causality from motorways which is the other variable representing land transportation to economic boost variables and vice versa.

Table 10. Causality Test Results for Infrastructure

$\boldsymbol{Infrastructure}$	$\Delta LogEXIM$	$\Delta LogExports$	$\Delta LogImport$	$\Delta LogGDP$	$\Delta LogPerCapita$
$\Delta\ LogInfra.\ does\ not\ cause\ of\ the\ variable$	0.2114	0.659228	0.99044	0.491921	0.503179
$The\ variable\ does\ not\ cause\ of\ \Delta\ LogInfra.$	0.1886	1.034776	0.00179	0.138181	0.101861

*Note: *p<0.1, **p<0.05, ***p<0.01*
Source: Own work

Infrastructure is the last variable of logistic services. Note that, this variable describes government spending to inland logistic infrastructure. In table 10, there is not causality from infrastructure to economic boost variables and vice versa. Consequently, it is right to say that there are only two infrastructure of logistic services variables, which have causality relationship with economic boost variables. One of them is railway freight and the other is divided road, which have comprehensive causality relationship with the economic boost variables.

We also checked impulse response functions. Impulse response functions pave the way to understand how economic boost variables are affected when a shock emerged in infrastructure of logistic services' variables. We perform impulse response analysis to only infrastructure of logistic service and economic boost variables, which considerably have causality. They are railway freight and divided road. Results are presented at Table 11 and Figure 4.

We can start with divided road. EXIM (total trade) reaches its peak in four periods when one standard deviation occurs in divided road. This reaction only can be meaningful when we compare other pieces of total trade. Export's response is more moderate and long duration to the one standard deviation in divided road. In other respect, import reacts more radically and reach its peak only in two periods. So we can say that import response is more rapidly to the divided road developments than other trade indicators. When it comes to response duration, EXIM and export sustain their responses longer periods than import. Lastly, we can consider about how GDP response to the one standard deviation in railways freight. Surprisingly, GDP

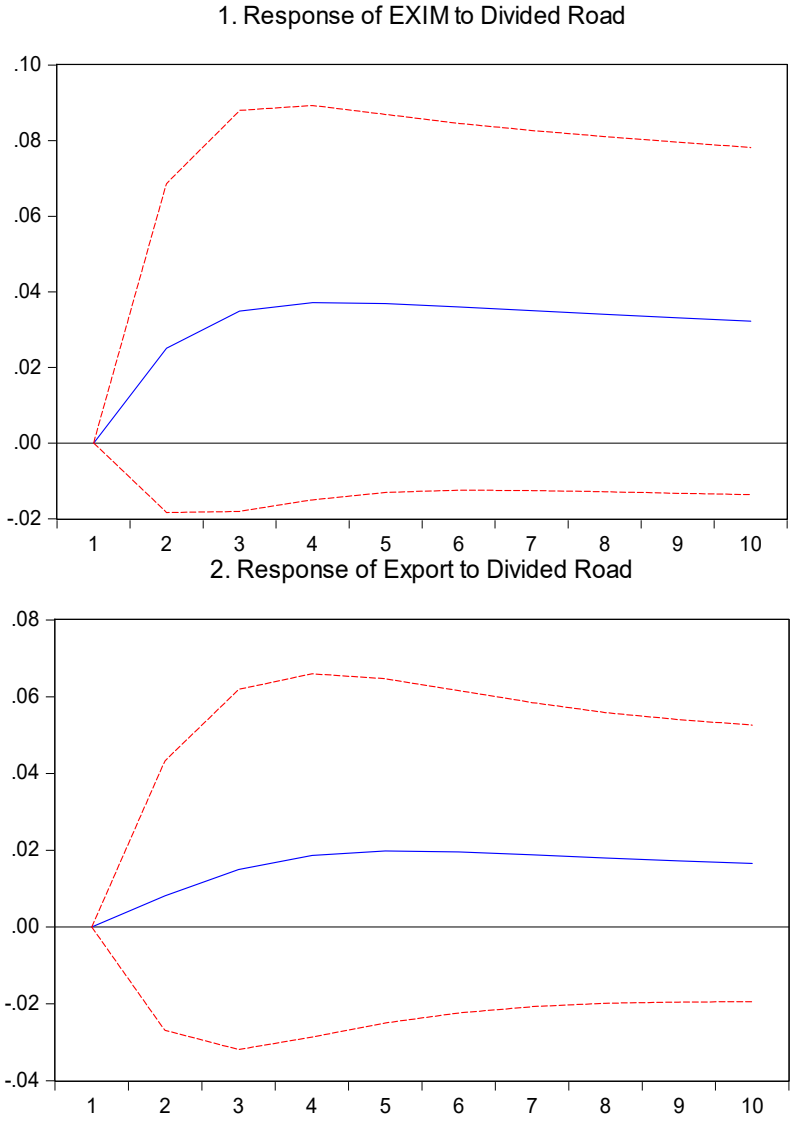
responses negatively to the railways freight. The negative reaction of GDP to the railways freight is lower in short period than long run. However, after seven period, the negative affect loses its virtue, gain steadiness and turn into positive. To conclude, as a part of total economic activity trade generally has a response to divided road, but import has the most delicate response to divided road in short run. So as a part of whole infrastructure of logistic services, we can say that divided road development affects total economic activity and economic boost by way of trade. On the other hand, railways freight brings to a halt GDP that commonly used as indicator of economic boost in both short and long period.

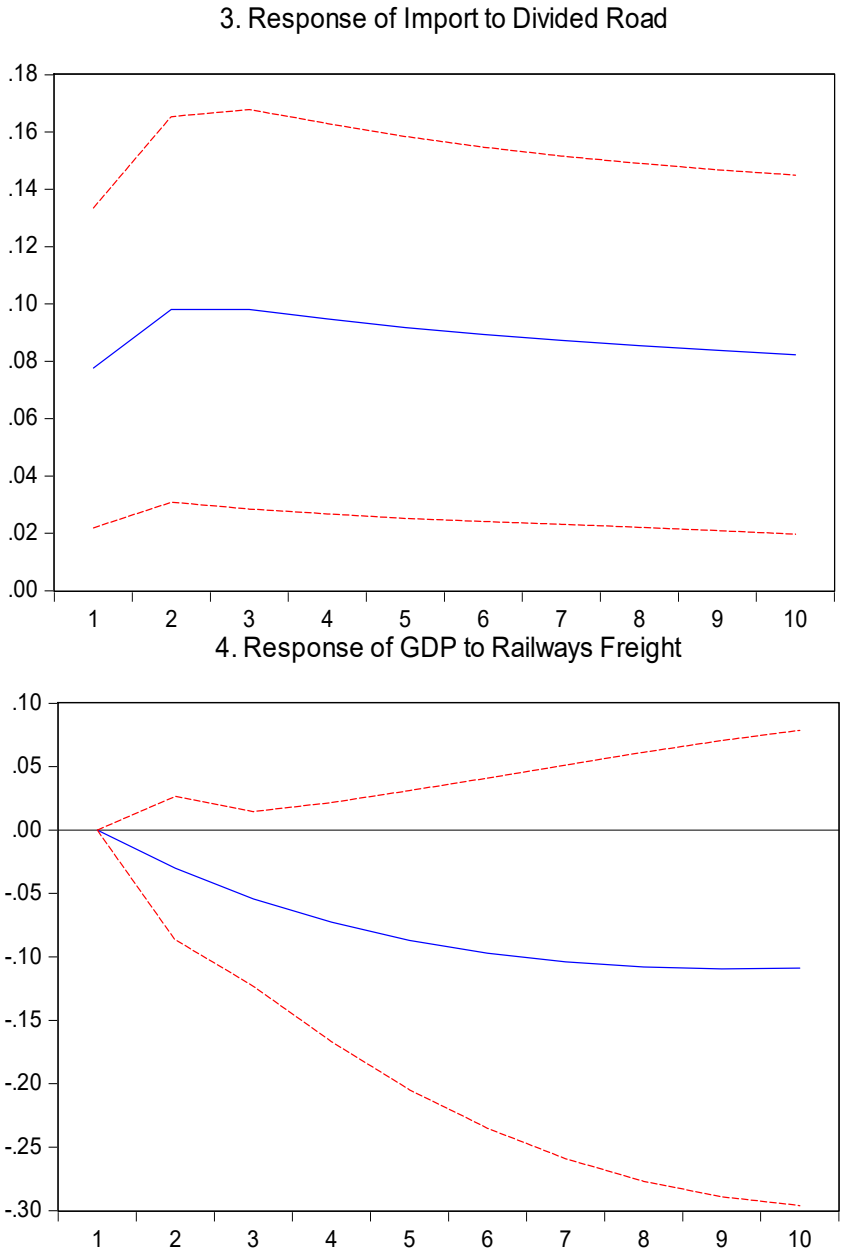
Table 11. Results of Impulse Response Analysis

Period	Divided Road ⬇			Railways Freight ⬇
	EXIM	Export	Import	GDP
1	0.000000 (0.00000)	0.000000 (0.00000)	0.077681 (0.02791)	0.000000 (0.00000)
2	0.025122 (0.02174)	0.008186 (0.01755)	0.098073 (0.03364)	-0.029957 (0.02829)
3	0.034938 (0.02652)	0.014984 (0.02346)	0.098088 (0.03485)	-0.054334 (0.03442)
4	0.037150 (0.02606)	0.018641 (0.02365)	0.094810 (0.03405)	-0.072660 (0.04719)
5	0.036900 (0.02499)	0.019815 (0.02241)	0.091792 (0.03330)	-0.086899 (0.05898)
6	0.036019 (0.02425)	0.019601 (0.02100)	0.089348 (0.03264)	-0.097141 (0.06907)
7	0.035035 (0.02380)	0.018836 (0.01979)	0.087306 (0.03212)	-0.104008 (0.07763)
8	0.034072 (0.02348)	0.017981 (0.01893)	0.085506 (0.03173)	-0.107949 (0.08458)
9	0.033150 (0.02321)	0.017218 (0.01838)	0.083851 (0.03147)	-0.109414 (0.08993)
10	0.032264 (0.02295)	0.016577 (0.01801)	0.082287 (0.03132)	-0.108807 (0.09369)

Note: ( ) is std. deviation
Source: Own work

Figure 4. Graphical Indication of Impulse Response Functions





Source: Own work

5. Conclusion

In this research we investigated the link between infrastructure of logistics services and economic boost in Turkey. We performed some econometric application using 1984-2020 data for this purpose. Contrast to general expectations we

extrapolated that infrastructure of logistics services are not explicit cause of economic boost in Turkey. Some infrastructure of logistics services indicators (air freight, container transportation, length of railways, railways freight, divided road, and motorways) move together with economic boost variables in the long run. If we accept GDP and per capita as indicators of economic boost, only railways freight, divided road, and motorways move together with these economic boost variables in the long run.

Also, we examined causality in addition to the investigation of the long run relationship between infrastructure of logistics services and economic boost in Turkey. Railway freight was single variable which cause GDP. The other variable, which has a causality relationship was divided roads which are the most important inland transportation mode for Turkey. Divided road was cause of EXIM, export, and import despite was not cause of GDP and per capita. No doubt, EXIM, export, and import are components of total economic activity and GDP. So this result means that divided road which is important part of inland transportation with railways can cause indirect economic boost. Also, this result shows us that both total trade and respective export and import are sensitive to divided road as an inland transportation mode.

The main reason why we concluded that there was not any significant evidence between infrastructure of logistics services and economic boost relationship is position of the other transportation modes. Except for inland transportation, modes such as maritime and air transportation were not a cause of economic boost. This result was striking because of maritime transportation. Air transportation has had one of the lowest freight shares comparing to other modes. Note that the mode has been preferred for light in weight but heavy in value goods. So, this result was not a surprise. However, maritime transportation has been the cornerstone of world trade for centuries. The mode has been preferred because of low per unit freight fee by industries and countries including Turkey. However, we could not find any causality from this important mode to economic boost variables. This result indicates that

improvements in infrastructure of other transportation modes, especially maritime, are not adequate to stimulate economic boost in Turkey. In addition, developments and investments in infrastructure of logistics services seem to be made with political concerns rather than economic concerns.

All these results indicate that economic boost in Turkey has not in close relationship with infrastructure of logistics services explicitly. Road transportation and its infrastructure is one step ahead among other modes with regards to economic activity, but it is not enough to conclude that infrastructure of logistics services triggers an economic boost in Turkey.

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