

# Econometric Analysis of Transport Sector on Economic Growth in Rwanda (1999-2018)

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## Abstract

The purpose of this study was to examine Econometric analysis of transport sector on economic growth in Rwanda for the period of 1999 up to 2018. It's an empirical study which used econometric techniques such as unit root test, Engle granger test/cointegration test, linear regression model and the error correction model to analyze the contribution of transport sector on economic growth based on Gross Capital formation in terms of transport infrastructures, trade balance as import and export can be affected by transport system, and contribution of transport services to economic growth. This study found that, there was a strong statistically significant relationship between GDP and transport sector as measured by transport services for both short run and long run as it is shown by R-squared of 0.997316 and 0.782009 of the long run regression model and error correction model respectively. ECM showed a quick recovery of 81.3% every year after a shock happen. This study concluded that there is a short run and long run relationship between Transport service and economic growth. This study recommends that policy implication that can be deduced from this study to facilitate transport sector through expansion of road networks and maintenance of existing road networks coupled with revitalization of alternative mode of transportation such as air transport, rail system and waterways will significantly improve the growth of the economy.

## Keywords

Gross Domestic Product, Gross Capital Formation, Trade Balance and Transport Services, and Transport Infrastructures

## 1. Introduction

Rwanda is a landlocked country and it is far from the maritime ports having the nearest port of Dar Es-Salaam approximately 1400 km away.

The country lacks a link to regional railway and Inland Water Transport, which means most trades are conducted by road. Moreover, the country is fully depending on imported fuel for transport. Consequently, transport costs of imports and exports are high and these have negative impacts on the economic growth and development of the country. Transport is therefore considered as a strategic sector to enable the expansion of the Rwandan economic base from predominantly agriculture based into the secondary and the tertiary sectors.

Transport infrastructure in Rwanda is comprised of the following Road transport with a network about 14,000 km, Air transport where Rwanda counts one international airport and six aerodromes with average 1.4 million passengers, Lake transport limited only on Lake Kivu. The transport service sector in Rwanda is rather informal and uncoordinated. Although at present there are 41 companies and cooperatives, the major market share of vehicles comes from individual operators. In terms of total available seat capacity, the individual operators provide 70% of the supply.

Rwandan economy is dominated by subsistence agriculture where 79% of the population is engaged in agriculture. The economy's trade balance is negative where exports are dominated by imports. The country's vision 2020/2050 through its national strategy for transformation one and 2035 agenda is to transform the economy in the lower middle income and upper middle-income economies by 2024 and 2035 respectively [1].

For the country to achieve its target, it requires all sectors of the economy to be more productive. All the sectors of the economy are exposed to the oil price shocks and transportation in general. Policy makers need evidences to inform policies about the economic sectors especially transport sector and how other sectors react to the change in transportation sector.

In general, the research aims at Econometric Analysis of Transport Sector on Economic Growth in Rwanda (1999-2018) in order to identify the contribution of Transport services, Gross Capital formation (Transport infrastructures), and Trade balance on Rwandan economic growth.

To achieve the purpose mentioned, this paper is organized into five sections. Following this introduction, there is Section 2 which focuses on review of related literatures while methodology is discussed in Section 3. Section 4 presents the results and discussions of findings. Conclusion and recommendations are in the last Section 5.

### **1.1. Research Problem**

Transport is a key in economy of a country as all economic activities depend on transport facilities such as people and commodities movement. Level of infrastructure and oil price affect the economy of a country, in 2007, almost twenty percent of World Bank lending was allocated to transportation infrastructure projects, a larger share than that of education, health and social services combined [2]. Previous researcher analysed the relationship between transport infrastructure and per capita income and job creation. Literature of [3] and [4] found

a neutral relationship among infrastructure investment, job creation and per capita income.

Findings of previous research did not analyse impact of transport sector on economic growth. However this sector is subject to oil price shock causing an increase in price level for other commodities. This research aims at analysing the relationship between transport services and economic growth in Rwanda and indicates at which level transport sector is contributing to economic growth.

## 1.2. Research Objectives

The study focuses on the following specific objectives:

- 1) To analyse the influence of Gross Capital formation in terms of transport infrastructures on Economic growth of Rwanda
- 2) To determine the influence of trade balance on Economic growth of Rwanda as it may be affected by the quality of transport system
- 3) To determine the level of contribution of transport services to economic growth of Rwanda

## 1.3. Hypothesis

This research is guided by the following null hypotheses as tentative possible answers that finally at the end we count to confirm or reject:

**Ho1:** Gross Capital formation in terms of transport infrastructures does not have any influence on the economic growth in Rwanda.

**Ho2:** Trade balance does not have any influence on economic growth in Rwanda.

**Ho3:** Transport services do not have any influence on economy of Rwanda.

## 2. Literature Review

There are views about transport infrastructures investment and its relation with jobs creation. The first view suggests a positive relationship between infrastructure investment and jobs creation [4]. The second view finds a neutral relationship among infrastructure investment, jobs creation and an increase in per capita income [3]. The third view argues that public investments, such as roads, airport, ports, enhance income per capita and create jobs [4]. [5], however, noted that the change in infrastructure stock, such as roads, did not significantly create new employment opportunities. In contrast to the above two views, [3] found that there was an extremely impact of infrastructure investment, including roads, on income per capita and jobs creation. Generally, transportation infrastructures carry societal costs, such as public health and safety, which are often ignored in analysing their costs and benefits in the decision-making process [6].

Studies on the Nigerian economy [7] indicate that transportation costs form a significant proportion of the final price of goods. [8] found that there is a positive relationship between transportation infrastructure and economic growth in sub-Saharan Africa. In his research, [9] found that transport facilities were a

major differentiating factor in explaining growth gaps. With Combination of panel data and cross sectional, [10] found that transport capital contributes to economic growth for Africa countries.

The [11] panel causality analysis shows the feedback effect of transport energy consumption and transport infrastructure with economic growth. The empirical results add a new dimension to the importance of investing in modern infrastructure that facilitates the use of more energy-efficient modes and alternative technologies that positively affect the economy with minimizing negative externalities.

Principles of development (increasing well-being and equity) as well as sustainability (preserving natural and man-made capital) should be inherent in sustainable transport policies and manifested in transport trends [12].

We lack a rigorous empirical understanding of the extent to which transportation infrastructure projects actually reduce the costs of trading, and how the resulting trade cost reductions affect welfare.

### Conceptual Framework

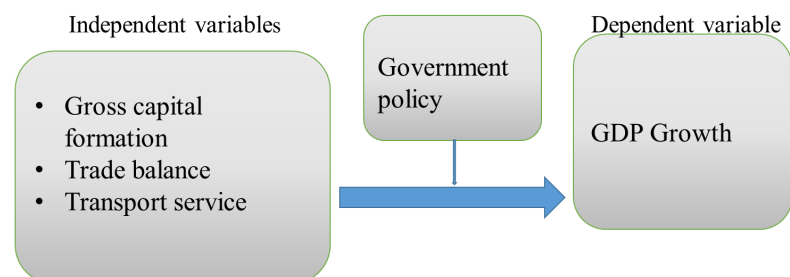
In **Figure 1**, Gross Capital formation is used in this model as transport infrastructures where government provide Roads, airports, railways, and ports to increase transport service, the more the quality of transport infrastructures, the more investors will likely to invest in transport, the more transport cost decreases and rate of unemployment decrease, the more the cost of transport of commodities decrease, the more trade will be facilitated. Trade balance is the difference between export and import, transport service represents air transport, land transport and water transport.

## 3. Research Methodology

### 3.1. Data and Data Source

Secondary data on gross domestic product, gross capital formation, transport services and trade balance were extracted from the national institute of statistics of Rwanda (NISR) from 1999 up to 2018. This study has a sample of 19 annual periods from 1999-2018.

Variables used:



**Figure 1.** Conceptual frameworks.

### 3.2. Model1: Long Run Regression Model

$$GDP = C(1) + C(2)*GROSS\_CAP + C(3)*TRANSPORT\ SERVICE + C(4)*TRADE\ BALANCE + \mu$$

where GDP denote gross domestic product, GROSS\_CAP denote gross capital formation, transport services to denote income from transport activities and trade balance is the total export minus total import.

### 3.3. Model 2: Error Correction Model

$$D(GDP) = C(0) + C(1)*D(GROSS\_CAP) + C(2)*D(TRADE\_BAL) + C(3)*D(TRANSP\_SERVICES) + C(4)*U(-1) + \mu$$

where  $D(GDP)$  denote change in gross domestic product,  $D(GROSS\_CAP)$  denote change in gross capital formation,  $D(transport\ services)$  to denote change income from transport activities,  $D(trade\ balance)$  is change in total export minus total import and  $U(-1)$  denote the error correction term of lag one.

## 4. Results

This chapter presents the result of empirical analysis of transport sector on economic growth in Rwanda. This result produced using Eviews7 are presented as below.

### 4.1. Unit Root Test

The result of unit root test presented in **Table 1** shows that GDP, gross capital formation and trade balance are integrated at first difference (“I(1)”order one) whereas transport services is integrated at second difference (“I(2)”order two). This means that each variable under study has a time trend.

### 4.2. Cointegration

To proceed, the researcher conducted cointegration test to see if the linear combination of the variables under study is stationary. The result of cointegration presented in **Table 2** shows that the linear combination is stationary indicating that there is cointegrating relationship among the variables under study, or the error term is stationary.

### 4.3. Granger Causality

The result of granger causality in **Table 3** shows that gross capital formation,

**Table 1.** Unit root test results computed with Eviews7.

Variables	ADF Test				Decision
	Model	ADF <sub>calculated</sub>	ADF <sub>critical</sub>	Probability	
GDP	Trend and Intercept	-3.865956	-3.710482	0.0381**	I (1)
GROSS_CAP	Trend and Intercept	-4.139886	-3.710482	0.0235**	I (1)
TRADE_BAL	Trend and intercept	-5.268142	-4.616209	0.0031***	I (1)
TRANSP_SERVICES	Tend and Intercept	-5.342771	-4.616209	0.0027***	I (2)

(\*), (\*\*) and (\*\*\*) denotes Stationary at 10%, 5% and 1% levels of significance respectively.

**Table 2.** Cointegration test results computed with Eviews7.

Variable	Engle Granger (EG) Test				Decision
	Model	EG <sub>calculated</sub>	EG <sub>critical</sub>	Probability	
Residual	None	-3.364965	-2.692358	0.0020***	I (0)

(\*), (\*\*) and (\*\*\*) denotes Stationary at 10%, 5% and 1% levels of significance respectively.

**Table 3.** Granger causality test results computed with Eviews7.

Pairwise Granger Causality Tests

Date: 07/30/19 Time: 01:16

Sample: 1999 2018

Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
GROSS_CAP does not Granger Cause GDP	18	0.98694	0.3990
GDP does not Granger Cause GROSS_CAP		6.14466	0.0132
TRADE_BAL does not Granger Cause GDP	18	0.89751	0.4314
GDP does not Granger Cause TRADE_BAL		9.45834	0.0029
TRANSP_SERVICES does not Granger Cause GDP	18	1.52629	0.2539
GDP does not Granger Cause TRANSP_SERVICES		15.7303	0.0003
TRADE_BAL does not Granger Cause GROSS_CAP	18	1.17526	0.3395
GROSS_CAP does not Granger Cause TRADE_BAL		14.9492	0.0004
TRANSP_SERVICES does not Granger Cause GROSS_CAP	18	5.05880	0.0237
GROSS_CAP does not Granger Cause TRANSP_SERVICES		1.40189	0.2810
TRANSP_SERVICES does not Granger Cause TRADE_BAL	18	16.5274	0.0003
TRADE_BAL does not Granger Cause TRANSP_SERVICES		2.65744	0.1077

trade balance and transport services significantly granger causes GDP. This means that the variation of GDP is explained by gross capital formation, trade balance and transport services as the probability calculated is greater than critical probability therefore the null hypothesis is rejected.

#### 4.4. Regression Results

##### 4.4.1. Long Run Regression Results

$$GDP = C(0) + C(1)*GROSS\_CAP + C(2)*TRADE\_BAL + C(3)*TRANSP\_SERVICES$$

$$GDP = 79.072 + 2.841 * GROSS\_CAP + 0.826 * TRADE\_BAL + 11.033 * TRANSP\_SERVICES$$

The result of long-run regression model in **Table 4** shows that all the coefficients are significant, calculated probabilities are less than critical probability, this means that an increase of gross capital formation, trade balance and transport services by one unit is associated with an increase of GDP by 2.841260, 0.826272 and 11.03252 respectively.

**Table 4.** Long run regression results.

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Dependent Variable: GDP  
 Method: Least Squares  
 Date: 07/30/19 Time: 04:41  
 Sample: 1999 2018  
 Included observations: 20

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Variable	Coefficient	Std. Error	t-Statistic	Prob.
GROSS_CAP	2.841260	0.550781	5.158603	0.0001
TRADE_BAL	0.826272	0.383335	2.155482	0.0467
TRANSP_SERVICES	11.03252	3.019625	3.653605	0.0021
C	79.07179	127.1518	0.621869	0.5428
R-squared	0.997316	Mean dependent var		3346.100
Adjusted R-squared	0.996812	S.D. dependent var		2455.391
S.E. of regression	138.6322	Akaike info criterion		12.87838
Sum squared resid	307502.0	Schwarz criterion		13.07753
Log likelihood	-124.7838	Hannan-Quinn criter.		12.91726
F-statistic	1981.427	Durbin-Watson stat		1.535361
Prob(F-statistic)	0.000000			

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Transport services has a significant strong positive relationship with GDP, this is in line with economic theories which predict a positive relationship between GDP and transport services (an increase of transport services is associated with an increase of GDP). This is because of sensitivity of transport mainly oil prices on the other sectors of the economy.

A small change in oil prices lead to change in transport cost, through transport price of other commodities (goods and services) respond to oil price changes. This means that an increase of oil price raise the cost transport and raw materials increase and end up with high commodity prices.

**4.4.2. Error Correction Results**

$$D(GDP) = C(0) + C(1) * D(GROSS\_CAP) + C(2) * D(TRADE\_BAL) + C(3) * D(TRANSP\_SERVICES) + C(4) * U1(-1)$$

$$D(GDP) = 56.406 + 1.680 * D(GROSS\_CAP) + 0.781 * D(TRADE\_BAL) + 14.687 * D(TRANSP\_SERVICES) - 0.813 * U1(-1)$$

The error correction result in **Table 5** shows a quick recovery after a shock happen, in one-year GDP return to its original path at 81.3% after the oil price shock. This gives signal for policy makers, in the case of an increase of oil price both transport cost and cost of raw material rise rapidly but if policies are taken it shows its impact quickly. All the slopes of the model are significant, calculated probabilities are less than critical probability of 10% indicating a short run relationship of variables in the model. An increase of gross capital formation, trade

**Table 5.** Error correction results.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
<i>D</i> (GROSS_CAP)	1.680401	0.589529	2.850414	0.0128
<i>D</i> (TRADE_BAL)	0.781311	0.241771	3.231620	0.0060
<i>D</i> (TRANSP_SERVICES)	14.68661	4.281015	3.430637	0.0041
<i>U</i> 1(-1)	-0.813290	0.272302	-2.986719	0.0098
<i>C</i>	56.40657	57.07769	0.988242	0.3398
R-squared	0.782009	Mean dependent var		399.0526
Adjusted R-squared	0.719726	S.D. dependent var		234.4131
S.E. of regression	124.1003	Akaike info criterion		12.70099
Sum squared resid	215612.5	Schwarz criterion		12.94953
Log likelihood	-115.6594	Hannan-Quinn criter.		12.74305
F-statistic	12.55574	Durbin-Watson stat		1.967291
Prob(F-statistic)	0.000151			

balance and transport services by one Percent lead to an increase of GDP by 1.689529, 0.781311 and 14.68661 Percent in short run.

Durbin Watson for both the error correction model and the long run regression model of 1.967291 and 1.535361 are closer to 2, this indicates that there is no autocorrelation in the result of the above mentioned two models.

#### 4.5. Normality Test

The probability of Jarque-Berra of 0.219470 is greater than 10% critical probability, so the null hypothesis is rejected. This means that the results are normally distributed as it is shown by Normality test in **Figure 2**.

#### 4.6. Stability Test

In **Table 6**, the probabilities calculated of the Ramsey Rest test are less than probability critical indicating that it is statistically significant, so the regression results of the model are stable.

#### 4.7. Discussions

Econometric analysis of transport sector on economic growth in Rwanda for the period of 1999 up to 2018 is an empirical analysis study which used econometric approach.

This research used the long run regression model and the error correction



**Table 6.** Stability test results.

Ramsey RESET Test

Equation: REG1

Specification: GDP GROSS\_CAP TRADE\_BAL TRANSP\_SERVICES C

Omitted Variables: Squares of fitted values			
	Value	df	Probability
t-statistic	2.020239	15	0.0616
F-statistic	4.081364	(1, 15)	0.0616
Likelihood ratio	4.813239	1	0.0282

F-test summary:			
	Sum of Sq.	df	Mean Squares
Test SSR	65,772.42	1	65,772.42
Restricted SSR	307,502.0	16	19,218.88
Unrestricted SSR	241,729.6	15	16,115.31
Unrestricted SSR	241,729.6	15	16,115.31

LR test summary:		
	Value	df
Restricted LogL	-124.7838	16
Unrestricted LogL	-122.3772	15

Unrestricted Test Equation:

Dependent Variable: GDP

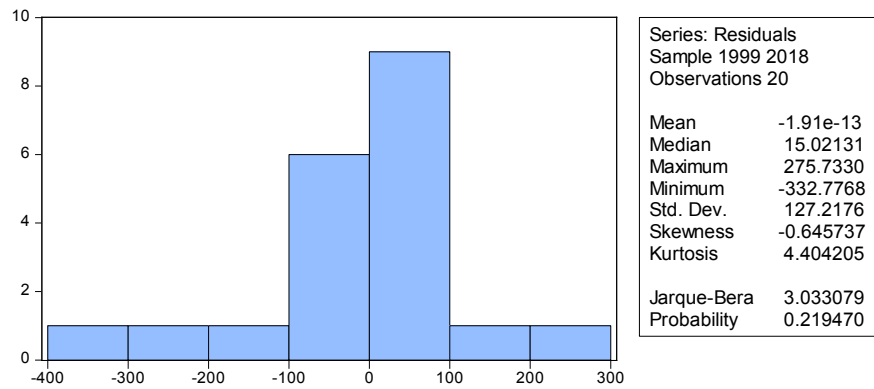
Method: Least Squares

Date: 07/30/19 Time: 04:36

Sample: 1999 2018

Included observations: 20

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GROSS_CAP	2.431938	0.543528	4.474356	0.0004
TRADE_BAL	0.614636	0.366320	1.677866	0.1141
TRANSP_SERVICES	10.36457	2.784780	3.721863	0.0020
C	164.9257	123.9465	1.330619	0.2032
FITTED <sup>2</sup>	1.21E-05	5.97E-06	2.020239	0.0616
R-squared	0.997890	Mean dependent var		3346.100
Adjusted R-squared	0.997327	S.D. dependent var		2455.391
S.E. of regression	126.9461	Akaike info criterion		12.73772
Sum squared resid	241729.6	Schwarz criterion		12.98665
Log likelihood	-122.3772	Hannan-Quinn criter.		12.78631
F-statistic	1773.286	Durbin-Watson stat		2.086806
Prob(F-statistic)	0.000000			



**Figure 2.** Normality test results.

model to evaluate the relationship among variables under study. The result show a statistically significant positive relationship between transport services and gross domestic product for both short run and short run. The result showed a strong statistically significant relationship between GDP and transport sector as measured by transport services for both short run and long run as it is shown by R-squared of 0.997316 and 0.782009 of the long run regression model and error correction model respectively.

Adequate, efficient, and effective transport systems are important for access to markets, employment, education and basic services critical to poverty alleviation; at the same time, transportation is expected to be a major driving force behind a growing world demand for energy and it has a significant environmental footprint. Therefore, integrated approaches to policy making should be promoted, including policies/planning for land use, infrastructure development, public transport systems and goods delivery networks, with a view to providing affordable, efficient and safe transportation, increasing energy efficiency, and reducing pollution and congestion effects.

Transport accidents (fatalities or injuries) lead to substantial social and economic losses for families and society. In order to evaluate transport safety, the current situation, trends and controlling factors (e.g. speeding and drink-driving) of transport accidents should be controlled. Finally, transportation affects the environment negatively through the consumption of non-renewable fuels, Carbon emissions, noise and ecosystem degradation. At the same time, transport infrastructure and services are impacted by the environmental conditions and their variability.

Infrastructure, particularly transport infrastructure, play a key role in Adam Smith's vision of economic development, No roads, no transport, no trade, no specialization, no economies of scale, no productivity progress, and no development.

## 5. Conclusion

Econometric analysis of transport sector on economic growth in Rwanda for the period of 1999 up to 2018 is an empirical analysis study which used econometric

approach. This research used the long run regression model to evaluate the relation between variables under this study. Results show a statistically significant positive relationship between transport services and gross domestic product for both short run and long run. The result showed a strong statistically significant relationship between GDP and transport sector as measured by transport services for both short run and long run as it is shown by R-squared of 0.997316 and 0.782009 of the long run regression model and error correction model respectively. These results imply that the effect of Transportation infrastructure is slow to occur but long lived: an increase in infrastructure has little short run impact on output but leads to a higher growth rate and higher output in the long run.

## 6. Recommendations

The policy implication that can be deduced from this study is that, policies to increase gross capital formation, improve trade balance, facilitate transport sector through expansion of road network and maintenance of existing road network coupled with revitalization of alternative mode of transportation such as rail system and waterways will significantly improve the growth of the economy. Businesses are subject to oil price shock, hence a slow economic growth. Policy makers should take actions on using vehicles which use electricity or Gas where possible to reduce dependence on oil. Transport Infrastructure and National Development should improve the quality and reliability of transport infrastructure and services to reduce transport costs and attract domestic and foreign investment in Rwanda. An efficient transport system intends to contribute to poverty reduction by facilitating rural communities' access to economic activities such as markets and social and other support services.

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## Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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