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alphanumeric journal

The Journal of Operations Research, Statistics, Econometrics and Management Information Systems

Volume 7, Issue 3, 2019

ULUK 2018 Congress Special Issue

Received: December 31, 2018
Accepted: May 05, 2019
Published Online: September 22, 2019

AJ ID: 2018.07.03.ECON.01
DOI: 10.17093/alphanumeric.505636
Research Article

Railway vs Highway Transportation and Economic Growth: The Case of Turkey

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ABSTRACT

Influences of Railway and Highway transportations on economic growth is analyzed in this paper. The analysis aims to find out the effects of transportation investment on per capita growth. OLS (Ordinary Least square), Engel-Granger Co-integration and Error Correction methods were employed in the analysis. A positive relation was found between annually constructed transportation means (railway and highway) and economic growth in the short-run analysis. Likewise, a positive relation was found in the long-run analysis.

Keywords: Economic Growth, Highway, Railway, Transportation

Demir Yoluna Karşılık Kara Yolu Taşımacılığı ve Ekonomik Büyüme: Türkiye Örneği

ÖZ

Bu makalede demir yolu ve kara yolu taşımacılığının ekonomik büyümeye olan etkileri incelenmiştir. Analiz ulaştırma yatırımlarının kişi başına gelir büyümesine olan etkisini bulmayı amaçlamaktadır. Analizde EKK (En Küçük Kareler), Engel-Granger Eş Bütünleşme ve Hata Düzeltme yöntemleri kullanılmıştır. Kısa dönem analizinde yıllık inşa edilen kara yolu ve demir yolu uzunlukları ile ekonomik büyüme arasında pozitif bir ilişki olduğu tespit edilmiştir. Aynı şekilde, uzun dönemli analizde de pozitif yönlü bir ilişki bulunmuştur.

Anahtar Kelimeler: Ekonomik Büyüme, Karayolu, Demiryolu, Taşımacılık

1. Introduction

Since 1923, the Turkish economy has undergone big efforts to integrate itself with the international economic system. The private sector was supported by central government infrastructure policies while transportation investments were one of the great items in that policies list.

Railway investments received a lot of funds and attention by the new founded Republic. The total length of railways was 1,378 km in 1923. This was doubled in 1929 to 2,766 km. The total length then dramatically increased to 7009 km in 1941 and reached 8,135 km in 1971. The 1970s saw the investment period. The total railways length rose to 10,144 km in 1980. It was 11,005 km in 2008 and 12,608 km in 2017. Two rapid growths in railways lengths can be easily recognized in Figure 1. The first period is between 1923-1940, and the second period is between 2008 and 2017. There was a sharp increase between 1970-1975, the reason for this increase is unknown.

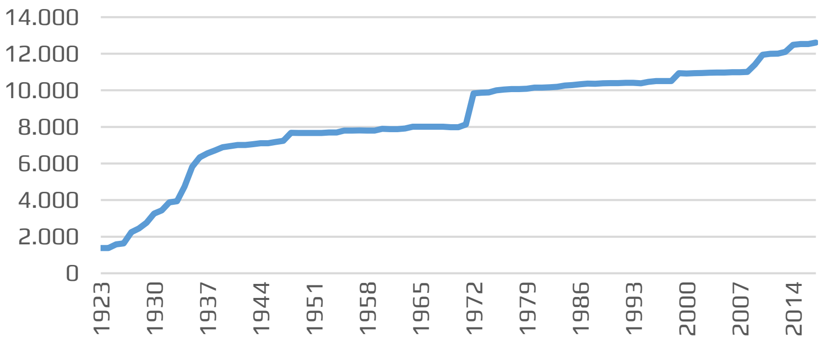

Figure 1. Railways (KMs)

The young republic placed Highways investments in secondary position behind the railway investments due to limited financial sources. Meanwhile, time railways infrastructure developed rapidly. However, the set back with railway was that they could not deliver the goods to final destinations. Furthermore, it was not economic to provide services for a small amount of goods going short distances. Highways were a solution to both these problems. The need for highways increased by the day. The General Directorate of Highways was founded in 1950. There is no annual data for highways before 1967.

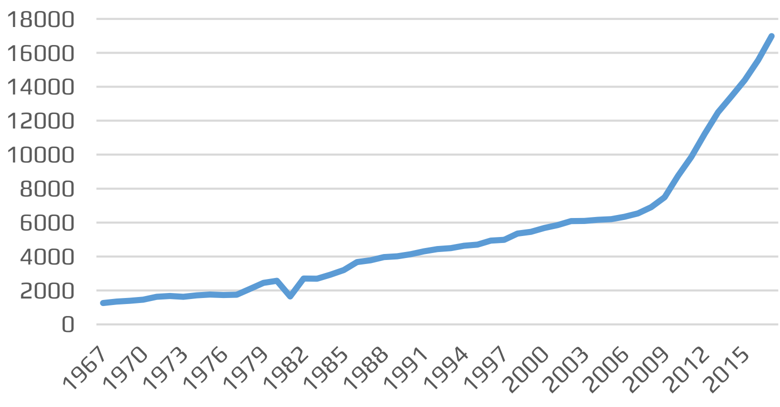

Figure 2. Highways (KMs)

The total length of concrete roads was 1259 KMs. This reached 2571 KMs in 1980. It was doubled to 5350 KMs in 1998. In 2002 it was 6082 KMs and today it is 12608 KMs. From 1967 to 2003 road constructions increased in a positive trend except for the year 1981. After 2003 road investment trend increased sharply.

There is a positive trend in per capita income time series with constant 2010 US prices. Per capita income was 4,000 USD in 1967. This increased to 5111 in 1981 and reached 5,936 in 1986. The year 2002 statistics shows per capita income as 8003 USD and 2016's shows 16,991 US Dollars. The years 1980, 1994, 1999, 2001 and 2008 saw an economic recession.

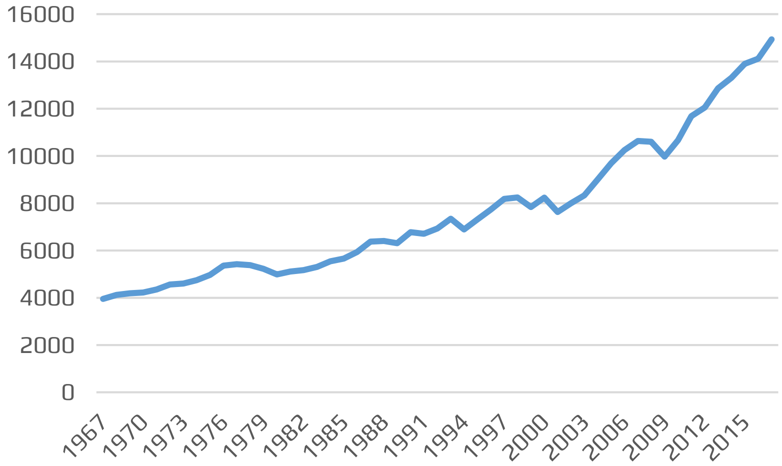

Figure 3. GDP per Capita (constant 2010 US$)

A research of the 3 key variables' inter-relation will follow in this paper. Their short-run and long-run relations are presented. Firstly, the Engel-Granger method is employed then the OLS model is run with stationary forms of variables. Both methods show that there is a positive influence of highways and railways on economic growth. A brief theory is given in the second section. General characteristics of series are introduced in the third section. An econometric analysis is run in the fourth section. All outputs are summarized in the conclusion.

2. Literature

Transport infrastructure investments are usually managed by central governments to ensure sustainable economic growth (Esfahani & Ramirez, 2003). They take place in national investment plans. The planning processes usually take a long times due to collecting data and then processing it. However, sometimes the return of investments does not map what was planned (Short & Kopp, 2005). Governments usually have to decide between macroeconomic long-run planning and profitable microeconomic short-run investment (Phang, 2003). Long-run infrastructure investments are not efficient for the short-run but are preferred for long-run sustainable growth (Herranz-Lonca, 2007). This kind of planning can be observed in iron curtain countries. For example, China has been paying a lot of attention on land and water transportation infrastructure investment for regional development. Researches shows that these kinds of investments have an important effect on income distribution (Banerjee, Duflo, & Qian, n.d.) and economic growth (Hong, Chu, & Wang, 2011). Developing countries like India have also been paying a lot of attention on transportation investments. Researches show that railway investments between 1970 and 2010 have a big influence on economic growth (Pradhan & Bagchi, 2013). Transportation activities are projected to grow in the coming future in India as well (Ramanathan & Parikh, 1999). Same kinds of central planning projects could be found in western capitalist countries. Railway investments in the 19th century and modern highway investments in the 20th century were accepted as one of the main reasons behind sustainable economic growth in USA (National Economic Council, 2014). Rapid development in Midwest is explained by railway investments (Atack, Bateman, Haines, & Margo, 2010).

Other researches give guidelines on transportation investments. Transportation infrastructure investments have indirect influences on economic growth by positive externalities and scale effects (Banister & Berechman, 2001). At the same time transportation investments also have positives effects on productivity growth. Travelling time is reducing and caring costs are minimized (Mahady & Lahr, 2008).

3. Data Set

The data set covers 51 observations starting from the year 1967 and finishing in 2017, these are sourced from different institutions databases.

GDP per Capita series is sourced from the World Bank, World Development Indicators Database. The series was published according to the 2010 constant US Dollar.

The Highways statistics is given from the General Directorate of Highway's statistics web page.

The Railways series was sourced from the Directorate General of Public Railway's statistics web page. Railways series give information about the annual total length of active railways in Turkey.

The variables' times series graphs are given in Figure 4. Each graph shows a positive trend and intercepts. ln(GDP) shows a decline during crisis years. ln(railways) resemble a stair case. Significant developments can be seen in particular government administrations years. ln(highway) shows a smooth positive trend except for the 1980 army revolution.

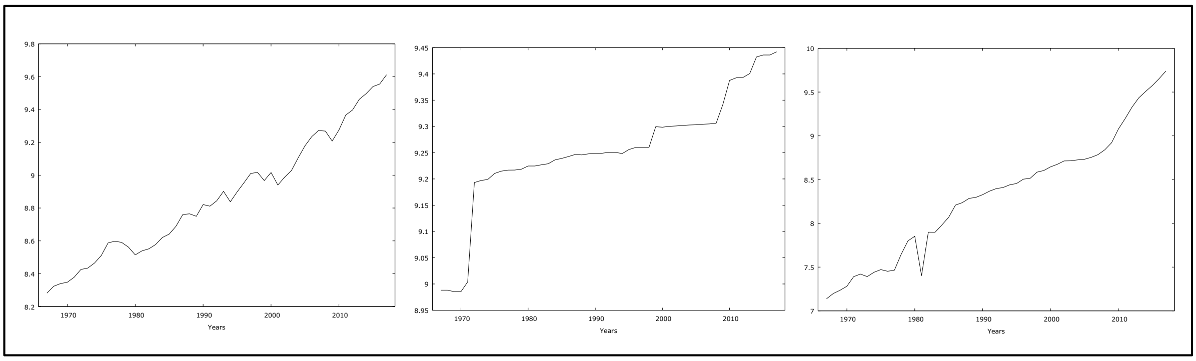

Figure 4. ln(GDP), ln(Railway), ln(Highway)

3.1. Unit Root Test

Augmented Dickey-Fuller Test is run for all variables. The test results show that all variables have unit root. In another words, they are not stationary in level.

in level			
Variable	t-statistics	Probability	Model
$\ln{(GDP\ per\ Capita)_t}$	-0.7011	0.7361	trend and intercept
$\ln(Railways)_t$	2.57608	0.2925	trend and intercept
$\ln(Highways)_t$	-1.67021	0.7646	trend and intercept
first difference			
Variable	t-statistics	Probability	Model
$\Delta(\ln(GDP\ per\ Capita)_t)$	-3.07087	0.002084	no trend and no intercept
$\Delta(\ln(Railways)_t)$	-5.91577	0.00000	no trend and no intercept
$\Delta(\ln(Highways)_t)$	-1.65047	0.09347	no trend and no intercept

Table 1. Stationary Tests of Variable in Level and First Difference.

Then same test is run for the first differences of the same series. The test results show that all series' are stationary in first difference. In other words, they do not have a unit root in their first difference form. All time series are integrated in first difference order I(1).

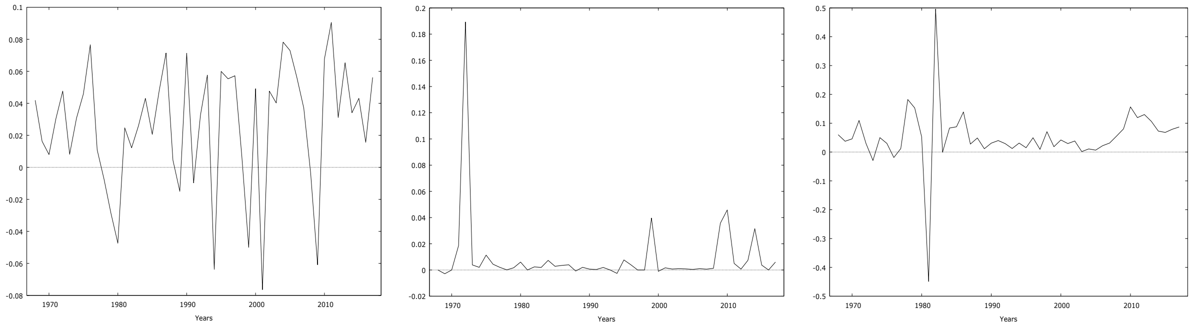

Figure 5. Δ(ln(GDP)), Δ(ln(Railway)), Δ(ln(Highway))

4. Model

We aimed to explain the Turkish economic growth by two independent variables which are; railway and highway investments in Turkey.

GDP=GDP(Railway, Highway)

We built our OLS model as:

$$\ln(GDP)_t = \beta_0 + \beta_1 \ln(Railway)_t + \beta_2 \ln(Highway)_t + \varepsilon_t$$

Dependent and independent variable series' natural logarithm forms are used in the analysis. It is a linear model. There are no lag variables in OLS model.

5. Analysis

5.1. Engle-Granger Model

A search of the long run relation between the variables will be shown using the Engle and Granger method. This method (Engle & Granger, 1987) aims to discover whether variables are co-integrated of order CI(1,1) if they are I(1).

The OLS method with natural logarithm of the variables' series is run. The analysis results are given in Table 2.

Dependent Variable: ln(GDP)				
Sample: 1967-2017				
Observation: 51				
Variable	**Coefficient**	**Std. Error**	**t-ratio**	**p-value**
constant	2.49298	1.81772	1.371	0.1766
ln(railway)	0.266886	0.223867	1.192	0.2391
ln(highway)	0.469618	0.0348123	13.49	5.98e-018
Mean dependent var	8.867781		**S.D. dependent var**	0.368945
Sum squared resid	0.297334		**S.E. of regression**	0.078705
R-squared	0.956313		**Adjusted R-squared**	0.954493
F(2, 48)	525.3656		**P-value(F)**	2.34e-33
Log-likelihood	58.82464		**Akaike criterion**	−111.6493
Schwarz criterion	−105.8538		**Hannan-Quinn**	−109.4347
rho	0.646293		**Durbin-Watson**	0.703197

Table 2. Ordinary Least Square Model

There is a positive influence of highways and railways on GDP per Capita. The parameters′ signs were found positive as expected. β0′s and β1′s t-ratios are out of 10% confidence interval. β2′s t-ratio stays in the 5 percent confidence boundary.

F-statistic value is significant. The R-square was calculated as 95%. It is quite high. Durbin Watson statistics is 0.7 which should have been close to 2. The OLS model gives spurious results because the series are not stationary in level. The long-run relation between variables are tested by Engle-Granger Co-integration Test.

All the variables of our model are integrated in the same order I(1) as we run OLS model. OLS results are:

$$\ln(GDP)_t = 2.49 + 0{,}26\ln(Railway)_t + 0{,}46\ln(Highway)_t + \varepsilon_t$$

The residual of model (εt) provides information about the deviation. This deviation is calculated by the sum of differences in the long-run relation values′ 2nd powers (squares). If the residual (εt) is found stationary, variables are co-integrated of order (1,1).

The residual′s graph and unit stationarity test results are given in Figure 6 and Table 3.

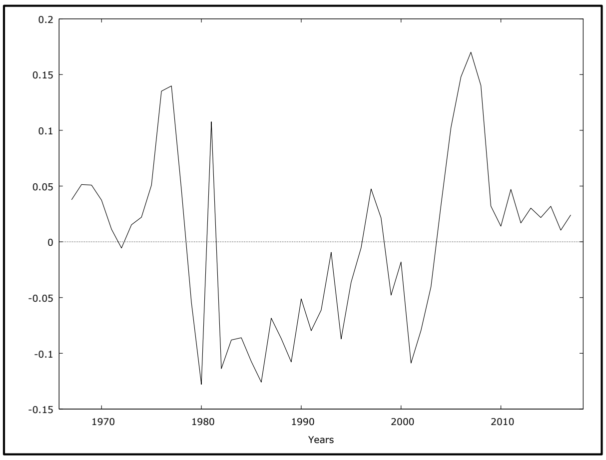

Figure 6. Residual

in level, I(0)			
Variable	t-statistics	Probability	Model
ε_t	-3.25257	0.00164	no trend and no intercept

Table 3. Stationary Tests of Residual (εt)

There is no intercept and trend in residual's time series graph. The stationary test's t-statistics exceed the critical value of 1% confidence boundary. The residual is significantly found stationary in level (0) (Dikmen, 2018). It can therefore be concluded that the variables' series of ln(GDP per Capita), ln(Railway) and ln(Highway) are co-integrated in order (1,1,1).

For the last step, the Error Correction Model will be used which is formed as follows:

$$\Delta[\ln(GDP)] = \beta_0 + \beta_1\Delta[\ln(Railway)] + \beta_2\Delta[\ln(Highway)] + \beta_3\varepsilon_{t-1} + u_t$$

The OLS results are given in Table 4. The error correction term is εt-1. Its sign is negative as expected (Sevüktekin & Çınar, 2014). But, the parameter is not statistically significant. It's parameter β3 provides information on the amount of periods needed to correct the model. The data is set up annually. We can conclude that the model is corrected 11% yearly.

Dependent Variable: Δ(ln GDP)				
Sample: 1968-2017				
Observation: 50				
Variable	**Coefficient**	**Std. Error**	**t-ratio**	**p-value**
constant	0.0251985	0.00663205	3.800	0.0004
Δ[ln(railway)]	0.0654527	0.202672	0.3229	0.7482
Δ[ln(Highway)]	0.0143094	0.0575139	0.2488	0.8046
ε_{t-1}	−0.114905	0.0787441	−1.459	0.1513
Mean dependent var	0.026593		**S.D. dependent var**	0.039333
Sum squared resid	0.072245		**S.E. of regression**	0.039630
R-squared	0.046990		**Adjusted R-squared**	-0.015163
F(3, 46)	0.756032		**P-value(F)**	0.524560
Log-likelihood	92.54592		**Akaike criterion**	−177.0918
Schwarz criterion	−169.4438		**Hannan-Quinn**	−174.1794
rho	0.075002		**Durbin-Watson**	1.833393

Table 4. The Error Correction Model

5.2. An Alternative OLS Model

We decided to do an analysis with the first difference of the same variables' time series. The aim of this test is to find out the relation between variables with stationary series. Our model is written as:

$$\Delta[\ln(GDP)]_t = \beta_0 + \beta_1\Delta[\ln(Railway)]_{t-1} + \beta_2\Delta[\ln(Highway)]_{t-1} + \varepsilon_t$$

The Output of the OLS model is given in Table. 4. The parameters' signs were found positive. Two independent variables' parameters t-statistics values could not exceed 10 % significance boundary (Sevüktekin, 2013). F-statistics and R2 values were found very low. Durbin-Watson statistics is very close to 2 which means there is no auto-correlation (Tarı, 2011).

Dependent Variable: $\Delta[\ln(GDP)]_t$				
Sample: 1969-2017				
Observation: 49				
	Coefficient	**Std. Error**	**t-ratio**	**p-value**
constant	0.0249060	0.00666642	3.736	0.0005
$\Delta[\ln(Railway)]_{t-1}$	0.102732	0.205920	0.4989	0.6202
$\Delta[\ln(Highway)]_{t-1}$	0.00848498	0.0544560	0.1558	0.8769
Mean dependent var	0.026281		**S.D. dependent var**	0.039678
Sum squared resid	0.075116		**S.E. of regression**	0.040410
R-squared	0.005983		**Adjusted R-squared**	-0.037235
F(2, 46)	0.138441		**P-value(F)**	0.871076
Log-likelihood	89.24524		**Akaike criterion**	−172.4905
Schwarz criterion	−166.8150		**Hannan-Quinn**	−170.3372
Rho	0.017193		**Durbin-Watson**	1.952458

Table 5. OLS Model

6. Conclusion

The total lengths of Railways and highways have a positive influence on economic growth. This long-run relation is found using the Engle-Granger method. The relation between the three variables reach an equilibrium in around a decade. The effect of railways on economic growth is greater than highways. However railway investments take long and its finance is not as easy as highways. That's why railway investments are planned and run by central governments.

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