MATHEMATICAL RELATIONSHIP BETWEEN TRANSPORTATION & ECONOMIC GROWTH BY VECTOR AUTO-REGRESSION MODEL

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Abstract. Transportation as one of the effective factors on economic growth has a leading role in every country's policies. Facilitating the trade and business, the transportation sector provides both national and international growth and increases the accessibility grounds to national welfare and facilities. Thus, in the process of economic growth it has a very main and effective role while it is also affected by the process of economic growth and development. This study mainly aims at investigating the role of development of the transportation sector in economic growth of the country using the statistics within 1971-2004. For the empirical testing of the model, Vector Auto-Regression Model has been used. Investigating the stationary state and co-integration of the variables, the researcher has determined the collection degree of the variables of the model and then specified the number of optimal lags of the model. Next, the number of the co-integration vectors of the model is determined and then the desirable model is designated indicating that the development of the transportation sector has a positive and long-term effect on the country's economic growth. Furthermore, the effects of different shocks of the transportation sector on the economic growth over time as well as the degree of regression variances of the variable viz added value of transportation sector on economic growth are taken into consideration in this study by using the Analysis of Prognosis Error.

1 Introduction

Transportation is from infrastructures and one of the important components of production-consumption cycle. Therefore, it has a leading and effective role in the process of economic growth while it is also affected by the process of economic growth and development. The effect made by transportation on the country's spatial and basic structure gives rise to the concentration or non-concentration of economic activities in different areas of the country and consequently the area's growth and recession become accessible and inaccessible, respectively. Now, the main research question of this study arises as to whether there is a positive and significant relation between the transportation sector development and the economic growth in the economy of Iran. First, the theoretical principles of transportation sector development and economic growth are discussed in this study and then the function of transportation sector in the economy of Iran is investigated. Next, the model is introduced and estimated and finally the results and implications are presented.

2 Relationship between Transportation Sector Development and the Country's Economic Growth

In economics, the total services leading to the resources' transmission and transportation have the economic value and are accounted for as some part of production process since they are added to the first price of the resources being transported from the areas of consumption surplus to the areas of consumption. Such an increase is the result and process of the transportation. Along with the sustainable growth of the world trade and production and also the fundamental changes in national business flourishing with the tendency towards non-oil export development, the importance of transportation as principal substructure of business and trade becomes necessary. The freight and service transportation causes the economic resources such as investment, labor, and technology to be exchanged between producers and consumers. In other words, the demand for transportation is derived from other economic and social activities and is the function of demand variances for freight and services in other areas or sectors of the country's economy. The studies carried out by World Bank confirm that in the transportation sector by making exchange and trade easy, the national and international growth is provided and the accessibility grounds to national welfare and facilities are increased. The experiences of the developed countries have demonstrated that in macroeconomics the transportation development has been continuously a cause for economic growth as well as social output increase to private investment. In microeconomics, making transportation better directly causes the fall in the price of freight and services leading to a drop in production and distribution costs and with the widespread development of the markets, the grounds for a healthy competition increases. Moreover, making the transportation substructures in urban and rural areas better results in the increase of labor efficiency and output, reduction of transportation costs and finally decrease of concentration.

3 Investigating the Function of Transportation Sector in the Economy of Iran

Activities of transportation sector enjoyed a rather good growth in 2003. As shown in Table3-1., the added value of the mentioned sector in constant price of 1997 had an increase to 28380.8 billion Rials demonstrating a growth of 4/7% to that of the previous year (27112.5 Billion Rials).

Transportation Derivations	Year			Change Percent		Share (%)	
	2001	2002	2003	2002	2003	2002	2003
Ground Transportation	25518.6	25146.1	26322.5	-1.5	4.7	92.7	92.7
Air Transportation	1076.9	1021.4	1069.1	-5.2	4.7	3.8	3.8
Sea Transportation	828.6	945.00	989.2	14.00	4.7	3.5	3.5
Total	27424.1	27112.5	28380.8	-1.1	4.7	100.00	100.00

Table 1. Added Value of Transportation Sector in Constant Price Of 1977

The statistics related to fixed gross investment based on economic sectors in 2003 shows that by absorbing 16.2% of the total mentioned investment to the current prices, the transportation sector has a growth of 10% in constant price of 1977 that in comparison to the growth of 30.4% to that of 2002 stands in a lower level. The investment decrease in the transportation sector structure for limiting the total growth of investment in this sector has been effective. Investigating the figures related to investment on transportation sector based on construction and machinery illustrates that in 2003 the most investment has been made in machinery. From total 51.7 thousand billion Rials of the invested money to the current prices, around 84.5% is allocated to the machinery showing an increase in the mentioned proportion in comparison to that of the previous year. The wear and tear of machinery and equipment in all transportation sectors of the country including air, sea and land transportation as well as the considerable tolls related to the concerned accidents all present the necessity for investment more than before. Furthermore, the considerable effect of equipment and development of the transportation fleet in reducing the costs of freight distribution within the production and consumption centers of the country increases the necessity for the investment on this sector. Investigating the statistics of transportation sector in 2003 depicts that totally in land transportation sector (road and railway) 65.2 billion individual-kilometer were transported and 118 billion ton-kilometer freight were carried showing an increase of 7.6% and 18.7% to that of the previous year. In the mentioned year and in air and sea transportation sector, 13.2 million and 3717 thousand people, and 117.4 thousand and 85.5 million tons freight were carried, respectively which demonstrate an increase of 10.9% and 46.9% in the passenger sector, and 37.3% and 12.3% in the freight sector.

4 Investigating the Relation Test of Economic Growth & Transportation Development

4.1 Model Introduction

Investigating the study's hypotheses, the researcher used the Model of Vector Auto-Regression (VAR). In the simultaneous conventional methods, the variables are divided into two groups of exogenous and endogenous and for estimating the coefficients of the structural equation, a series of limitations to the structural model coefficients was taken into account as some presupposition. But in the models of Vector Auto-Regression, the concerned variables are defined as functions of lag length, other variables and also random components. None of the components of the matrices consider the coefficients equal to zero and in other words, the zero limitations are not framed for the model's coefficients. Although one can include the net exogenous variables in VAR model, there is no optional division of the variables to exogenous and endogenous; the same as what is common in the simultaneous conventional methods. The degree of lag (m) determining the model's dynamic attribute is specified by considering the compatibility of the results of the statistical data and based on some yardsticks such as Akaike and Schwartz criterion. Therefore, apart from the limitation in the number of observations (being an avoidable barrier to determine the high degrees of lags) other considerations such as what is encountered in recognizing the structural coefficients in the simultaneous equation methods are not concerned. Thus in some cases where the theoretical bases of the investigated subject do not enjoy the required cohesion, there exists an area of more applications for VAR models. But, this should not be conceived that the simple models of VAR are completely irrelevant to or do not require the specific economic theories. Because, the variables of the model are determined in accordance with the economic theories.

4.2 Statistical Data

The time series is during 1971-2004 including three variables: two endogenous and one exogenous. In this model, the variable showing the transportation growth is the added value of transportation. The added value of transportation sector indicates the economic activities of that sector. The log of non-oil real gross domestic product demonstrates the economic growth. Because the economy of Iran is an oil-base economy and a major part of Iran national income is provided by oil sale. Consequently, reducing the effects of oil income growth on economic growth, one should separately consider the added value of oil sector to the flat rate and gross domestic product (non-oil). The added value of oil sector is used in the equation as another variable. This is because of the main effect of this element on the economic activities. The model being used in this study is as the following:

$$LGDP = C_0 + C_1 LTRA + C_2 LOIL \quad (1)$$

The abbreviations used in the preceding model are as the following:

LGDP: log of non-oil real gross domestic product to flat rate of 1977

LTRA: log of added value of transportation sector to flat rate of 1977

LOIL: log of added value of oil sector to flat rate of 1977

4.3 Unit Root Test

The first stage is determining the collection degree of the model's variables for investigating and assuring about disappearance of the false regression. Thus, one should investigate the degree of the variables' collection degree and specify if there exists a stationary relation between the variables of the model. Generalized Augmented Dickey-Fuller (ADF) test is one the common tests in this regard. In Table4-1, the results of ADF test for the devised models in VAR and also the variables of the first subtraction are presented. The intercept is inserted in all the equations. The part above the table is for the tests related to the normalized variables and the part below is allotted to the tests carried out on the first subtraction of the concerned variables. Three different types of the test equations are used in this study; that is the test is taken for normalized and first degree-subtracted variables for three lags of 0, 1 and 2. This table includes the computed t-statistics for different states. The cases of rejecting the hypothesis of inactiveness in probability levels of 10%, 5% and 1% are specified by *, **, and ***. As concluded from the results of Table4-1, the variables including log of added value in transportation sector, log of non-oil real gross domestic product and log of added value in oil sector are from the first degree integration (I(1)).

Variables	ADF Statistical Test with no Lag	ADF Statistical Test with 1 Lag	ADF Statistical Test with 2 Lags
Normalized Variables of the Model			
LTRA	-2.61	-1.109	-1.29
LGDP	-2.3	-1.11	-1.54
LOIL	-1.97	-2.54	-2.13
First-Degree Subtracted Variables of the Model			
$\Delta(LTRA)$	***-4.14	**-3.13	***-3.71
$\Delta(LGDP)$	***-3.69	-2.43	***-4.24
$\Delta(LOIL)$	***-4.59	***-4.8	**-3.23

Note: In levels of 10%, 5% and 1%, t-ADF critical values are -2.62, -2.96 and -3.76, respectively. Thus, in the above table, the signs of *, **, and *** reject the hypothesis of inactiveness in 10%, 5% and 1%, accordingly.

Table 2. ADF Test Determining the Inactiveness of Variables

4.4 Determining the Number of Optimal Lags

Before estimating the model, one should specify the length of the lags that should be inserted in the model to guarantee that the error terms have the classic properties and in other words do not have consequent regression, enjoy the normal distribution with the average of zero and variance of σ^2 and are distributed separately from each other. The minimum criterion of AIC(n) in this sample proposes the first degree:

AIC (1) = 71/61

The minimum criterion of SBC(n) puts forward the first degree:

SBC (1) = 65/45

Since these criteria are processed by Microfit- the degree determined by Microfit software is one degree lower than that of Eviews software, the first degree suggested here is equivalent to the second degree in Eviews software.

4.5 Determining the Number of Co-Integration Vectors & Determining the Desirable Model

This test is used for piloting the existence of long-term balanced relationship between some variables. In this method, the five different models are first estimated based on their intercept and trend. After estimating these models, first the null hypothesis of the co-integrated vector from the most restricted state (state 1) to the most unrestricted state (state 5) is tested. If this hypothesis is rejected, based on the critical numbers of trace statistics and maximum Eigen value, the hypothesis of one co-integrated vector is again tested from the most restricted state to the most unrestricted one. This test is used for higher degrees and finally it is finished when null hypothesis is accepted. Based on Table4-2, the hypothesis of one co-integrated vector in the second state (based on the critical numbers of trace statistics and maximum Eigen value) is accepted in determining the co-integrated model by using Johannes Method,.

H_0 Hypothesis	H_1 Hypothesis	Model II	Model III	Model IV
(λ_{trace})				
r = 0	r > = 1	48.85 (34.87)	36.47 (31.54)	52.31 (42.34)
r < = 1	r > = 2	13.27 (20.18)	11.16 (17.86)	19.87 (25.77)
r < = 2	r > = 3	3.27 (9.16)	1.79 (8.07)	6.62 (12.39)
(λ_{max})				
r = 0	r = 1	35.58 (22.04)	25.31 (21.12)	32.44 (25.42)
r < = 1	r = 2	9.99 (15.87)	9.37 14.88	13.24 (19.22)
r < = 2	r = 3	3.27 (9.16)	1.79 (8.07)	6.62 (12.39)

Note: the numbers in the parentheses are the critical amount of the trace test statistics and Maximum Eigen Value in 95% confidence interval.

Table 3. Determining the Number of Co-Integrated Vectors Using Trace Statistics (λ_{trace}) and Maximum Eigen Value (λ_{max})

The co-integration equations obtained from the model are as the followings:

$$LGDP = -12.03 + 0.26\ TRA + 2.13\ LOIL \quad (2)$$

In which:

LGDP: log of non-oil real gross domestic product to flat rate of 1977

LTRA: log of added value of transportation sector to flat rate of 1977

LOIL: log of added value of oil sector to flat rate of 1977

As it is seen in the equation (2), there is a positive relation, in long term, among the log of non-oil real gross domestic product, log of added value of transportation sector and log of added value of oil sector. The results of the model depict that for every change of 1% in the added value of transportation sector, the economic growth of the country will have the change of 26%.

4.6 Shocks & Variance Analysis of Prognosis Error

If an economic growth shock happens by the log of added value of transportation sector, this shock positively appears and initially, causes its increase along three periods but reduces its intensity along the next period and yet after a period continues its own positive trend. As shown in Figure4-1, if there is a positive shock caused by the economic growth, it leads to a positive mutation of the log of added value of transportation sector within the seven periods and then continues its own positive and consistent trend.

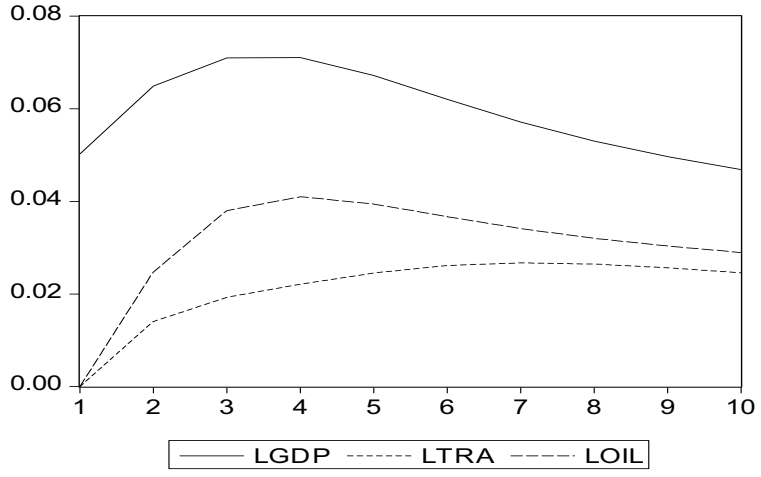

Figure 1. Economic Growth Interaction against Variances by a Standard Deviation

As shown in Table4-3, the variance analysis sheds light on the fact that in the first period the highest percentage of variances is related to the economic growth, then to the log of added value of oil sector and finally to the log of added value of the transportation sector. But the share of economic growth is continuously decreasing and the shares related to the log of added value of oil sector and the log of added value of the transportation sector are increasing bearing out that in the follow-up periods (in long-term) first the log of added value of oil sector and then the log of added value of the transportation sector have a high power in the regression of the country's economic growth.

Period	S.E.	LGDP	LTRA	LOIL
1	0.050241	100.0000	0.000000	0.000000
2	0.086867	89.29090	2.602774	8.106328
3	0.119995	81.79177	3.941624	14.26661
4	0.146997	77.84947	4.882774	17.26776
5	0.168157	75.46023	5.853005	18.68677
6	0.184806	73.74756	6.843620	19.40882
7	0.198222	72.41013	7.763490	19.82638
8	0.209341	71.33589	8.554463	20.10965
9	0.218782	70.46538	9.203541	20.33108
10	0.226935	69.75538	9.725110	20.51951
Ordering: LGDP LTRA LOIL				

Table 4. Added Value of Transportation Sector in Constant Price Of 1977

5 Conclusion

Transportation sector as a pre-requisite and infrastructure of development has a leading and efficient role in nurturing the societies' possibilities and potential competence that by freight and passenger transportation provides an inseparable connection between the different elements of growth and development and brings about the establishment of a quick and widespread reinforcement of the country's economic, social and cultural sectors-thus it proves its role and importance as one of the most effective indexes of growth and development. Therefore, considering the optimal use of this sector's capabilities and determining the policies towards increasing its efficiency are of great importance. The role of transportation sector development in the economic growth of the country is investigated in this study. In the estimated model, three variables were considered: (1) log of added value of transportation sector, (2) log of non-oil real gross domestic product and (3) log of added value of oil sector. In this model, there is a co-integration vector supporting a positive and long-term relation between transportation sector development and economic growth. The results of the model depict that for every change of 1% in the added value of transportation sector, the economic growth of the country will have the change of 26%. Investigating the effects of shocks, one can conclude that If an economic growth shock happens by the log of added value of transportation sector, this shock positively appears and initially, causes its increase along three periods but reduces its intensity along the next period and yet after a period continues its own positive trend. Moreover, if there is a positive shock caused by the economic growth, it leads to a positive mutation of the log of added value of transportation sector within the seven periods and then continues its own positive and consistent trend. About the variance analysis in the first period, the highest proportion of regression is related to economic growth and then log of added value of oil sector and finally log of added value of transportation sector. The regression proportion of these variables in the economic growth variances is less. Considering the estimated model, one can see that the transportation sector has a positive effect on the economic growth but this positive effect is weak validating the non-development of transportation sector. Therefore, investment on different areas of transportation not only results in the market reinforcement in different ways but also brings about different areas of employment and every individual's product consumption. It also increases the society's production power and thus, provides favorable prosperities under the balanced circumstances for transportation development.

6 References

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