Impact of Economic Inputs on Production of Transportation Services in Iran

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Abstract

In recent years, the value-added created in the transportation industry is about 8 percent of GDP of Iran. Due to the high-induced effect of transportation sector on the whole economy, analyzing transportation production function and its determinant is of great value for policymakers. The objective of the present research is to estimate the transportation production for the case of Iran and to examine the economic inputs of this sector using the auto-regressive distributed lags (ARDL) method based on time series of 1960 to 2014. The research results show, In long-term, the effect of capital, in comparison to energy input and labour, on the production of transportation services is quite stronger by production elasticity of 0.81 while labour and energy production elasticity is near 0.07 and 0.21. Based on the statistical test, the hypothesis of the existence of the economy of scale in transportation sector could not be rejected. Moreover, the coefficient of error correction term is equal to (-0.29), indicating a 29% adjustment toward equilibrium in each period, which It means, after imposing any shock in transportation production, it takes about three periods (years) to converge again to the long run trend.

Keywords: Production function, transport sector, production elasticity, ARDL

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1. Introduction

The transportation is one of the main infrastructures of any country in the process of production and distribution of goods. Improving its quality of services will increase production and productivity in other sectors of the economy [Rohani Nejad et al. 2015]. In recent years, based on Central Bank of Iran statistics, the value-added created in the transportation industry of Iran is about 8 percent of the country's total production. On the other hand, Socio-economic impacts of transportation are essential issues in transportation planning and appropriate transportation planning is the key to sound regional development [Khaksari and Asadi, 2017].

Transportation services availability can lead to higher productivity and increase in economic output due to the reduction in transportation costs, improvements in access to markets and raw materials, reduction in travel times, congestion reductions, and many other benefits. These benefits can potentially allow countries to improve their comparative economic advantages [Agbelie, 2014]. It is interesting that even in developed countries, the new expansion of transport infrastructure has a significant role in stimulating economic growth, but negative external effects of transportation on people are also under the intense focus of researchers [Meersman and Nazemzadeh, 2017]. Also, transport investment has a significant impact on where economic activity occurs. Over time, changes in access and mobility can lead to changes in the economic and social landscape of countries. It can influence the geography of agricultural production, manufacturing, and the knowledge-based service sector through its impact on how easy and cost-effective it is to move around [Dalziel and Saunders, 2014]. Besides having an impact on the economy of the region in which they are located, transportation infrastructure services may cause additional impacts on other regions. This effect is famous as the spillover [Arbués et al. 2015].

Transport services production level influences the costs and benefits associated with other economic sectors production. Therefore, understanding the effect of production input factors on the value-added of the transportation sector is very important for policymakers, as they can better plan the development of this sector and the entire economy.

The production of all goods and services can be described using the concepts of inputs, outputs, and technology. Inputs have to be acquired by the firm and combined to produce and supply outputs. In the case of transport, the firm has to use vehicles, terminals, rights-of-way, energy, labor and so on, to produce movements of freight or passengers, from many different origins to many destinations in various periods and at various frequencies [Dalziel and Saunders, 2014]. In an economic sense, Researchers aggregate inputs in transportation sector in the form of labor, capital, and energy [Lin and Ahmad, 2017]. In economics, a production function is one that specifies the output of a firm, an industry, or an entire economy for all combinations of inputs. This function is an assumed technological relationship, based on the current state of engineering knowledge; it does not represent the result of economic choices, but rather is an externally given entity that influences economic decision-making. Almost all economic theories presuppose a Production function, either on the firm level or the aggregate level [Daly, 1999; Cohen and Harcourt, 2003].

In the present paper, using ARDL model and time series data, the elasticity of input factors affecting the production of the transportation sector, are analyzed and compared. Meanwhile, the return to scale in the transportation sector .was examined by authors.

The paper consists of 7 sections including an introduction to the importance of transportation industry, a review of previous studies, theoretical foundations, research methodology and model estimation, research findings, conclusions and suggestions.

2. Literature Review

The methodological approach of the present paper for estimation of the production function and input elasticity has been applied for the transportation sector, but this approach is also applicable for the other economic sectors, such as agriculture and manufacturing. Therefore, a review of references could be a stepping stone to form this paper's approach.

A general review of references reveals that most papers take into account the production factors e.g. capital and labor which enables incorporation of the potential progress of technology, i.e., the capital-labor substitution possibility. To give an example, Solow [Solow, 1957] investigated the effect of technical progress in aggregate production function or Gow [Gow, 2002] derived production functions depending on capital, labor, energy, and specific material inputs for olefin alkylation processes in refinery engineering. Moreover, Mishra [Mishra, 2010] prepared a paper giving a brief history of production functions and their usage in different economic sectors.

Also, in some researches, energy factor added to incorporate change via energy efficiency parameters and environmental effect of production. In the following, a review of this literature is presented.

Arbués et al. [Arbués, Baños and Mayor, 2015] studied the existence of direct and spillover effects of the road, railway, airport and seaport infrastructure projects by estimating a production function. The estimated production function takes the form of a Spatial Durbin Model and is estimated using panel data from the 47 peninsular Spanish provinces by alternatively applying a Maximum Likelihood estimator and Instrumental variables/Generalized Method of Moments Estimators. According to the estimates, road transport infrastructure positively affects the output of the region in which the infrastructure is availabe and its neighboring provinces.

Lin and Ahmad [Lin and Ahmad, 2017] established a trans-log production function for Pakistan transport sector and the input factors capital, labor and energy are included. Output elasticities of each factor and the substitution elasticities between these factors have been estimated and analyzed for the sample period of 1980–2013. The results suggest that by allocating more capital in the transport sector, the relevant energy saving technology could be promoted, thereby realizing the substitution between capital and energy and reduction of CO_2 emission as a result. It further suggests that by the continuous upgrading of the capital, substitution between energy and labor is achievable and the transition of Pakistan transport sector from labor intensive to capital intensive can be realized.

Lin and Liu [Lin and Liu, 2017] established a production function model with input factors including energy, capital and labor for China's heavy industry. In the ridge regression method, the output elasticity of each input factor and the substitution elasticity between input factors are analyzed. The empirical results show that the output elasticity of energy, capital, and labor are all positive, while the output elasticities of energy and capital are relatively higher, indicating that China's heavy industry is energy- and capital-intensive. More capital input can help to improve energy efficiency and thus accomplish the goal of energy conservation in China's heavy industry.

Banaeian and Zangeneh [Banaeian and Zangeneh, 2011] in their research estimated a production function, to obtain the relationship between agricultural inputs and walnut yield in veiw of energy inputs, and to make an economic analysis in walnut orchards in Hamedan, Iran. For this purpose, researchers used Cobb-Douglas production function method. Econometric analysis results revealed that human labor, farmyard manure, chemical fertilizers, water for irrigation and transformation contributed significantly to the field. The results of sensitivity analysis of the energy inputs showed that the Marginal Physical Productivity (MPP) value of human labor was the highest, followed by farmyard manure and water for irrigation energy inputs, respectively.

Holmgren and Merkel [Holmgren and Merkel, 2017] in their paper, mentioned that investing in infrastructure is often seen as an essential part of economic policy, at the regional, national as well as international level. Therefore, investing in infrastructure is often presented as a solution to some problems such as unemployment, depopulation of rural areas and low economic activity. Their study aimed to provide a systematic analysis of previous studies of this relationship. For that purpose, a meta-analysis of 776 estimates of the elasticity of production concerning infrastructure, was performed. The estimated effect (elasticity of production) of investing in infrastructure varies from −0.06 to 0.52. The effects appear to vary depending on the type of infrastructure in with the investment is made as well as between industries.

Lindenberger [Lindenberger, 2003] in his paper, derives production functions designed to model the eVolution of service industries. The derivation is based on specifying the output elasticicities of the factors according to differential equations and asymptotic technological boundary conditions in factor space. The derived functional forms incorporate labor, capital, energy, and technology parameters, whose time changes model innovation and structural change. The model is applied to the eVolution of the German market-determined services 1960-1989.

In respect to considering the effects of transport investment on economic growth, lots of case studies carried out in recent years. Below some of the latest ones are included. What is important in recent years is that especially in developed countries, besides studying the positive effects of transport development on economic growth, the negative external impacts of transportation on people life are also under study.

Jiang et al. [Jiang, He, Zhang, Qin and Shao, 2017] proposed a structural equation model (SEM) to comprehensively consider the bi-directional relationship between multimodal transportation investment and economic development. Also, they formulated the SEM model system with variables that reflect transportation supply in geographically adjacent areas to investigate spatial spillover effects. Results showed that transportation investment has impacts on economic growth, but are different at the national level and provincial level. These differences can be associated with phases of economic development, transportation investment policy, transportation infrastructure service level, spillovers from other regions, as well as reform policies carried out by the central government.

Khaksari and Asadi Sisakht [Khaksari and Asadi Sisakht, 2017] argued that Socio-economic impacts of transportation are essential issues in transportation planning and appropriate transportation planning is the key to sound regional development. Based on their studies, one of the major planning issues is the transportation equity. In their paper, the relative level of transportation development in different provinces was determined using taxonomy method. Their study showed that transport infrastructure development and regional development are highly correlated.

Meersman and Nazemzadeh [Meersman and Nazemzadeh, 2017] studied the role of the expansion of transport infrastructure in stimulating economic growth in developed countries. They mentioned that it is hard to generalize the potential growth impact of transport infrastructure as it can differ over regions and will be affected by the presence or absence of other drivers of economic growth. The massive traffic flows generate adverse external effects for people, planet, and profit.

Based on aggregate growth modeling and a causality test, some error-correction models are estimated using annual data for Belgium. They revealed that for Belgium GDP per capita is not only positively impacted by traditional indicators such as the openness of the Belgian economy, the rate of investment as a whole, and technological change, but also by the length of the motorways, the rail network and the investments in port infrastructure.

Saidi et al. [Saidi, Shahbaz and Akhtar, 2018] investigated the impact of transport energy consumption and transport infrastructure on economic growth by utilizing panel data on MENA countries (the Middle East and North Africa region) from 2000 to 2016. Using the Generalized Method of Moments (GMM), they found that transport infrastructure positively contributes to economic growth in all regions.

Table 1. Brief Review of Literature

General Field	Study	Aggregation Level	model	Conclusion
Production Function	Arbués et al. (2015)	47 peninsular Spanish provinces	Spatial Durbin Model and panel data	Road transport infrastructure positively affects the output of the region in which the infrastructure is located and its neighboring provinces.
	Lin and Ahmad (2017)	Pakistan	trans-log production function	By continuous upgrading of the capital, substitution between energy and labor can also be achieved, and the transition of Pakistan transport sector from labor intensive to capital intensive is realizable.
	Lin and Liu (2017)	China	the ridge regression method	More capital input can help to improve energy efficiency and thus accomplish the goal of energy conservation in China's heavy industry.
	Banaeian and Zangeneh (2011)	Iran	Cobb-Douglas production function method	The Marginal Physical Productivity (MPP) value of human labor was the highest, followed by farmyard manure and water for irrigation energy inputs, respectively.
	Holmgren and Merkel (2017)	Norway	meta-analysis	Estimated effect (elasticity of production) of investing in infrastructure varies from −0.06 to 0.52. The effects appear to vary depending on the type of infrastructure in with the investment is made as well as between industries.
	Lindenberger (2003)	Germany	Production Function	the replacement of expensive routine labor by energy-driven and increasingly information processing capital in the course of technological progress in the observed direction of increasing automation
Transportation investment and economic growth	Jiang et al. (2017)	china	structural equation model (SEM)	Transportation investment has impacts on economic growth, but are different at the national level and provincial level.
	Khaksari and Asadi Sisakht (2017)	Iran	taxonomy method	Transport infrastructure development and regional development are highly correlated.
	Meersman and Nazemzadeh (2017)	Belgium	aggregate growth modeling and a causality test	GDP per capita is not only positively impacted by traditional indicators such as the openness of the Belgian economy, the rate of investment as a whole, and technological change, but also by the length of the motorways, the rail network and the investments in port infrastructure.
	Saidi et al. (2018)	MENA countries (the Middle East and North Africa region)	panel data and Generalized Method of Moments (GMM)	The empirical results added 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.

Source: Summary of reviewed existing literature

The empirical results added 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.

3. Theoretical Foundations

The first aim of the production function is to address attribution efficiency in the use of factor inputs in production and the resulting distribution of income to those factors. Under certain assumptions, the production function can be used to derive a marginal product for each factor, which implies an ideal division of the income generated from the output into an income due to each input factor of production [Banaeian and Zangeneh, 2011].

In 1928, Douglas and Cobb [Douglas and Cobb, 1928] published a study in which they modeled the growth of the American economy during the period 1899 - 1922. They considered a simplified view of the economy in which production output is determined by the amount of labor inVolved and the amount of capital invested. While many other factors are affecting economic performance, their model proved to be remarkably accurate.

The function they used to model production was of the form:

$$P\,(L, K) = bL^{\alpha}K^{\beta} \qquad (1)$$

In this equation:

P = total production (the monetary value of all goods produced in one year)

L = labor force (the total person-hours per year)

K = capital input (the monetary value of all machinery, equipment, and building)

b = total factor of productivity

α, β = is the output elasticity of labor and capital, respectively. These values are constants determined by available technology.

Output elasticity measures the responsiveness of output to a change in levels of either labor or capital used in production, ceteris paribus. For example, if α = 0.15, a 1% increase in labor would lead to approximately a 0.15% increase in output.

Further, if α + β =1, the production function has constant returns to scale. That is if L and K are each increased by 20%, then P increases by 20%.

Returns to scale refer to a technical property of production that examines changes in output after a proportional change in all inputs (where all inputs increase by a constant factor).

If the production function is denoted by P = P (L, K), then the partial derivative δP/δL is the rate at which production changes concerning the amount of labour. Economists call it the marginal production concerning labor or the marginal productivity of labor. Likewise, the partial derivative δP/δL is the rate of change of production concerning capital and is called the marginal productivity of capital.

In these terms, the assumptions made by Douglas and Cobb can be stated as follows [Eklund, 2013]:

1. If either labor or capital vanishes, then so will production.
2. The marginal productivity of labor is proportional to the amount of production per unit of labor.
3. The marginal productivity of capital is proportional to the amount of production per unit of capital.

Because the production per unit of labor is P/L, assumption 2 says that, $\frac{\partial P}{\partial L} = \alpha \frac{P}{L}$ for some constant α. If we keep K constant (K = K_0), then this partial differential equation becomes an ordinary differential equation: $\frac{dP}{dL} = \alpha \frac{P}{L}$.

This separable differential equation can be solved by re-arranging the terms and integrating both sides:

$$\int \frac{1}{P}\, dP = \alpha \int \frac{1}{L}\, dL \qquad (2)$$

$$\ln(P) = \alpha \ln(cL) \quad , \quad \ln(P) = \ln(cL^{\alpha})$$

Moreover, finally,

$$P\,(L, K_0) = C_1(K_0)L^{\alpha} \qquad (3)$$

Where $C_1(K_0)$ is the constant of integration and we write it as a function of K_0 since it could depend on the value of K_0.

Similarly, assumption 3 says that $\frac{\partial P}{\partial K} = \beta \frac{P}{K}$, keeping L constant ($L = L_0$), this differential equation can be solved to:

$$P(L_0, K) = C_2(L_0)K^{\beta} \quad (4)$$

Moreover, combining equations:

$$P(L, K) = bL^{\alpha}K^{\beta} \quad (5)$$

Where b is a constant that is independent of both L and K. Assumption 1 shows that $\alpha > 0$ and $\beta > 0$.

Notice from equations five that if labor and capital are both increased by a factor m, then

$$P(mL, mK) = b(mL)^{\alpha}(mK)^{\beta} = m^{\alpha+\beta}bL^{\alpha}K^{\beta} = m^{\alpha+\beta}P(L, K) \quad (6)$$

If $\alpha + \beta = 1$ (meaning constant returns to scale), then $P(mL, mK) = mP(L, K)$ Which means that production is also increased by a factor of m, as discussed earlier. In general, the production function that is extracted based on the maximization of corporate profits can be shown as the Cobb Douglas function as follows:

$$Q = f(K, L, IPM) \quad (7)$$

In which, Q is the amount of production, K is a physical accumulation of capital, L is labor force, and IPM represents raw materials and intermediate goods. In such a relationship, services provided by physical capital are assumed to be exactly proportional to the level of capital accumulation.

Assuming that the above function is separable from the IPM variable, the general production function used in the present model, based on the reviewed literature is Equation No.8:

$$Q_T = f(K_T, L_T, E_T) \quad (8)$$

The parameters of the transport supply function are as follows:

Q_T: Production of transport sector at constant prices in 2004

K_T: Capital of transport sector at constant prices in 2004

L_T: Labour in the transport sector (people)

E_T: Energy consumption of transport sector at constant prices in 2004

4. The Methodology of Research and Estimation of the Model

This paper is a causal-causative study that explores and interprets the relationships between variables. The data of this research are gathered from the Central Bank of the Islamic Republic of Iran and the Center for Statistics of Iran from 1960 to 2014. We estimate based on the econometric method of Auto-Regressive Distributed Lags (ARDL) and Eviews software.

In regression based on time-series data formation of a spurious regression is probable if just a conventional OLS estimation applied on non-stationary time series [Banerjee et al. 1993]. In fact, the non-stationarity may be due to the presence of a unit root in both explained and explanatory variables in a regression equation. In the other word, any two nominal economic variables are likely to be correlated with each other, even without any meaningful casuality relationships. Therefore, conventional regression might provide misleading statistical evidence of a linear relationship between non-stationary variables. In Econometrics, the Unit root and Cointegration analysis have become a way to circumvent the spurious regression.

A large number of past studies have used the Johansen cointegration technique to determine the long-term relationships between variables of interest. In fact, this remains the technique of choice for many researchers who argue that this is the most accurate method to apply for I(1) variables. Recently, however, a series of studies by Pesaran and Shin [Pesaran and Shin, 1998]; Pesaran and Pesaran [Pesaran and Pesaran, 1997]; Pesaran and Smith [Pesaran and Smith, 1998] and Pesaran et al. [Pesaran, Shin and Smith, 2001] have introduced an alternative cointegration technique known as the ‘Autoregressive Distributed Lag (ARDL)’ bound test. This technique has some advantages over Johansen cointegration techniques. First, the ARDL model is the more statistically significant approach to determine the cointegration relation in small samples [Ghatak and Siddiki, 2001], while the Johansen co-integration techniques require large data samples for validity.

A second advantage of the ARDL approach is that while other cointegration techniques require all of the regressors to be integrated of the same order; the ARDL approach can be applied whether the regressors are I(1) or I(0). This means that the ARDL approach avoids the pre-testing problems associated with standard cointegration, which requires that the variables already classified into I(1) or I(0) [Pesaran et al. 2001; Pahlavani et al. 2005]

To determine the stationarity condition of variables, we use the Augmented Dicky Fuller Test (ADF) to determine the order of co-integration of variables of the model. In the next step, after estimating the coefficients of the equations using the ARDL model, the test for checking the existence of long-term cointegration between variables (Banerjee test) performed. Also, the serial autocorrelation test, heteroskedasticity test, conditional heteroskedasticity test, the normality test of residuals, as well as the model Specification test, also investigated.

Because the equations are estimated using the ARDL method, the model will consist of three groups of dynamic equations of the model, long-run equilibrium equations and error correction model (ECM). Generally, the steps are as follows:

- Estimation of the dynamic form of the model
- Testing the null hypothesis of unit root existence or non-cointegration of model variables
- Achieving a long run equilibrium equations
- Testing the stationary of residual of the long-term estimated functions
- Analyzing the link between short-term fluctuations and long-term equilibrium values with the help of the error correction model (ECM).

5. Research Findings

5.1 Stationary of Variables Test

Based on the literature, before estimation, it is first necessary to perform the unit root test for all variables of the model. That is if the variables were non-stationary the occurrence of spurious regression is probable. With this regard, Augmented Dicky Fuller test (ADF) applied, and as is shown in table 2, three of the parameters are stationary at level and fifth of them are stationary of degree one, and the ARDL technique is applicable.

Table 2. Stationary characteristics of model variables based on ADF test

Variable name	Function mode	Test statistic	Critical statistics	StationaryTest Result
LOG(QT)	(C, T, 1)	-2.026573	-3.495295	I(1)
DLOG(QT)	(C, -, 0)	-5.079980	-2.916566	I(0)
LOG(KT)	(C, T, 1)	-2.444512	-3.495295	I(1)
DLOG(KT)	(-, -, 1)	-7.323705	-1.947119	I(1)
LOG(LT)	(C, T, 1)	-3.018096	-3.495295	I(1)
DLOG(LT)	(C, -, 0)	-3.591689	-2.916566	I(0)
LOG(ET)	(C, T, 1)	-2.448803	-3.510740	I(1)
DLOG(ET)	(C, -, 0)	-4.215189	-2.926622	I(0)

Source: Research Findings

Description: The critical values for the Dickey-Fuller test are at the level of 5%. Symbol of LOG denote Napierian logarithm in mathematics, i.e., LOG equals to *ln*, and DLOG means Delta *ln or* $\Delta \boldsymbol{ln}$.

5.2 Results from the Estimation of the Dynamic Form Of ARDL

In this section, the dynamic model of transport production function investigated (Table 3 and Equation 9).
This equation includes explained production of the transport sector (QT), and explanatory variables as the capital accumulation (KT), the labor (LT) and the energy consumption (ET) in the transport sector. Three dummy variables have been used to improve the quality of estimations. These are D4953 (The period of 1970-1974 as a proxy for the economic boom of the Iranian economy by a two-digit economic growth and low inflation), D6163 (The effect of partial victory between years 1982 and 1984 during Iran's imposed war with Iraq) and D8384 (the side effect of administration transmission from president Khatami to president Ahmadinezhad during years 2003 to 2004).

Considering the dynamic form of the model, it is observable that an optimal lag of degree 1 is necessary for the variables of the model. The test statistics of model variable approved the quality of the estimations, as all variables coefficient are theoretically expected and statistically significant, and the goodness of fit criteria (Adjusted R-squared) is more than 99% (Table 3). As shown in table 3, the Banerjee-Dolado and Master Test showed the existence of a long-term equilibrium relationship between these explanatory variables (KT, LT, ET, and Dummy variables) and explained one (QT). Based on dynamic form, we are going to explain the long-term equation and Error Correction Model (ECM).

Table 3. Results from the estimation of the dynamic pattern of ARDL

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LOG(QT(-1))	0.714330	0.044568	16.02775	0.0000
LOG(LT)	1.049194	0.161247	6.506757	0.0000
LOG(LT(-1))	-1.028068	0.161526	-6.364709	0.0000
LOG(KT)	0.922091	0.175504	5.253963	0.0000
LOG(KT(-1))	-0.691469	0.145920	-4.738690	0.0000
LOG(ET)	0.060804	0.020502	2.965826	0.0051
D4953	0.161646	0.019865	8.137290	0.0000
D8384	-0.051733	0.008951	-5.779382	0.0000
D6163	0.045577	0.008874	5.135799	0.0000
R-squared	0.994442	Mean dependent var		11.29856
Adjusted R-squared	0.993302	S.D. dependent var		0.765048
S.E. of regression	0.062613	Akaike info criterion		-2.536336
Sum squared resid	0.152894	Schwarz criterion		-2.185486
Log likelihood	69.87207	Hannan-Quinn criteria.		-2.403750
Durbin-Watson stat	2.228421	Banerjee-Dolado-Master statistics:		-6.4

Source: Research Findings

$$ln(QT) = 0.71\, ln(QT(-1)) + 1.049 * ln(\text{LT}) - 1.028 * ln\big(\text{LT}\,(-1)\big) + 0.92 * ln(\text{KT}) - 0.69 * ln(\text{KT}\,(-1)) + 0.06 * ln(\text{ET}) + 0.16 * \text{D4953} - 0.05 * \text{D8384} + 0.045 * \text{D6163} \quad (9)$$

5.3 Results of Long-Term Model Estimation

In the following, a long-term equilibrium relationship is provided (Table 4 and Equation 10).

As can be seen, in the long-term model of the transport production function, the sign of all coefficients of the variables are as expected. The results show the production elasticity of capital, labor, and energy consumption in transportation respectively as 0.81, 0.07 and 0.21. Based on confidence interval test the effect of capital on the production of transportation services is well above other two inputs. On the other hand, provided Ceteris paribus condition, every one percent increase in the capital input will lead to 0.81 percentage increase in production of the transportation sector, while the same amount increase in the labor and energy consumption will lead to just 0.07 and 0.21 percentage increase in, the dependent variable (QT). This result is in accordance with the literature reviewed [Lin and Ahmad, 2017], [Lin and Liu, 2017].

Furthermore, the hypothesis of the existence of the economy of scale in the transportation sector, based on the statistical test, could not be rejected. On the other words, an equal λ percentage increase in all three inputs (KT, LT, ET) provided Ceteris paribus condition, can increase the production of transportation sector by η percentage, while η>λ.

5.4 Results of Error Correction Estimation (ECM)

An ECM is a short-run model that incorporates a mechanism that restores a variable to its long-term relationship from a disequilibrium position. On the other words, ECM links the long-run equilibrium relationship between time series variables implied by co-integration with the short-run dynamic adjustment mechanism. Therefore, the estimation of ECM is useful, and it could clarify the adjustment process toward an equilibrium state.

The results of this model presented below (Table 5 and Equation 11). As the results, all estimated coefficients are statistically significant. The coefficient of error correction term is equal to (-0.29), indicating a 29% adjustment of the nonequilibrium error of the production function of transportation in each period.

Table 4. Results of long-term model estimation

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(LT)	0.073953	0.071751	1.030685	0.0309
LOG(KT)	0.807303	0.018291	44.136997	0.0000
LOG(ET)	0.212849	0.051507	4.132414	0.0002
D4953	0.565847	0.145861	3.879359	0.0004
D8384	-0.181094	0.010563	-17.144659	0.0000
D6163	0.159543	0.044060	3.620997	0.0008

Source: Research Finding

$$ln(QT) = 0.074 * ln(\mathrm{LT}) + 0.807 * ln(\mathrm{KT}) + 0.212 * ln(\mathrm{ET}) + 0.56 * \mathrm{D4953} - 0.18 * \mathrm{D8384} + 0.16 * \mathrm{D6163} \quad (10)$$

Table 5. Results of estimating the short-run pattern (error correction)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLOG(LT)	1.049194	0.161247	6.506757	0.0000
DLOG(KT)	0.922091	0.175504	5.253963	0.0000
DLOG(ET)	0.060804	0.020502	2.965826	0.0051
D(D4953)	0.161646	0.019865	8.137290	0.0000
D(D8384)	-0.051733	0.008951	-5.779382	0.0000
D(D6163)	0.045577	0.008874	5.135799	0.0000
CointEq(-1)	-0.285670	0.044568	-6.409714	0.0000

Source: Research Finding

$$\Delta ln(\mathrm{QT}) = 1.049 * \Delta ln(\mathrm{LT}) + 0.922 * \Delta ln(\mathrm{KT}) + 0.061 * \Delta ln(\mathrm{ET}) + 0.161 * \Delta(\mathrm{D4953}) - 0.051 * \Delta(\mathrm{D8384}) + 0.045 * \Delta(\mathrm{D6163}) - 0.285 * \mathrm{ECM}(-1) \quad (11)$$

6. Conclusions and Suggestions

The transportation is an important economic sector, as it, directly and indirectly, induces value in the whole economy. Therefore, analyzing transportation production function and understanding its determinant is of great use for policymakers. In the present study, in the form of econometrics estimation, general production function of transportation sector investigated.

As shown in this paper, based on time series variable between the period of 1960 to 2014 (1338 to 1393 in Persian calendar) labor, capital, and energy inputs, along with some dummy variables, are significant variables in explanation of transportation production tracks. Some significant findings are as following:

1- In long-term, the effect of capital on the production of transportation services is well above the other two inputs. In point estimation view, provided Ceteris paribus condition, every one per cent increase in the capital input will lead to 0.81 per cent increase in production of the transportation sector, while the same amount increase in the labour and energy consumption will lead to just 0.07 and 0.21 percentage increase in the depended variable (QT). It implies the importance of investment in the transportation sector to achieve improvement in production.

2- Based on the statistical test, the hypothesis of the existence of the economy of scale in transportation sector could not be rejected. It means that an equal λ percent increase in all three inputs (KT, LT, ET) provided Ceteris paribus condition, can lead to η percent increase in the production of the transportation sector, while η>λ. It may have a policy implication that this sector can be a potent candidate for boosting economic growth in the whole economy. Of course, the economy of scale of other economic sectors should be justified before conclusion in this regard.

3- The coefficient of error correction term is equal to (-0.29), indicating a 29% adjustment toward equilibrium in each period, which is a suitable adjustment speed. It means, after imposing any shock in transportation production, it takes about three periods (years) to converge again to the long run trend.

4- The expected signs of the coefficients in the model are in line with the theoretical foundations. The most important explanatory variable for transportation production is capital and the least important is labor. This is evident in other research such as Lin and Ahmad [Lin and Ahmad, 2017] or Lin and Liu [Lin and Liu, 2017].

The reason is that transportation sector is capital intensive.

For further study, there are some opportunities to broaden the scope of the work and at the same time improve the policy implications of the research. Provided availability of time series data, disaggregation of the transportation production function to each mode are of great value, as it could provide comparative input-elasticity.

Another suggestion is to perform a spatial transportation production estimation for distinguishing the lever geographical point in the transportation sector.

Also, by determining the effects of different types of energy carrier (i.e. petroleum products, electricity, gas, and coal), different type of investment (i.e. infrastructure, rolling stock, and so on) and finally different type of labour (i.e. managers, drivers, administrative personnel and so on) on the transportation sector production the roadmap toward transportation development on the country will become more apparent. In general, all of these studies will be like a DSS (Decision Support System) for policymakers, which can help them to better plan for the future.

7. References

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