Road Transport Infrastructure and Economic Growth in Kenya

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Abstract

The empirical debate on the role of road transport infrastructure on domestic economic growth is inconclusive and is characterized by two main opposing views: the road-led economic growth hypothesis and the distorting effect of infrastructure growth hypothesis. The objective of this paper is to examine the effect of road transportation infrastructure on economic growth in Kenya using time series data over the period 1990-2020. Empirically, the study develops a transport-growth model that is an extension of Solow (1956) neoclassical growth function and estimates the model with time series data of Kenya. The study adopted Autoregressive Distributed Lag (ARDL) model and Granger causality approach as the technique for testing the study relationship. The key finding of this study demonstrated that the growth in road length as proxied by road sector expenditure contributed positively to economic growth in both short-run and long run. Applying error correction model, it was observed that there is causality between road infrastructure development and economic growth. This study, therefore, interrogates and accepts the infrastructure–growth hypothesis that increased road transport infrastructure stimulates long-run economy expansion in the Kenyan context. The study suggests that expansion of road transport infrastructure will lead to substantial growth of the Kenya economy though gross capital formation. Therefore, within its stated scope, this finding informs the formulation of relevant and vibrant study transport policy to boost road infrastructure growth and hence sustainable economic growth in Kenya.

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1 Introduction

Economic literature and growth theories identify transport infrastructure development as one of the ingredients of sustaining development and key for accelerating economic growth in any economy (Pradhan & Bagchi, 2013). Of these transport infrastructures, road infrastructure is crucial in increasing connectivity across the country, accelerating gross capital formation, reducing cost of production through reduced transport costs and increasing the movement of human capital, goods and services among others. A number of road project economic analyses using HDM-4 model support the core role of good road network project in enhancing efficiency in road transport movement and cutting cost and time wastage in population traffic (Boopen, 2006; Rudra *et al.*, 2013). According to the empirical works of Boopen (2006) better developed road network will provide the needed linkages between spatially separated facilities, enables social contact and interaction possible as well as providing access to better education , health and major key social services that accelerate further economic growth and sustainable development (Rudra *et al.*, 2013).

Empirical studies argue that well developed infrastructure sectors can influence local economic growth and development in a number of ways through influencing growth production function. First, as an input road transport infrastructure can influence economic growth function as unpaid direct factor of production. Second, better developed and efficient transport infrastructure can make other existing infrastructure to be more productive. For instance well maintained and designed road network reduce time of passenger and goods and services movement, and thus reducing the cost of production process. Finally through agglomeration, good road network will attract new investors and thus grow local economy (Pradhan & Bagchi, 2013; Gisore, 2022).

Kenya's ambitious plan to build more road infrastructure and improve transport network has been informed by the desire to increase road connectivity since increased connectivity will translate to the positive multiplier on the overall economic growth. In addition, it is noteworthy that these efforts are not only geared towards construction of international trunk roads but also county, urban, rural and the feeder roads in efforts of increasing connectivity and growing capital formation. From Kenya's vision 2030 blue print to independence economic sessional paper, road transport network development has been the major objective. In Kenya road transport remains the major mode of transport carrying the about 80 percent of all cargo transported and passenger traffic (KeNHA, 2021). As reported in 2010, the length of the entire Road Network in Kenya is 160,886 km of five classifications (A, B, C, D, E).

A review of the current efforts in road infrastructure development in Kenya reveals that the government has focused on different financing models in attempts to diversify financing source at its disposal (Ng *et al.,* 2019). These include the use of annuity financing, development loans from China and other development partners, international loans from World Bank, issuance of the sovereign bonds as well as the infrastructural bonds through the Nairobi and International securities exchange. Further effort are being undertaken to adopt public- private partnership (PPP) as a move by the government to solve the financing gaps. All these efforts are clear indication of the key role the road infrastructure plays in enhancing economic growth through capital formation in Kenya (Rudra et al., 2013). However, the fact remains the demand for road transport in Kenya outstrips supply given the transport sector is entirely dependent on roads transport networks. In addition, the reviewed empirical literature presents mixed and inconclusive results as well. Given the above mentioned concerted efforts by the government towards development of road transport network and inconclusive empirical findings, investigations on the relation between road transport infrastructure and economic growth in Kenya with an aim of informing policy implications is core.

2 Literature Review

The debate on the impact of road infrastructure development on economic growth is inconclusive and is characterized by two main opposing views: the transport-led economic growth hypothesis (Barro, 1990) and the distorting effect between transport and Growth (Mendoza et al., 1997). Barro (1990) empirical work and theory has greatly influenced the theoretical literature on the relation between road infrastructure and economic growth. The empirical work identified the core role of infrastructure development on economic growth. However, Barro (1990) noted that positive effect of infrastructure development on roads can be wiped out completely by the taxes levied by the government to finance them. This finding was affirmed by the latter studies (Garcia-Mila et al., 1996; Mendoza et al., 1997) who concluded that the negative effect of government infrastructure spending on economic growth simply arises from the distortions and the disincentives effects arising from taxation as a source of financing infrastructural projects. As captured in public economics and public finance, these distortions arise from the government's domestic borrowing to finance infrastructure through the open market operations which increase the cost of funds in the local market thus crowding out private sector borrowing, which plays a major role in capital formation and growth.

The Solow growth model (Solow, 1956), in its original form, does not talk about road infrastructure; it rather identifies labor, capital and technological advances as the main determinants of economic growth. However, it was later extended to include other factors such as population growth, savings as well as infrastructure amongst others (Barro, 1990; Gisore, 2021). Within the modified Solow model, which supports the infrastructure led economic growth, road is included as an additional input in the neoclassical aggregate production function while labor, capital and technology are the main factors influencing economic growth through capital formation (Tang & Tan, 2017).

From the reviewed empirical literature, it is evident that different empirical studies report mixed results and some are inconclusive on the relationship between transport infrastructure investment and economic growth. Some of the studies report a positive relationship while others report a negative relationship between road infrastructure development and economic growth. For instance, Boopen (2006) report a positive relationship in 38 sub-Saharan countries while Garcia-Mila et al. (1996), report a negative relationship in United States between road infrastructure and economic growth. Therefore, there is need to analyse the Kenyan scenario to provide concrete information on the trend and effect of road network development on economic growth.

3 Research Methodology

3.1 Area of Study

The research was carried out in Kenya. Kenya is located in the East African region. Kenya's latitude and longitude are 0.0236° S and 37.9062° E respectively (Gisore, 2021). Kenya has done major capital investment in road transport infrastructure across the economy in order to increase connectivity, spur gross capital formation and accelerate further economic growth. In Kenya road transport network remains the major mode of transport carrying the about 80 percent of all cargo transported and passenger traffic (KeNHA, 2021). As reported in 2010, the length of the entire Road Network in Kenya is about 160,886 km of five classifications (A, B, C, D, E). Figure 1 present the map of Kenya road network showing the location of the study area.

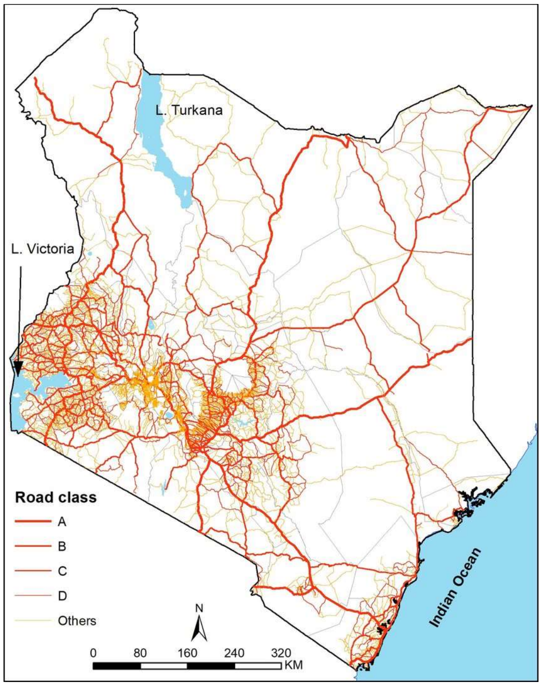

Figure 1: Kenya Road Network.
Source: KeNHA (2021).

3.2 Data and Variables

This section describes the data and variables used in this research. All data and variables used were secondary data obtained from various sources, such as the statistical abstracts, economic survey, World Bank reports, Kenya National Highways Authority (KeNHA), *Kenya Roads Board* (*KRB*) and International Road Federations (IRF) over the period from 1990 to 2020. The description of variables and data sources is given in Table 1.

Table 1: Description of Data Variables

Variables	Description	Unit of Measurement	Source
Y_t	Economic Growth	Gross Domestic Product in Million in dollars	World Bank and economic survey
R_t	Road Infrastructure Transport	annual public road spending	World Bank, KRB, and KeNHA
S_t	Gross Savings	annual gross savings % GDP	World Bank reports

3.3 Empirical Model

The study adopted modified fashion of Balaguer and Cantavella-Jorda (2002) regression model to capture the effect of road transport on economic growth. The model has been used in a number of studies like Ng *et al. (*2019) to reveal the effect of road infrastructure on economic growth; this study modified the Balaguer and Cantavella-Jorda (2002) model as shown:

$$LY_t = \alpha_0 + \alpha_1 LR_t + \alpha_2 LS + \mu_t \ldots\ldots\ldots\ldots [1]$$

Where Y_t is proxied by annual real GDP growth, R_t is as defined as road transport infrastructure proxied by road sector expenditure, and S_t is the gross savings variable, μ_t is the stochastic term, L is the natural log, α_0 is the constant term, α_1 *and* α_2 are coefficients associated with the logarithms of R and S, respectively. Logs (ln) of the study variables were used during estimation of the model so as to allow for estimation coefficients to be interpreted as elasticities.

3.4 The Bounds Test Approach

To investigate the existence of a long-run relationship between road transport infrastructure and economic growth portrayed by equation [1], the study employed the bounds testing approach developed by Pesaran *et al.* (2001) within the intuition of the ARDL model. After carrying out unit root tests, the study followed Pesaran *et al.* (2001), Kibet et al. (2019) and Thomi et al. (2021) in transforming equation [1] into the ARDL (p, w_1, w_2) bounds testing model as follows:

$$\Delta LY_t = \alpha_1 + \sum_{i=1}^{p} \alpha_{1i}\Delta LY_{t-i} + \sum_{i=0}^{w} \alpha_{2i}\Delta LR_{t-i} + \sum_{i=0}^{w} \alpha_{3i}\Delta LS_{t-i} + \beta_{11}LY_{t-1} + \beta_{21}LR_{t-1} + \beta_{31}LS_{t-1} + \mu_{1t} \ldots\ldots\ldots [2]$$

$$\Delta LR_t = \alpha_{02} + \sum_{i=1}^{p} \alpha_{2i}\Delta LR_{t-i} + \sum_{i=0}^{w} \alpha_{3i}\Delta LY_{t-i} + \sum_{i=0}^{w} \alpha_{4i}\Delta LS_{t-i} + \beta_{12}LY_{t-1} + \beta_{22}LR_{t-1} + \beta_{32}LS_{t-1} + \mu_{2t} \ldots\ldots\ldots [3]$$

$$\Delta LS_t = \alpha_{03} + \sum_{i=1}^{p} \alpha_{2i}\Delta LS_{t-i} + \sum_{i=0}^{w} \alpha_{3i}\Delta LY_{t-i} + \sum_{i=0}^{w} \alpha_{4i}\Delta LR_{t-i} + \beta_{13}LY_{t-1} + \beta_{23}LR_{t-1} + \beta_{33}LS_{t-1} + \mu_{3t} \ldots\ldots\ldots [4]$$

Where Δ is the difference operator and p and w are lag orders. The null hypothesis for non-cointegration was tested based on the F – statistic (from the Wald test). The bounds test, through the F-statistic (Narayan, 2005), will be used to examine the joint significance of the coefficients on the one period lagged levels of the variables in equations [2 – 4]. Critical bounds values can be obtained from Narayan (2005).

3.5 The Error Correction Model: Granger Causality Test

The direction of causality between road infrastructure and economic growth will be analyzed using the Granger causality test in an error correction framework arrived at from an ARDL (p, w_1, w_2) framework with the following specification:

$$\Delta LY_t = \alpha_0 + \sum_{i=1}^{p} \alpha_{2i}\Delta LY_{t-i} + \sum_{i=0}^{w} \alpha_{3i}\Delta LR_{t-i} + \sum_{i=0}^{w} \alpha_{4i}\Delta LS_{t-i} + \emptyset_1 ECT_{t-1} + \varepsilon_{1t}. [5]$$

$$\Delta LR_t = \alpha_0 + \sum_{i=1}^{p} \alpha_{2i} \Delta LR_{t-i} + \sum_{i=0}^{w} \alpha_{3i} \Delta LY_{t-i} + \sum_{i=0}^{w} \alpha_{4i} \Delta LS_{t-i} + \emptyset_2 ECT_{t-1} + \varepsilon_{2t} \dots \dots [6]$$

$$\Delta LS_t = \alpha_0 + \alpha_1 t + \sum_{i=1}^{p} \alpha_{2i} \Delta LS_{t-i} + \sum_{i=0}^{w} \alpha_{3i} \Delta LY_{t-i} + \sum_{i=0}^{w} \alpha_{4i} \Delta LR_{t-i} + \emptyset_3 ECT_{t-1} + \varepsilon_{3t} \dots \dots [7]$$

Where α_{2i} to α_{4i} are short term dynamic coefficients and ECT_{t-1} is the lagged error correction term derived from the long run regression model specified as in equation [5].

4 Results and Discussion

Table 1 show the Phillips-Peron unit root test results. The unit root test was employed to eliminate any possibility of spurious regressions and erroneous findings (Thomi et al., 2021).

Table 1: Phillips-Peron Unit Root Test Results

Variables	Phillips-Peron at Level		Order	Phillips-Peron at First difference		Order
	t value	P-value		t value	P-value	
Y	-1.891440	0.0565	I(1)	-8.660398***	0.0000	I(0)
R	2.251658	0.9999	I(1)	-7.159593***	0.0000	I(0)
S	-2.801566	0.0661	I(1)	-9.256772***	0.0000	I(0)

Notes: **R**– Road transport infrastructure, **S**– Gross savings, **Y**– economic growth

*** one percent level of significance, **five percent level of significance

From Table 1, economic growth, savings and road transport infrastructure were determined to be stationary after first differencing implying that they are integrated of order one.

Table 2 reports the bound test cointegration results from ARDL regression analysis. In line with previous studies such as Belloumi (2010), Bayesian information criterion (BIC) was used as the model selection criteria.

Table 2: Co integration tests

Dependent Variable	F-statistic	Decision	Conclusion	
Δ(LOG(Y))	5.467883	Cointegrated	Estimate ARDL & ECM models	
Δ(LOG(R))	1.215153	Not cointegrated	Estimate an ARDL model only	
Narayan (2005) Critical Bounds Values				
Critical Values	1%	2.5%	5%	10%
Upper bounds	7.32	5.98	4.96	3.96
Lower bounds	4.42	3.57	2.90	2.25

As presented in Table 2, the results for both bound test indicate that only one co integrating equation which imply that there exists a long-run relationship among the variables in one equation. The study proceeded to apply ARDL model since the long run relationship exists in one equation. Table 3, ARDL was applied to capture the long-run and short run effect of road transport on economic growth.

Table 3: ARDL long-run model result

Dependent Variable: LOG(Y)				
Variable	**Coefficient**	**Standard Error**	**t-Statistic**	**Probability**
LOG(Y(-1))	1.080611	0.202515	5.335963	0.0000***
LOG(R)	0.128404	0.060370	2.126946	0.0427**
LOG(S)	1.265199	0.701233	1.804250	0.0889*
C	1.783672	0.427235	4.174923	0.0013***
*NB: ***, ** and * indicate statistical significance at 1%, 5% and 10% levels of significance, respectively.*				

The goodness of Fit Test	Adjusted R-squared = 0.5737
F-Statics	F (3,31) = 7.6709 P-value(F) = 0.0000
Breusch-Godfrey LM Test	F (1,31) = 12.4787 Prob> F = 0.0000
Breusch-Godfrey Test	F (3,31) = 1.0895 Prob> F = 0.4657

Table 3 result implies road transport infrastructure explains positively economic growth in Kenya. An increase in road infrastructure development by 1% will more than proportionately increase economic growth by approximately 0.12%. This implies that better developed road network will stimulate economic growth in Kenya. The ARDL estimations in Table 3 also demonstrated that the coefficient for the interaction variable between the road infrastructure in both short-run and long-run models was positively significant with economic growth at 5% significance level. This shows that the road infrastructure development enhance capital formation and economic growth. This is particularly true as the development in road infrastructure could improve the transport efficiency, income accumulation, output, delivery of goods, increase capital formation and thus grow the economy. Transport infrastructure can also affect economic growth by changing aggregate demand. For instance, transportation infrastructure construction can create and increase demand for intermediate inputs from other sectors and stimulate multiplier effects in the economy.

These results support the validity of the road transport led growth in the long run in Kenya and are particularly in line with many country-specific studies such as Calderon (2009) and, Chengete and Alagidede (2017) who established a positive relationship between infrastructure development and growth. This can be attributed to improved connectivity and efficiency. An efficient road infrastructure or road network can create a competitive edge in moving goods economically. Conversely, lack of road infrastructure or road network systems are barriers to agriculture, industry and trade, and may hinder the process of urbanization and socioeconomic development and thus slow local growth. However, this study contrasted similar research by Garcia-Mila et al. (1996). In line with the disincentive approach, Garcia-Mila et al. (1996) noted that such a scenario could be attributed to the fact that if infrastructure development is financed by taxation and domestic borrowing then local investors will be discouraged from borrowing to invest and cause crowding out effect as a result of increase in cost of borrowing. This will wipe out all benefits attributed to road transportation infrastructure development.

The coefficient of the gross savings has the expected positive sign and is statistically significant at 10% level of significance. This implies in Kenya gross savings positively affects the rate of economic growth. An increase in savings by 1 percent will more than proportionately increase economic growth by over 1.26 percent in Kenya. Countries with higher rates of savings have had a faster economic growth than those with lower saving rates. Capital accumulation creates greater opportunities for production and the productivity of a country by providing an additional income stream from savings that will be invested in road transport infrastructure development. The finding agree with similar findings by Misztal, 2011) and Sabra and Eltalla (2016), on the effects of savings on economic growth, they concluded that the effects are significantly positive—that is, increases in domestic savings have contributed to the country's economic growth through increase in local investment and capital accumulation.

Table 4 presents Results of the Short run relationship – Error Correction Model (Causality Test). As earlier stated, since the result of the unit root test revealed all the variables are $I(1)$ and there is evidence of cointegration, the Granger causality test is executed in the ECM, which shows the difference between short-run and long-run causalities.

Table 4: ARDL-ECM model

Dependent Variable: D(LOG(Y))				
Variable	**Coefficient**	**Standard Error**	**t-Statistic**	**Probability**
C	2.728862	0.772133	3.534186	0.0025***
DLOG(R)	0.626210	0.341425	1.834105	0.0842*
DLOG(S)	1.406175	0.591965	2.375435	0.0296**
ECT(-1)	-0.797661	0.188221	-4.237905	0.0002***
*NB: ***, ** and * indicate statistical significance at 1%, 5% and 10% levels of significance, respectively.*				

The results indicate that the coefficient of the lagged error correction term (ECT (-1)) has the expected negative sign and is statistically significant at 1% level of significance. This implies the existence of a stable long run relationship and points to a long run co integration relationship between road infrastructure development and economic growth in the long run in Kenya. The coefficient of the lagged error correction term is -0.797661, implying that a deviation from the long run equilibrium following a short run shock is corrected by about 0.798% after one year. This speed of adjustment after a shock is comparatively high and is not only acceptable but also reasonable for a small open economy like Kenya where investing in large road infrastructure is increasingly becoming the new economic model for accelerating economic growth by every regime. Furthermore, the short-run coefficient results indicate similar regression results as captured long-run effects equation. They support the core role of road infrastructure development on economic growth.

The coefficient of determination (adjusted R^2) shows that 57 percent of the dependent variable is explained within the model which implies it fits the regression function well. The F test result indicates that all the independent variables have explanatory power at a 1percent level of significance. The Breusch-Godfrey heteroscedasticity test is designed to ascertain whether or not there exists a heteroscedasticity issue. There is no problem with heteroscedasticit in the model. The Breusch-Godfrey Serial Correlation LM test shows there is a serial correlation. This study used robust standard error to correct the serial correlation problem.

5 Conclusion and Recommendations

From the above regression analysis it is clear the major role of road transport infrastructure on stimulating economic growth is captured by the positive and significant coefficient of the regression model. It shows Kenya's economic growth is responsive to changes in physical infrastructure. This finding support the importance of good road connectivity across the country as captured by Kenya's vision 2030 blue print on infrastructure development. The study supports the multiplier effect of road connectivity across the country on economic growth. The study result maintain the need to increase the supply of new roads in county, urban, rural areas and feeder roads geared towards satisfying increasing demand and also accelerating economic growth in Kenya through cutting production cost. Another key finding of this study was that the increase in savings would lead to rise in infrastructure investment and contributes to economic growth. Most empirical studies emphasizes that the main factor in increasing in-country capital is the increase of savings and that, in that regard, developing countries should prioritize programs that promote domestic savings, in order for capital to be invested towards the most productive sectors like road infrastructure development.

From the findings of this study, there's a necessity for further road transport data disaggregation into public roads and private roads expenditure for deeper policy prescription.

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