# INVESTMENT IN ROAD TRANSPORT INFRASTRUCTURE AND ECONOMIC GROWTH IN NIGERIA: A VECTOR ERROR CORRECTION MODEL APPROACH

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## ABSTRACT
The study examined the investment in road transport and economic growth in Nigeria and used secondary data by employing an ex-post facto research design, using time series data for 1980-2015 on public infrastructure expenditure, exchange rate, and inflation rate measured by the consumer price index. The data were sourced from the Central Bank of Nigeria (CBN) statistical bulletin (2017), National Bureau of Statistics (NBS) and World Development Indicators (2017). Co-integration econometric techniques were applied in the analysis of the long-run equilibrium relationship or co-integration test confirmed the existence of a long-run relationship with Max-Eigen values of two co-integrating equations (Me = 40.98, $P<0.05$); while the trace statistic values showed three co-integrating equations ($t_s = 27.13$, $P<0.05$). The value of -0.21 of the coefficient error correction term suggested that road transport infrastructure investment and economic growth would converge towards its long-run equilibrium at a moderate speed after the fluctuation. The results further revealed that a unit per cent change in road transport investment would positively change economic growth by 0.22 per cent at a 5% significance level.
**Keywords:** Road Investment, Co-integration, Error Correction Model, Economic Growth

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## 1. INTRODUCTION

Many studies have analysed the relationship between infrastructure and economic growth. The consensus from these studies is that the basic infrastructural facilities are related to economic growth including Barro (1988), Aschauer (1989) and (Calderon and Serven, 2008). Pravakar (2010) posited that investment in infrastructure creates production facilities and stimulates economic activities, reducing transaction costs and trade costs. It improves competitiveness and provides employment opportunities to the people. In contrast, a lack of infrastructure creates bottlenecks for sustainable growth and poverty reduction. Infrastructure is a basic amenity or social capital of a country, or a part of it, which make economic and social activities possible by providing transportation, public health and education services and buildings for community activities, railways, airports, hospitals, schools, roads, sewage systems and reservoirs etc. These constitute the major types of infrastructure investment (Sedar, 2007).

The Nigerian economy has experienced impressive growth in recent years in terms of the Gross Domestic Product (GDP). To the National Planning Commission of Nigeria, the country's nominal GDP increased from $166.53 Billion in 2009 to $243.99 Billion and $257.42 Billion in 2011 and 2012 respectively (NPC, 2013). This GDP performance has resulted in the elevation of Nigeria's ranking in the global GDP ranking from 44th in 2010 to 36th in 2012. In 2013 the economy grew at 6.7 per cent (NBS, 2013), while it has grown by 7 per cent average in the last decade. This makes it one of the fastest-growing economies in the world. The growth rate in Nigeria has been quite encouraging when compared with what obtains in other emerging markets and developing economies around the world. For instance, between 2011 and 2012 the emerging markets and developing countries grew at 6.4 per cent and 5.1 per cent respectively.

Economic literature identifies five channels through which infrastructure can positively impact on economic growth: (i) Infrastructure may simply be regarded as a direct input into the production process and hence serve as a factor of production; (ii) infrastructure may be regarded as a complement to other inputs into the production process, in the sense that its improvements may lower the cost of production or its deficiency may create a number of costs for firms, (iii) infrastructure may stimulate factor accumulation for example, providing facilities for human capital development; (iv) infrastructure investment can also boost aggregate demand through increased expenditure during construction, and possibly during maintenance operations; and finally, (v) infrastructure investment can also serve as a tool to guide industrial policy; Government might attempt to activate this channel by investing in specific infrastructure projects with the intention of guiding private-sector investment decisions (Fedderke and Garlick, 2008).

The importance of transport infrastructure to a nation cannot be overemphasized as efficient transport infrastructure facilities act as catalysts for development. There is therefore cause for concern while considering the transport infrastructure base in Nigeria today which compares unfavourably with those of several African nations both in terms of quality and service coverage. In particular, the rural areas, where the bulk of our population resides, are largely deprived of basic pieces of transport infrastructure.

According to Olomola (2003), inadequate provision of transport infrastructure and services provides a basis for explaining the incidence of poverty across various Nigerian communities in both urban and rural areas. The categories of transport problems that can be identified are bad roads, fuel problems (high fuel price, shortage of fuel supply and consequential high transport cost), traffic congestion (long waiting time, bad driving habits, hold-ups), inadequate high passenger capacity/mass transit vehicles and overloading, high cost and shortage of spare parts, poor vehicle maintenance and old vehicles. It is established that inadequate transport facilities and services as well as the constraints imposed on the mobility and accessibility of people to facilities such as markets, hospitals and water sources have grave implications on deepening poverty levels. Thus, there is a need for urgent policy measures to address the prevailing travel and transport problems.

## 2. LITERATURE REVIEW

Investment in transportation infrastructure has been recognized as a crucial growth promoting strategy (Crescenzi et al. 2016). Some recent studies have validated this conclusion on the symmetric impacts of transport infrastructures on economic growth, and these include Kauzen et al. (2020) for Tanzania, Kalan and Gokasar (2020) for Turkey, Popov (2020) for Russia, Hanedar and Uysal (2020) for the Ottman Empire, Babatunde (2018) for Nigeria, Stawiarska (2018) for Poland, Cigu et al. (2019) and Vlahinić Lenz, et al. (2018) for European Union (EU) economies and Xueliang (2013) for China. In India, studies that have found either mutual feedbacks between road infrastructure and economic growth or a unidirectional causality from rail infrastructure to economic growth include Pradhan and Bagchi (2013) and Vidyarthi and Mishra (2020). Furthermore, Saidi et al. (2018) used the generalized method of moments (GMM) technique to establish that transport energy consumption, transport infrastructure and economic growth share positive correlations in Middle East and North African (MENA) countries. The study also used panel causality procedure to demonstrate that a feedback effect exists between economic growth and each of transport energy consumption and transport infrastructure with economic growth.

Bakare (2011) used data spanning from 1979 to 2009 found the presence of a significant relationship between capital formation and economic growth in Nigeria. However, Nigeria from the mid-1980s to 2013 has experienced a GFCF-GDP ratio of less than 20 per cent; this could be a reason for the country's meagre economic performance.

Loto (2011) examined the relationship between government spending and growth in a linear form using the OLS method. The time series were tested for the order of integration of the individual series by conducting a unit root test for stationarity. The study employed each of the variables in the standard Dickey-Fuller test. The essence of using the technique is to identify the relationship between government spending on the chosen sector and economic growth in Nigeria. The variables used include GDP growth rate, Education spending, Health spending, Agriculture, Transport and Communication. The outcome of the result revealed the existence of an equilibrium condition that keeps the variables in proportion to each other in the long run.

In a study on South Africa, Fedderke and Bogetic (2009) investigated several different measures of transport infrastructure, kilometres of open railway lines, kilometres of total roads and kilometres of paved roads. For the latter, the authors employ a panel data set in the estimation with observations from 1970 to 1993. In addition to single-equation non-instrumented estimators, the authors employ instrumental variables to correct for endogeneity bias and reverse causality. The authors distinguish between direct and indirect effects, where the former concerns labour productivity growth and the latter TFP growth, both based on value-added production functions.

Rudra, Nevile, Yuosre and Bele (2013) used autoregressive distributed lag (ARDL) and vector error correction model (VECM) in India using annual data (1970-2012). Found that transport infrastructure cointegrated with foreign direct investment (FDI) and economic growth indicating the presence of a long-run equilibrium relationship among variables.

Andres et al (2008) provided further support along similar lines. The impact of transport infrastructure is felt in terms of international competitiveness as well. When transportation costs fall, high-productivity exporting firms survive and grow, while low-productivity exporting firms are likely to fail. This reallocation raises aggregate productivity and produces non-traditional welfare gains from trade. The reason is that it is costly to export so only those firms that are already productive can overcome such costs and reap new exporting opportunities. Reductions in trade costs, thus, benefit large, productive, skill- and capital-intensive firms more because they export and import (Bernard, Jensen, Redding and Schott, 2007).

Oyesiku, Onakoya and Folawewo (2013) also investigated the impact of public sector investment in transport on economic growth, using Nigeria as a case study. The empirical model for the study was developed using the endogenous growth model in which transport investment entered into the production function as input, using the Ordinary Least Squares (OLS) estimation technique and time-series properties tests conducted on variables. Their findings show that transportation played an insignificant role in the determination of economic growth in Nigeria. An increase in public funding and a complete overhauling of the transportation system in the country was recommended. Onakoya and Somoye (2013) examined the impact of public capital expenditure on economic growth in Nigeria using the three-stage least squares (3SLS) technique and macro-econometric model of simultaneous equations to capture the disaggregated impact of public capital expenditure on the different sectors of the economy. Their study showed that public capital expenditure contributes positively to economic growth in Nigeria. The results also indicate that public capital expenditure directly promotes the output of oil and infrastructure but is directly deleterious to the output of manufacturing and agriculture.

Ojide, Oyedele, Ukwueze, and Ikpeze, (2016) examined rural household earning return to road infrastructure using a structured questionnaire and an interview guide to collect data from 400 households, the findings show that Ogoni community had suffered from inadequate access road. Majority (about 56. 6%) of the households indicated that access road in the community is low. However, the study confirms that household earning return to improvement in road infrastructure in Ogoni community is positive and significant ($p<0.01$). The result shows a marginal effect of 0.303 unit increase in the log-odds of being in a higher category of household income given an increase in the categories of good access road. Therefore, to reduce poverty in the community, there is need for more government, cooperate organizations and people-centered efforts towards the provision of more access road in the community.

Ogundipe, et al. (2020) used GMM regression to investigate the role of road infrastructure on foreign direct investment (FDI) influx in ECOWAS and found that the responsiveness of FDI to physical infrastructures and the responsiveness of economic growth to road infrastructures declined.

Usman. et al (2011), in their study, explained how public expenditure is used as a proxy for public capital which is further decomposed by sectors. This helps to investigate the impact of each sector on economic growth. A multivariate time series framework is used. The Augmented Dickey-Fuller test indicated that two of the variables are stationary at levels. Philip Peron test shows that three are stationary at levels and others at first difference. Results of the regression show that in the short-run public spending has no impact on growth. However, cointegration and VEC results show that there is a long-run relationship between public expenditure and growth.

## 3. METHODOLOGY

This study employed the *ex-post* facto research investigation using a time series data 1980 – 2015 to facilitate the estimation of the models, secondary data was sourced from CBN, WDI (2016). The study attempted to access the existing information and data relating to investments made by the government in road transport and compared it with the macroeconomic data on the economic growth of the country. This was informed by the a priori expectation of inter-linkages of various macro-economic variables driving the economy such as GDP, this study thus developed a mathematical model based on the endogenous growth theory.

### 3.1 Theoretical Framework

The role of infrastructure investment in economic development is scrutinised using two theoretical approaches i.e. the neoclassical theory and the endogenous growth theory. The two theories provide insight into the expected impacts of infrastructure. In recent times, endogenous growth theories explain regional growth through public capital. This discussion further expatriates in the work of Aschuar (1989), Munnell (1990) and Barro (1990).

The improvement in endogenous growth theory aroused research on the long-run impact of infrastructure investment on economic growth. The production function is presented in the form.

$$Y = f(A, K, N) \quad 1$$

Y is output as GDP per capita, A is total factor productivity and technology, K is private capital and taken as per capita gross fixed capital formation in the private sector and N is labour and measured as labour force participation rate.

$$Y_t = f(A_t, K_t^{\alpha}, N_t^{\beta}) \quad 2$$

Since A is endogenous in equation (2), the study incorporates the determinants of total factor productivity as follows:

$$A_t = f(EXR_t, G_t, CPI_t) \quad 3$$

G is public infrastructure expenditure, EXR is the exchange rate and INF is the inflation rate measured by the consumer price index. Substituting equation 3 into equation 2

$$Y_t = f(K_t^{\alpha}, N_t^{\beta}, EXR_t^{\beta_1}, G_t^{\beta_2}, CPI_t^{\beta_3}) \quad 4$$

Taking the natural log on both sides of equation 4

$$\ln Y_t = C + \alpha \ln K_t + \beta_0 \ln N_t + \beta_1 \ln EXR_t + \beta_2 \ln G_t + \beta_3 \ln CPI_t + \varepsilon_t \quad 5$$

Private capital is generally believed to have a favourable impact on economic growth through increased productivity of the economy. It is believed that more private investment minimizes the public funding gap. Public investment in infrastructure is an important input in a growth theory. It is believed that it has a favourable impact on economic growth. The positive contribution of infrastructure investment to productivity was also confirmed by the literature (Aschuar, 1989).

The error term in equation (5) is assumed to have zero means and constant variance. Specifically, the study assumed that:

$$E(\varepsilon_t) = 0$$

$$Cov(X_{it,}\varepsilon_t) = 0$$

$$Cov(\varepsilon_{it}, \varepsilon_{js}) = \begin{cases} \sigma_i^2, & if \quad i = j, \quad t = s \\ 0, & otherwise \end{cases}$$

Thus, equation (5) is the basic model derived from the framework of endogenous growth theory through production function that served as the basis for empirical analysis to examine the relationship between road transport infrastructure investment and economic growth in Nigeria.

## 3.2 Model Specification

**Road Transport Infrastructure Investment and Economic Growth Model**

To examine the impact of road transport infrastructure investment on economic growth, the study drew the empirical model from the endogenous growth model and the theoretical framework that followed. Hence, the estimated model to empirically analyse the impact of road transport infrastructure investment on economic growth was drawn from equation (5) and re-specified as equation (6):

$$\ln Y_t = C + \alpha \ln K_t + \beta_0 \ln N_t + \beta_1 \ln EXR_t + \beta_2 \ln G_t + \beta_3 \ln CPI_t + \varepsilon_t \qquad 6$$

Since road transport infrastructure investment is an input in the production process and a capital investment that is invested by the government to enhance the provision of public goods. This investment in road transport infrastructure is one of the public infrastructure investments by the government to enhance productivity. Thus, the $G_t$ in equation (6) above is replaced as the road transport infrastructure investment which is denoted as (RINV) and $Y_t$ is also replaced as $EC_t$ which implies economic growth. Hence, equation (6) is re-specified as follows:

$$\ln EC_t = C + \alpha \ln K_t + \beta_0 \ln N_t + \beta_1 \ln EXR_t + \beta_2 \ln RINV_t + \beta_3 \ln CPI_t + \varepsilon_t \qquad 7$$

Therefore, equation (7) is used to analyse the impact of road transport infrastructure investment on economic growth in Nigeria.

## 3.3 Estimation Techniques

**The Johansen Tests**

The Johansen tests are called the maximum eigenvalue test and the trace test. Let r be the rank of $\Pi$. This is the same as the number of cointegrating vectors. The Johansen tests are likelihood-ratio tests. There are two tests: The maximum eigenvalue test and the trace test.

For both test statistics, the initial Johansen test is a test of the null hypothesis of no cointegration against the alternative of cointegration. The tests differ in terms of the alternative hypothesis.

**Error Correction Model (ECM)**

An Error Correction Model (ECM) can apply to find out the short-run dynamics of the model. The equation for ECM is

$$\Delta Y_t = \beta_0 + \beta_1 \Delta X_t + \beta_2 ecm_{t-1} + \varepsilon_t \qquad 8$$

Δ is the first difference operator, $\varepsilon_t$ is a random error term and $ecm_{t-1} = Y_{t-1} - \alpha_1 - \alpha_2 X_{t-1}$ that is the one period lagged value of the error term from the cointegrating regression. ECM equation (8) states that ΔY depends on ΔX and also on the equilibrium error term. If the latter is non-zero, then the model is out of equilibrium. Suppose Δ X is zero and $ecm_{t-1}$ is positive. This means $Y_{t-1}$ is too high to be in equilibrium that is, $Y_{t-1}$ is above its equilibrium value. Since $\beta_2$ is expected to be negative, the term $\beta_2 ecm_{t-1}$ is negative and therefore $\Delta Y_t$ will be negative to restore the equilibrium. That is, if $Y_t$ is above its equilibrium value, it will start falling in the next period to correct the equilibrium error. On the other hand if $ecm_{t-1}$ is negative, Y is below its equilibrium value, $\beta_2 ecm_{t-1}$ will be positive, which will cause $\Delta Y_t$ to be positive, leading $Y_t$ to rise in period t. Thus the absolute value of $\beta_2$ decides how quickly the equilibrium is restored.

## 4. RESULTS AND DISCUSSION OF FINDINGS

### Unit root test

This study employs Augmented Dickey-Fuller (ADF) using automatic lag length selection based on Akaike Information Criterion (AIC) and Schwarz Information Criterion (SIC). The result of the unit root test is presented in table 1.

**Table 1: Unit Root Test using Augmented Dickey-Fuller Test (ADF)**

| **Variables** | **Level** | **First Difference** | **Order of Integration** |
|---|---|---|---|
| ***CPI*** | -1.32 | -3.39 | I(1) |
| ***EXR*** | -2.18 | -4.98 | I(1) |
| ***K*** | -0.84 | -5.98 | I(1) |
| ***RGDP*** | 0.75 | -3.40 | I(1) |
| ***RINV*** | 0.54 | -4.57 | I(1) |
| ***REXP*** | -0.70 | -7.47 | I(1) |
| ***Critical Value*** | 5%: -2.95 | | |

**Source: Authors Computation, 2020**

Table 1 shows that the variables employed in the study ranging from real GDP, road transport infrastructure investment, inflation rate, physical capital, and exchange rate to road expenditure were all non-stationary at the level at 5% significance level. Meanwhile, when the variables were subjected to the first difference; the results indicated that all the variables were significant at a 5% level showing that real GDP, road transport infrastructure investment, inflation rate, physical capital, exchange rate and road expenditure are all stationary at first difference. The implication of this was that all the variables were I (1) series indicating that the variables were I (1) order of integration.

## Co-integration Test and Error Correction Model

Having established the order of integration of our series, the study determined the number of long-run equilibrium relationships or Co-integrating vectors between the variables. Since the variables are found to be integrated of the same order, such as I(1) as shown above using Augmented Dickey-Fuller test results, it implies that an equilibrium relationship might exist among the variables. Therefore, this study conducted a Cointegration test in line with the Johansen test taking into consideration the variables that were integrated of order one I(1) using the decision of ADF. This indicated that the following variables were included in the model for estimating the co-integration test – real GDP, road transport infrastructure investment, inflation rate, physical capital, and exchange rate and road expenditure.

Thus, the result of the co-integration test presented in table 2 showed that the Max-Eigen values had two cointegrating equations while the Trace statistic values showed three co-integrating equations since the hypotheses of no co-integration were rejected at a 5% level for both tests using Mackinnon-HaugMichelis (1999) p-values. The study, therefore, concluded that the variables (real GDP, road transport infrastructure investment, inflation rate, physical capital, exchange rate and road expenditure) had long-run co-movement among them and could be used to estimate long-run relationships as well as draw long-run inference.

**Table 2: Johansen Cointegration Test Result**

| Hypothesized No. of CE(s) | Max-Eigen Statistic | 0.05 Critical Value | Trace Statistic | 0.05 Critical Value |
|---|---|---|---|---|
| **R = 0** | 45.18769* | 40.07757 | 136.9548* | 95.75366 |
| **R ≤ 1** | 40.98290* | 33.87687 | 91.76706* | 69.81889 |
| **R ≤ 2** | 25.66910 | 27.13162 | 50.78416* | 47.85613 |
| **R ≤ 3** | 20.26219 | 21.13162 | 25.11506 | 29.79707 |
| **R ≤ 4** | 3.827916 | 14.26460 | 4.852874 | 15.49471 |
| **R ≤ 5** | 1.024958 | 3.841466 | 1.024958 | 3.841466 |
| **MacKinnon-Haug-Michelis (1999) p-values | | | | |

**Source: Authors Computation, 2020**

**Table 3: Short-Run Analysis (Error Correction Mechanism)**

| *Dependent Variable: DLOG(RGDP)* | | | | |
|---|---|---|---|---|
| ***Variable*** | ***Coefficient*** | ***Std. Error*** | ***t-Statistic*** | ***Prob.*** |
| ***C*** | 0.019638 | 0.011232 | 1.748453 | 0.0922 |
| ***ECM(-1)*** | -0.209803 | 0.073964 | -2.836552 | 0.0087 |
| ***DLOG(K)*** | -0.038857 | 0.018720 | -2.075729 | 0.0479 |
| ***DLOG(RINV)*** | 0.218257 | 0.044096 | 4.949597 | 0.0000 |
| ***DLOG(CPI(-1))*** | 0.053032 | 0.042628 | 1.244051 | 0.2246 |
| ***DLOG(EXR)*** | 0.007838 | 0.016231 | 0.482897 | 0.6332 |
| ***DLOG(REXP(-1))*** | -0.013943 | 0.008391 | -1.661684 | 0.1086 |
| ***DLOG(RGDP(-1))*** | 0.360864 | 0.120031 | 3.006415 | 0.0058 |
| **R-squared** | 0.681107 | **Akaike info criterion** | | -4.184595 |
| **Adjusted R-squared** | 0.595251 | **Schwarz criterion** | | -3.825451 |
| **F-statistic** | 7.933146 | **Durbin-Watson stat** | | 1.925843 |
| **Prob(F-statistic)** | 0.000037 | | | |

**Source: Authors Computation, 2020**

In addition, after establishing the long-run relationship among the variables, the study investigated the short-run dynamics of the model using the Error Correction Mechanism (ECM). This shows the speed of convergence towards equilibrium among the variables. The result of the ECM is presented in table 3.

The empirical result presented in Table 3 was analysed with the use of the two-step Engle and Granger (1987) model which suggests that any set of Co-integrated time series has an error-correction representation, which reflects the short-run adjustment mechanism. The motive of the analysis is to discover whether the short-run dynamics are influenced by the estimated long-run equilibrium condition that is, the Co-integrating vectors.

A crucial parameter in the estimation of the short-run dynamic model (ECM) is the coefficient of the error-correction term which measures the speed of adjustment between road transport infrastructure investment and economic growth in Nigeria to the equilibrium level. Table 3shows that the coefficient of the ECM is negatively signed and statistically significant at a 5% level. This indicates that the speed of convergence among the variables towards equilibrium exists and confirmed that the relationship between road transport infrastructure investment and economic growth in Nigeria has an automatic adjustment mechanism. The economy, therefore, responds to deviations from equilibrium in a balancing manner. The value of -0.21of the coefficient of error correction term suggested that the road transport infrastructure investment and economic growth would converge towards its long-run equilibrium level at a moderate speed after the fluctuation in road transport infrastructure investment and economic growth. Eliminating, for instance, 95% of a fluctuation in road transport infrastructure investment and economic growth would take at least 7.56 years to converge in the long run.

Table 3 also shows the short-run relationship between road transport infrastructure investment and economic growth. The result in the table shows that there was a significant short-run relationship between road transport infrastructure investment and economic growth in Nigeria. It was therefore revealed that a unit per cent change in road transport infrastructure investment would positively change economic growth by 0.22 per cent at a 5% significance level. The findings of this result indicate that road transport infrastructure investment would increase economic growth by 0.22 per cent in the short run. This result is validated by the significance level of the F-statistic at 5% which indicates the overall significance of the model. The model also had high goodness of fit as evidenced by the value of the adjusted R-squared which shows that the explanatory power of the model explains approximately 60% of total variations in economic growth while leaving 40% unexplained. The result is further confirmed by the absence of the serial correlation as indicated by the value of Durbin- Watson d*- a statistic that was closed to 2.

## 5. CONCLUSION AND POLICY RECOMMENDATIONS

### 5.1 Conclusion

The study revealed that investment in road transport infrastructures does not have a significant effect on economic growth in Nigeria resulting from a low level of investment in transport infrastructure and the poor state of major road infrastructural facilities in the country but the effects of shocks on road transport infrastructure investment show that road transport infrastructure investment positively affects economic growth permanently in Nigeria which implies that a little increase in road transport infrastructure investment in Nigeria would spontaneously increase economic growth.

### 5.2 Policy Recommendations

i. The VAR/VECM shows that in terms of short-run adjustments a high growth path is critical for attracting private investment and government infrastructure investment on-road transportation. This is another important finding since the policy prescriptions of the National Development Plan place emphasise short-run adjustment. It is thus recommended that government should place an interest in both the short-run and long-run adjustments to the economy to take care of the shocks in the macroeconomic variables that would positively influence economic growth.

ii. Investment in national roads could be utilized to implement the objectives of our national goals as enshrined in the vision 2020 programme, government should establish a special intervention fund similar to that of banking, textiles and entertainment sectors, among others. This will ensure the availability of funds which will accelerate those sectors' development and consequently promotes regional, national and international trade and competitiveness; thereby enhancing efficiency in the movement of goods and services both from internal and external markets

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