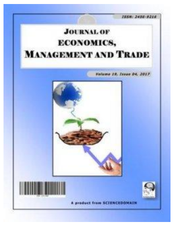

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The Impact of Transportation Infrastructure on Economic Growth: Empirical Evidence from Saudi Arabia

Ghadda M. Awad Yousif[1*]

[1]Faculty of Business and Administration, Princess Nourah Bint Abdulrahman University, Saudi Arabia.

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ABSTRACT

The transport sector is an important factor of economic activity, where it contributes directly to economic activities and employment. The road has a large indirect impact on all the other sectors and activities in the economy. The study aims to investigate the causality relations between road land and economic growth in Saudi Arabia. The study is based on secondary data gained from Saudi Arabia Monetary Agency and World Bank over the period of1988 to2017. The Granger causality test was used to investigate the relationship between the variables with Akiake Lag Length Selection Information Criteria, while Vector Autoregtression (VAR) model was used in order to find the causality. The result reveals unidirectional causality form real GDP to road; however, there is no evidence to support that transportation infrastructure is the cause of economic growth. Granger causality from GDP to investment in infrastructure indicates that reinvestment in infrastructure is caused by economic growth and not vice versa. Economic growth drove pressures on existing transport infrastructure and required additional investment. The finding is in line with the commonly accepted notion advocating that economic growth or development provide necessary financial and technical support for transportation infrastructure investment and improvement.

Corresponding author: E-mail: gmyousf@pnu.edu.sa, GMYousif@pnu.edu.sa;

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1. INTRODUCTION

Infrastructure is defined as a structure, facilities, services and systems serving a country, city, or area, necessary for functioning the economy. It typically characterizes technical structures such as roads, bridges, tunnels, water supply, sewers, electrical grids, telecommunications, and so forth, and is defined as, "the physical components of interrelated systems providing commodities and services essential to enable, sustain, or enhance societal living conditions [1].

The transport sector is an important component of the economy, because of its intensive use and a common tool used for development. This is even more in a global economy where economic opportunities have been increasingly related to the mobility of people, goods and information. A relation between the quantity and quality of transport infrastructure and the level of economic development is apparent. High-density transport infrastructure and highly connected road networks are indicators of high levels of development. At the macroeconomic level, the evidence shows that there is a strong relationship between expenditure on infrastructure and the growth of real GDP. While investment in infrastructure has a very high return, the importance of particular types of infrastructure declines beyond ascertains the level of GDP. At higher income levels - as in developed countries - its power and telecommunication tend to have higher share in GDP than roads and water. On the other hand low-income levels, as in developing counties, water shows the highest GDP share followed by transport [2].

Transport projects have various impacts on a community's economic development In general; transport projects improve overall accessibility and reduce production costs. This tends to increase economic activities and development. Some examples of the effectiveness of transportation include:

A new highway or public transport service increases a community's access to other areas. This increases businesses' labor pool, reduces their costs to obtain input materials and services, and expands their potential market. This may increase "economies of scale" in production processes, which means higher productivity through lower costs per unit of output.

- Improved accessibility may increase workers' ability to access education and employment opportunities (increasing their productivity and income) and increase access to recreation and cultural opportunities (increasing their welfare).
- New transportation links between cities and ports, and new types of inter-modal facilities and services at those locations make it possible for new patterns of international trade to develop. In some cases, the new links may improve the efficiency of business customer/client visits as well as product deliveries.
- Rising demand is driven by increased urbanization of population that creates a challenge for transportation providers in terms of maintaining an efficient and productive transport system in the face of population changes.

One of the key factors that play a pivotal role in a region's economic growth is the presence of a reliable and efficient transportation system. The provision of efficient infrastructure encourages investment in less developed areas by allowing wider movement of goods and people facilitates information flows and helps to commercialize and diversify the economy. Efficient transport systems provide economic and social opportunities and benefits that result in positive multipliers effects such as better accessibility to markets, employment and additional investments. When transport systems are deficient in terms of capacity or reliability, they can have an economic cost such as reduced or missed opportunities and lower quality of life. At the aggregate level, efficient transportation reduces costs in many economic sectors, while inefficient transportation increases these costs. In addition, the impacts of transportation are not always intended and can have unforeseen or unintended consequences. Transport sector carries an important social and environmental load, which cannot be neglected. Assessing the economic importance of transportation requires categorization of the type of impacts it conveys. These involve core (the physical characteristics of transportation), operational and geographical dimension [3].

Saudi Arabia is a vast country of 2,149,690 km^2, and is the second largest Arab state in Western Asia. The Kingdom has been categorized as a high-income state, and it is member of the “Group of Twenty” (G-20) world major economies. With a total population of approximately 32 million, motor vehicles remain the major means of transportation within, and in-between cities in the country. The country is endowed with abundant natural resources that could be well utilized to achieve higher levels of economic development. However, these resources cannot be isolated for getting efficient infrastructure, most importantly well-developed transport system. Considering the fact that the Kingdom possesses all these ample resources, it would have achieved the desired economic progress (economic growth, trade (imports and exports), domestic capital formation and unemployment reduction and utilization of resources. Against this background, and due to the importance of efficient infrastructure systems, the country needs to transform her abundant resources into real economic development [4].

The transport sector of Saudi Arabia emerged over the past four decades, as a driving force for the economic and social development of the Kingdom. The highway network with over 56,000 km of paved roads facilitates the movement of people and goods across the whole Kingdom [4] (UNDP/SAU10). Ministry of Transport (MOT) of Saudi Arabia in collaboration with international organizations had drafted a National Transportation [5] for developing sustainable transport systems and improving road safety.

Transportation system and intercity movement in megacities of Saudi Arabia is mainly land transport system. Private vehicles are dominating roads, representing the common transport mean for the majority of the population. The number of car ownership in Saudi Arabia rose from 423 per 1,000 people in 2012 to 430 2017 [6]. To support the policymakers and to fill the gap in the literature, the study will try to analyze the causality between current transportation infrastructure and economic growth in Saudi Arabia over the period 1988-2017. The importance of the research stems from the vital role of investment in the development process through improving infrastructure. Infrastructure and investment are both a driver and an engine of growth in developed and developing countries. It is necessary to sustain growth, create employment and it allows entrepreneurs to set economic activities in motion by bringing resources together to produce goods and services. Rapid and sustained economic growth is facilitated by competitive and well-functioning markets. They also have an important role in making the growth process more socially and geographically inclusive. The importance of study takes into consideration the size and abundant resources of Saudi Arabia; it becomes crucial to identify how transport is maximized by making the country's infrastructure more efficient. Moreover, it is very important to recognize how the transport system can contribute to economic growth rates through exports performance, imports, and high employment rates. Therefore, identifying the causality between transport and economic growth helps to know to what extent Saudi Arabia could adjust its transport infrastructure to maximize its national benefits and interests.

The study endeavors to achieve two broad and complementary objectives; firstly, is to analyze the role of the transport sector in economic development in the country. Secondly, to provide decision-making, planning with thorough explanation of the applied relationship between the transport system and the economic development in Saudi Arabia. These objectives are attained by testing two hypotheses; the first is if there is a positive relationship between road infrastructure and economic growth? Second hypotheses if there is a positive relationship between economic growth and road infrastructure?

The rest of the paper proceeds as follows; section two provides a literature review of the transport sector from different aspects and expressed the effects of transportation on economic growth. In addition, a background of the economic growth of Saudi Arabia and its infrastructure is provided. Subsequently, section three outlines the data and methodology adopted; the Dickey-Fuller Unit Root Test applied to test the stationary of the time series. Granger causality test was used to examine the causal relationship between the interested variables. Followed by section reports the results and policy implications of the finding the last section concludes the paper.

1.1 Review of the Empirical Literature

Transport sector contributes to economic development through job creation and its derived economic activities. Accordingly, a direct (freighters, managers, shippers) and indirect (insurance, finance, packaging, handling, travel agencies, transit operators) employment are associated with the transport sector. Producers and consumers make economic decisions on products, markets, costs, location, prices that are themselves based on transport services, their availability, costs, capacity, and reliability.

Weiss [7] examined the impact of infrastructure on economic growth for a sample of 31 developing counties over the period of1970 to 1992. He adopted a growth accounting approach with infrastructure proxies by two variables; power capacity per capita and road length per capita. The estimate suggests that infrastructure positively related to output growth and that the coefficient of the lagged infrastructure variable on current per capita GDP was significant and has a positive sign. In contrast, [8] in their attempt to explain Africa's growth using cross-section regression found no significant effect of either roads railways or electricity generation on productivity. This is interesting and in line with the many studies of Africa, which cite the poor state of its infrastructure.

Most evaluations of Structural Adjustment Programs in Africa aimed to search deficiencies in infrastructure as a major cause of poor supply response in economics under reforms. Adequate transport links encourage farmers to increase their marketable surplus, to use land more intensively, and to adopt more efficient techniques and modern inputs in the end [9]. Furthermore, tested the relationship between infrastructure and per capita GDP involves both sides in terms of the contribution of infrastructure to generate higher demand for infrastructure services [10].

The evidence obtained from the Survey of African Businesses, which measures the competitiveness index of 23 African countries, shows a strong correlation between the quality of infrastructure and the sentiments of foreign business. The result indicates the importance of infrastructure in business decision and operations; it ranks high on a list of complaints about all business and third for foreign-owned firms. Firms overwhelmingly indicate that roads are the most important [11].

Cantos et al. [12] tested the impact of transport infrastructures on the economic growth of both regions and sectors in Spain. An attempt was made to capture the spillover effects associated with transport infrastructures. Two different methodologies were used: the first one adopts an accounting approach based on a regression on indices of total factor productivity, the second uses an econometric estimation of the production function. Very similar elasticity was obtained with both methodologies for the private sector of the economy, both for the aggregate capital stock of transport infrastructure and for the various types of infrastructure. However, the disaggregated results for production sectors are not conclusive. The result confirmed the existence of very substantial spillover effects associated with transport infrastructures.

Peterson and Jessup [13] examined the interrelationship between infrastructure and activity using two Washington State highway infrastructure datasets in combination with county-level employment, wages, and establishment numbers for several industrial sectors for a subset of counties from of 1990 to2004. Methodologies adopted such as vector autoregressions, error correction models, and directed acyclic graphs. Results show the relationship between infrastructure investment and economic activity are often weak and are not uniform in effect.

Kruger [14] investigated the relationship between infrastructure's investments and economic activity in Sweden for the period of1980 to 2000. In order to overcome the problem of endogeneity, independent time scales were used to analyze the relationship. He also examined the dynamics between the variables by testing causality in the Granger point and constructing a vector autoregressive model separately for each timescale. The finding shows the causality nexus between growth and transport infrastructure investment is timescale- dependent since it reverses in a comparison of the short-run dynamics (2 - 4 years) and the longer-run dynamics (8 -16 years). This causality reversal is unique for infrastructure investments compared to investments in other sectors of the economy.

Deng [15] provided an updated survey focusing on estimation of transport infrastructure contributions to productivity and economic growth. The central questions addressed were possible reasons behind the conflicting results reported in the literature on the elasticity of economic output with respect to transportation infrastructure investment. The study remarked that controversial results attributed to ten causes (grouped into three categories). The first related to different contexts; research period, geographical scale, and country's capability in enabling economic development. Second is related to different phenomena that measured different economic sectors, different types of transport, and different quality levels of transport infrastructure; and third is related to distinct ways of measuring a similar phenomenon; to describe the dependent variable and explanatory variable, functional specification, and estimation method of the econometric model. Strong network externalities of transport infrastructure may result in nonlinearity of the relationship between transport infrastructure and economic growth. Moreover, the absence of spatial concerns in infrastructure's impacts is another important source of inconclusive results.

Mohmand et al. [16] tested the impact of transportation infrastructure on economic growth in Pakistan. A panel of data was employed using the unit root, cointegration and Granger Causality (GC) model to test whether causal linkages between economic growth and transportation infrastructure exist. The findings suggest that in the short run, there is no causality between the two variables at the national level, however, a unidirectional causality from economic development to infrastructure investment exist in the long run. At the provincial level, bidirectional causality in the rich and much-developed provinces exists, whereas a unidirectional GC exists from economic growth to transportation infrastructure in the underdeveloped provinces.

Zuo et al. [17] tested the government subsidies to the new energy vehicles (NEVs) technology to help the NEVs companies research their generic technology. Based on the lack of the effective decision-making mechanism for R&D subsidies by the government, avoiding the problems like a waste of the public resources, cheating for taking the subsidy and so on. Three-way decision theory is employed to solve the mechanism design, and the government's actions represent subsidize, delay decision-making and do not subsidize

1.2 Transport Sector in Saudi Arabia

Kingdom of Saudi Arabia is a vast country, where the main populated areas are not only scattered all over the country but also separated by deserts, sand dunes, valleys and mountains. Fast and reliable means of transportation become more important and essential. The principal aim of road construction in Saudi Arabia is to connect major urban centres with surrounding villages and towns, thereby opening up the entire nation to develop and to enable improvements in the quality of life by providing citizens with the ability to commute or move from place to another. Road construction has been a significant feature in the Kingdom's development and has dictated patterns of traffic movement. Most development projects, whether for public services, religious purposes, agriculture or industry, have required the construction of new roads [5].

The transport sector of Saudi Arabia emerged in the past as a driving force for economic and social development. The highway network length with over 56,000 km of paved roads facilitates the movement of goods and people across the whole country. Road fatalities in KSA have increased over the last decade from 17.4 – 24 km per 100,000 population compared with 10 in USA, and 5 in UK. Updated traffic regulations and technology-supported procedures to manage traffic and detect traffic violation have increased road safety and significantly reduced accident fatalities. To improve urban transportation in the major cities of the Kingdom integrated public transport concepts need to be developed, to include light rail and dedicated bus services. The railway network is expanding and thereby creating a regional railway network to facilitate high-speed passenger trains and support multimodal transport of goods. Private sector participation in aviation is enhancing competitive air transport services [5].

The massive growth in the use of motor transport worldwide witnessed in the early 20th century and has transformed every country on the planet. However, no country has changed more dramatically than Saudi Arabia; the world's leading oil producer. At the start of the 20th century, Saudi Arabia's population was small and the country had few industries, but currently is heavily industrialized with its enormous oil production slaking the world's demand for fuel. The government has now set aside huge sums of money to develop further its transport infrastructure system. Public and private transportation will both benefit from this massive investment program. Saudi Arabia government's plan to implement a multimodal transportation system includes new railways, metros, traffic systems, buses, bridges and roads. Huge infrastructure development at Riyadh (Saudi capital) where a multimodal transportation system of metros and buses will be ready to use by the end of 2019 [18].

Considering the Saudi budget for the period of 1990 to 2015, allocations of the transport and communications sector have seen escalating, as

Table 1. Contribution of transport sector in Saudi's GDP

Years	Share of Transport Sector in GDP as %	Budget of the transport sector in million (SR)
1990- 1995	2.11	8,268.1
1996- 2000	1.99	6,652.2
2001– 2005	1.36	6,458.4
2006-- 2010	4.02	11,951.3
2011–2015	5.46	47,261.4

Source: Saudi General Authority for Statistics (2015) [19]

shown in the Table 1a. It is observed that when there is a budget increase for the sector, the contribution to GDP increases at a high rate, indicating that the transport sector is a high-productive sector in terms of its growing contribution to the GDP growth of the country. However, there are a number of challenges ahead in the Kingdom's pursuit to meet its Saudi Vision 2030 objective of leveraging its location at the crossroads of three continents. The country's ranking with regard to global indices of competitiveness and logistics have declined since 2016 when the national plan was unveiled. The government expenditure on infrastructure and transportation increased 86% from SR 29bn ($7.7bn) to SR 54bn ($14.4bn) in 2018 budget [20].

Saudi Vision 2030 clearly acknowledge that it is necessary to improve the commercial environment and logistics systems if the nation and its businesses are to play an increasingly significant role in global trade, it must make improvements to its commercial environment and logistics systems [21]. One of the strategic objectives is to increase the country's position in the World Bank's 2016 Logistics Performance Index (LPI). The LPI is composed of three inputs: customs, infrastructure and service quality. In line with Saudi Vision 2030, Saudi Arabia is aiming to improve its current LPI position of 52nd to 25th." According to Saudi inter-city highways [21] the Kingdom's cross-border trade systems also a welcoming alarm with the country's performance., "Doing Business 2018".a world bank survey among 190 countries' business environments, the ease of doing business index shows Saudi Arabia ranked 161st out of the 190 countries. In terms of transport infrastructure, the Kingdom ranked 53rd for railways, 46th for air transport and 42nd for the quality of its ports, while its roads were ranked 34th – this reflects the improving situation or stable scores in each category. In addition to that, the reforms outlined in Saudi Vision 2030 and the objectives detailed in the NTS would help Saudi Arabia improve its ranking in all of these international indices and comparisons [22].

2. METHODOLOGY AND DATA

To accomplish the prescribed objectives and to validate the hypotheses, the study utilized econometric Granger [23] causality test and Akiake Lag Length Selection information criteria. The study also used Vector Autoregressive Model (VAR) to interpret the dynamic relationship between the variables. Since Granger test and (VAR) Model were performed between stationary time's series, the stationary (unit root) test was used. To make this reliable, a time series secondary macroeconomic dataset comprising annual observations for the periods from 1988 to 2017) was generated from World Bank reports [24] and Saudi Arabian Monetary Agency [25].

The unit root is a commonly used statistical test to determine whether each data series is non-stationary (that is unit root exist) or stationary (unit root do not exist). The importance of this test stems from the fact that it forms the preamble to the econometric analysis of long-run equilibrium relationships proposed by economic theory. On the economic grounds, the conceptual existence of equilibrium relationship proposed by economic theory that there exists the belief that certain economic variables should not wander freely or be independent to each other, instead, they are expected to move so that, they do not drift too far apart. Therefore, to develop a meaningful relationship between the underlying variables, the stationary properties of the data are examined in a preliminary step under a univariate analysis by implementing the Augmented Dickey- Fuller (ADF) test for the unit root (non- stationary), on pair of time series of paved roads and real gross domestic product that denoted as (ROAD) and (RGDP), respectively.

Since the critique of Sims [26] in the early eighties of the last century, multivariate data analysis in the context of VAR (henceforth: VAR) has evolved as a standard instrument in econometrics. Because statistical tests frequently used in determining inter-dependencies and dynamic relationships between variables, this methodology soon enriched by incorporating non-statistical a priori information. VAR models explain the endogenous variables solely by their own history.

The stationary VAR allows interpretations on the dynamic relationship between the variables. The VAR model for paved roads and real gross domestic product, formulated as:

$$RGDP_t = \delta_1 + \sum_{i=1}^{P} \beta_{1i}\, RGDP_{t-i} + \sum_{i=1}^{P} \beta_{2i}\, Road_{t-i} + U_{1t} \quad (1)$$

$$Road_t = \delta_2 + \sum_{i=1}^{P} \alpha_{1i}\, RGDP_{t-i} + \sum_{i=1}^{P} \alpha_{2i}\, Road_{t-i} + U_{2t} \quad (2)$$

Where:

δ, β, α, are parameters.
RGDP : Real Gross Domestic Product.
Road : Paved Roads.
U_t : are the stochastic error terms.

Assumptions about the error terms:

1. The expected residuals are zero: E (U_{1T}) =E $(U_{2t}) = 0$
2. The vector error terms are not auto-correlated:

E $(U_t U_s) = \sigma_i^2$ if s= t and
E $(U_t U_s) = 0$ if s≠t

Different tests are conducted using equations (1) and (2), in order to analyze the dynamic relationship between those variables.

The selected order is lag one (1) according to the criteria of Akaike information criterion, implies that we have VAR (1). The equations (1) and (2) of VAR is shown as:

$$RGDP_t = \delta_1 + \beta_1 RGDP_{t-1} + \beta_2 Road_{t-1} + U_{1t} \quad (3)$$

$$Road_t = \delta_2 + \alpha_1 RGDP_{t-1} + \alpha_2 Road_{t-1} + U_{2t} \quad (4)$$

The Granger causality test is a statistical hypothesis test for determining whether one-time series is useful in forecasting another, first proposed in 1969. Ordinarily, regressions reflect "mere" correlations, but Clive Granger argued that causality in economics tested for by measuring the ability is to predict the future values of a time series using prior values of another time series. Since the question of "true causality" is deeply philosophical, and because of the post hoc ergo propter hoc fallacy of assuming that one thing preceding another used as a proof of causation, econometricians assert that the Granger test finds only "predictive causality".

A time series X is said to Granger-cause Y if it can be shown, usually through a series of t-tests and F-tests on lagged values of X (and with lagged values of Y also included), that those X values provide statistically significant information about future values of Y.

To examine the causal relationship between infrastructure and economic activity, Granger (24) causality test was used. Granger's definition of causality based on two notions. The first is that the future cannot cause the past, while the past and present cause the future. The second notion is that causality exists only between two stochastic variables. It is not possible to talk about causality when the two variables are deterministic. Granger's test utilizes a one-sided distributed lag method, which is based to the incremental forecasting value of the past (or past plus present) history of one variable on another. A time series X is said to Granger-cause Y if it can be shown, usually through a series of F-tests on lagged values of X (and with lagged values of Y also known), that those X values provide statistically significant information about future values of Y. From an effective method, the test can be done by first doing a regression of ΔY on lagged values of ΔY. Once the appropriate lag interval for Y is proved significant (t-stat or p-value), subsequent regressions for lagged levels of ΔX are performed and added to the regression provided that they are significant in and of themselves, and add explanatory power to the model.

The above exercise repeated for multiple ΔX's (with each ΔX tested independently of other ΔX's, but in conjunction with the proven lag level of ΔY). More than one lag level of a variable can be included in the final regression model, if it is statistically significant and provides explanatory power.

The Granger causality test involves estimating the following pair of regressions:

$$y_t = \sum_{i-1}^{n} \alpha_i\, x_{t-i} + \sum_{j-1}^{n} \beta_j\, y_{t-j} + \varepsilon_{1t} \quad \text{(i)}$$

$$x_i = \sum_{i-1}^{n} \varphi_i\, x_{t-i} + \sum_{j-1}^{n} \delta_j\, y_{t-j} + \varepsilon_{2t} \quad \text{(ii)}$$

With the assumption that the disturbances ε_{1t} and ε_{2t} are uncorrelated. Four cases will be distinguished:

1. Unidirectional causality from x_i to y_t is indicated if the estimated coefficients on the lagged x_i in (i) are statistically different from zero as a group $(\sum_{i=1}^{n} \alpha_i \neq 0)$and the set of estimated coefficients on the laggedy_t in (ii) is not statistically different from zero$\left(\sum_{j=1}^{n} \delta_j \neq 0\right)$
2. Unidirectional causality from y_t to x_i is indicated if the estimated coefficients on the lagged y_t in the (ii) are statistically different from zero as a group $\left(\sum_{j=1}^{n} \delta_j \neq 0\right)$and the set of estimated coefficients on the lagged x_i in (i) is not statistically different from zero $(\sum_{i=1}^{n} \alpha_i \neq 0)$
3. Bilateral causality is indicated when the set of x_i and y_t coefficients are statistically different from zero in both regression equations (i) and (ii).
4. Independence – occurs when the set of x_i and y_t coefficients are not statistically significant in both regression equations (i) and (ii).

In all the four cases, it is assumed that the two variables are stationary.

The Granger causality test was used in this study to examine whether there is a relationship feedback between econometric models, paved roads and real gross domestic product, or not [27].

Akaike [28] definition of causality used to determine the optimum lag for each variable. The Akaike Information Criterion (commonly referred to simply as AIC) is a criterion for selecting the nested statistical or the AIC is essentially an estimated measure of the quality of each of the available econometric models as they relate to one another for a certain set of data, making it an ideal method for model selection.

The AIC is a number associated with each model:

$$AIC=\ln (s_m^2) + 2m/T$$

Where m is the number of parameters in the model, and s_m^2 (in an AR (m) example) is the estimated residual variance: s_m^2 = (sum of squared residuals for model m)/T. That is the average squared residual for model m. The criterion may minimize over choices of m to form a trade-off between the fit of the model (which lowers the sum of squared residuals) and the model's complexity, which measured by m. Thus an AR (m) model versus an AR (m+1) can be compared by this criterion for a given batch of data.

An equivalent formulation is: AIC=T ln (RSS) + 2K where K is the number of regression, T is the number of observations, and RSS is the residual sum of squares; minimize over K to pick K.

3. RESULTS AND DISCUSSION

3.1 Results of the Study

The result of the ADF unit root tests is presented in Table 1. The table illustrate RGDP is stationary in different one with intercept and significance at 10%, and Road is stationary in different one with intercept and significance at 5%.

Table 2 explains Akaike information criterion (AIC) by determining the optimum lag length via choosing the lower AIC value, as a result lag 2 is the optimum lag for the period from1988 to 2017.

Table 3 presents Granger causality tests results for the period of 1988 to 2017. The results recorded unidirectional causality from real GDP to road in lag (1) representing that the correlation was positive at the last years, because the economic activity was consistently increasing during the 1988 to 2017.

There is a strong positive correlation between the two variables paved roads (Road) and Real Gross Domestic Product (RGDP) R^2=0.78

Table 2. ADF unit root test for paved roads (road) and real gross domestic product (RGDP)

Variable	Test for unit root in	ADF test statistic	Critical value
Real Gross Domestic Product (RGDP)	1st difference	-4.135695	1% → -3.689194 5%→ -2.971853 10%→ -2.625121
Paved roads (ROAD)	1st difference	-7.512889	1% → -3.689194 5%→ -2.971853 10%→ -2.625121

Source: Author calculations based on data from WB and. SAMA reflecting the variables that the infrastructure plays a tangible role in contributing to economic growth and economic growth plays a tangible role in contributing to infrastructure. This indicates that Granger causality analysis can be conduct.

Vector autoregressive (VAR) models facilitate is to ascertain that there are substantial feedback effects and to determine the inter-relationships among the variables. The result presented in Table 5 shows that the coefficients of lagged RGDP (-1) and ROAD (-1) are significant in the regression of the RGDP, and coefficients of lagged RGDP (-2), and ROAD (-2) are insignificant in the regression of the RGDP. While coefficients of RGDP (-1), ROAD (-1) RGDP (-2) and ROAD (-2) are insignificant in the regression of the ROAD.

Table 3. Akaike information criterion (AIC) for the period of1988-2017

Lag	AIC
1	44.50*
2	45.46
3	45.48

Source: Author calculations based on data from WB and. SAMA 2017

Table 4. Correlation test for the period of1988 to 2017

	GDP	ROAD
GDP	1.000000	0.778845
ROAD	0.778845	1.000000

Source: Author calculations based on data from WB and. SAMA 2017

4. DISSCUSION

The results presented in Table 6, shows that there is an unidirectional causality from real GDP to road in lag (1), representing that the correlation was positive for the last years, because the economic activity was consistently increasing during the duration, 1988to2017. In addition, the change in the rate of economic growth is a does cause for a significant change in transportation infrastructure. The analysis provides sufficient proof that there is a unidirectional causal relationship from economic growth to transportation infrastructure and that real GDP Granger causes transportation development. This indicates that GDP is a significant cause for the development of transportation infrastructure in Saudi Arabia, because economic growth drove pressures on existing transport infrastructure and required

Table 5. Granger causality test results for the period of 1988-2017

Null hypothesis	Observations	F-statistic	Probability	Decision
Lags1:2				
ROAD does not Granger Cause RGDP	29	1.69121	0.2049	Don’t reject
RGDP does not Granger Cause ROAD	29	8.25450	0.0080	Reject

Source: Author calculations based on data from WB and. SAMA 2017

Table 6. Vector Auto regression (VAR) results for the period of 1988 to 2017)

Dependent variable	RGDP	ROAD
RGDP(-1)	1.057152 (0.22532) [4.69173]	0.017374 (0.01180) [1.47190]
RGDP(-2)	-0.099995 (0.22476) [-0.44490]	-0.012358 (0.01177) [-1.04961]
ROAD(-1)	6.142121 (4.60106) [1.33494]	0.140884 (0.24103) [0.58451]
ROAD(-2)	-1.631691 (4.61867) [-0.35328]	0.405803 (0.24195) [1.67722]
C	73074.85 (54891.1) [1.33127]	-3484.717 (2875.48) [-1.21187]

Source: Author calculations based on data from WB and. SAMA 2017 additional investment. The result is in line with the commonly accepted support advocating that economic growth provide necessary financial and technical support for the investment in transportation sector(citation needed please). On the other hand, there is no evidence to support that transportation infrastructure is the cause of economic growth.

5. CONCLUSION

The analysis provides sufficient evidence that there exists a unidirectional causal relationship between economic growth and transportation investment in Saudi Arabia, which means that GDP is indeed a significant cause of development of Saudi's transport infrastructure. Saudi Arabia is expected to maintain its position as the Middle East's largest market by more investment in infrastructure, because of the positive association between economic growth and investment in infrastructure. Demand is on the rise for industrial properties, including industrial cities and logistic facilities, and transportation and utilities projects plans. This follows the commonly accepted notion that economic growth provides necessary financial and technical support to transportation, infrastructure and investment for improvement. Hence, improved transportation infrastructure can enhance the efficiency of goods and labour movement for production. The reduction in time and effort required to produce goods, which translated directly into increased regional productivity. In addition, this notion should be supported and developed for efficient infrastructure, which can facilitate a country's economic growth.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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APPENDIX

Null Hypothesis: D(ROAD) has a unit root				
Exogenous: Constant				
Lag Length: 0 (Automatic - based on SIC, maxlag=7)				
Prob.*	**t-Statistic**			
0.0000	-7.512889	Augmented Dickey-Fuller test statistic		
	-3.689194		1% level	Test critical values:
	-2.971853		5% level	
	-2.625121		10% level	
***MacKinnon (1996) one-sided p-values.**				
Augmented Dickey-Fuller Test Equation				
		Dependent Variable: D(ROAD,2)		
		Method: Least Squares		
		Date: 11/21/18 Time: 20:54		
		Sample (adjusted): 1990 2017		
Included observations: 28 after adjustments				
Prob.	t-Statistic	Std. Error	Coefficient	Variable
0.0000	-7.512889	0.210808	-1.583779	D(ROAD(-1))
0.4111	0.835337	708.8904	592.1621	C
513.1429	Mean dependent var		0.684632	R-squared
6554.002	S.D. dependent var		0.672503	Adjusted R-squared
19.36601	Akaike info criterion		3750.682	S.E. of regression
19.46117	Schwarz criterion		3.66E+08	Sum squared resid
19.39510	Hannan-Quinn criter.		-269.1242	Log likelihood
2.025803	Durbin-Watson stat		56.44350	F-statistic

First difference

Null Hypothesis: D(GDP) has a unit root				
Exogenous: Constant				
Lag Length: 0 (Automatic - based on SIC, maxlag=7)				
Prob.*	**t-Statistic**			
0.0034	-4.135695	**Augmented Dickey-Fuller test statistic**		
	-3.689194		1% level	Test critical values:
	-2.971853		5% level	
	-2.625121		10% level	
	***MacKinnon (1996) one-sided p-values.**			
	Augmented Dickey-Fuller Test Equation			
		Dependent Variable: D(GDP,2)		
		Method: Least Squares		
		Date: 11/21/18 Time: 21:08		
		Sample (adjusted): 1990 2017		
	Included observations: 28 after adjustments			
Prob.	**t-Statistic**	**Std. Error**	**Coefficient**	**Variable**
0.0003	-4.135695	0.194351	-0.803777	D(GDP(-1))
0.0118	2.708199	17007.48	46059.64	C
-618.8929	Mean dependent var		0.396807	R-squared
85061.00	S.D. dependent var		0.373608	Adjusted R-squared
25.14110	Akaike info criterion		67321.49	S.E. of regression
25.23625	Schwarz criterion		1.18E+11	Sum squared resid
25.17019	Hannan-Quinn criter.		-349.9753	Log likelihood
1.689660	Durbin-Watson stat		17.10397	F-statistic
			0.000328	Prob(F-statistic)

FIRST DIFFRENCE

Pairwise Granger Causality Tests			
Date: 11/21/18 Time: 21:15			
	Sample: 1988 2017		
		Lags: 1	
Prob.	**F-Statistic**	**Obs**	**Null Hypothesis:**
0.2049	1.69121	29	ROAD does not Granger Cause GDP
0.0080	8.25450	GDP does not Granger Cause ROAD	

Vector Autoregression Estimates
Date: 11/21/18 Time: 21:21
Sample (adjusted): 1990 2017
Included observations: 28 after adjustments
Standard errors in ( ) & t-statistics in [ ]

ROAD	**GDP**	
0.017374	1.057152	GDP(-1)
(0.01180)	(0.22532)	
[1.47190]	[4.69173]	
-0.012358	-0.099995	GDP(-2)
(0.01177)	(0.22476)	
[-1.04961]	[-0.44490]	
0.140884	6.142121	ROAD(-1)
(0.24103)	(4.60106)	
[0.58451]	[1.33494]	
0.405803	-1.631691	ROAD(-2)
(0.24195)	(4.61867)	
[1.67722]	[-0.35328]	
-3484.717	73074.85	C
(2875.48)	(54891.1)	
[-1.21187]	[1.33127]	
0.730589	0.981700	R-squared
0.683735	0.978517	Adj. R-squared
2.97E+08	1.08E+11	Sum sq. resids
3591.389	68557.20	S.E. equation
15.59283	308.4587	F-statistic
-266.1926	-348.7682	Log likelihood
19.37090	25.26916	Akaike AIC
19.60879	25.50705	Schwarz SC
11701.21	1732085.	Mean dependent
6386.112	467746.2	S.D. dependent
5.28E+16	Determinant resid covariance (dof adj.)	
3.56E+16	Determinant resid covariance	
-613.0194	Log likelihood	
44.50138	Akaike information criterion	
44.97717	Schwarz criterion	

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