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# Estimation of Passenger Rail Demand Function in Tehran Province by using Ols Method

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## Abstract

*In this article we review the estimation of passenger rail demand function in Tehran province using Eviews 7 software, and current techniques in econometrics . In order to do so first we try to investigate the stationarity of the pattern variables using the Philips Perron (PP) test and after that we assure from stationarity of pattern variables. After this step, the long run and equilibrium relation between these variable were prompted using the Engle Granger cointegration test. and according to the results , the long run and equilibrium relationship exist between variables. Then the studied pattern was estimated by Ordinary Least Squares (OLS) estimate methods and the results confirm to theoretical and statistical expectations .So that the variables of rail lines length and income have positive and meaningful relationship with transportation demand, but the variable of train ticket price has negative and meaningful relationship with transportation demand. Regarding the studied pattern is a logarithm linear Regression. The coefficients represents the transportation demand elasticity relative to length of rail lines, income and train ticket price. For assuring from non-existence of serial correlation and variance heteroskedasticity problem in the pattern , we have proceeded to two issues .The results are reported that two mentioned problems are not in the pattern .*

***Keywords:*** *Passenger Rail Demand, Tehran Province, OLS estimate method, Elasticity*

## Introduction

Transportation section is one of the most important components of each country's economy. This section not only influences the economic development of a country but also undergoes qualitative and quantitative changes during social-economic development. In national accounts classifications, transportation activities are categorized in civil service category. Some of the experts regard transportation as an outcome of the move from the place relation of Supply and Demand with centers of production and consumption of goods and services. Others consider transportation as the movement of human beings and goods between the regions rich in passenger and goods using transportation facilities.

Transportation fulfils the need of moving people and cargoes from one point to another one, the provided services in transportation need to be coordinated, extensive, fast, regular comfortable and inexpensive (Weisbrod, 2008). Transportation services are divided into 3 categories of land, marine and airway. Land transportation includes roads (within and between cities) and railways (Metro: underground trains – Tram: railways in the city - Railway: regular railways between cities).

Railway systems usually operate on special-made routes, without restriction or any interference from road vehicles. Railways are the common public transportation system in use in some cities in the world which is divided into two types of above ground and underground. Tram is the most common type of aboveground railway and metro is the most common type of underground one. Also, suburban railway system is generally designed for the trips longer than that of metro system and the distance between its stations are also longer. The tracks of this system are usually separated, but they can also have level crossings. Suburban railway services are called express transportation in some parts of metro rails services that the whole or part of which are built underground and have one or several routes and have fixed stations and are accessible through the ground level entrances(Hosseini, 2004).

Transport economics, as a branch of economics, studies transportation networks and their relationship to various sectors of economy of communities (Ja'fari Samimi, 2009). In fact, transportation economy is a branch of economics that by analyzing supply and demand factors, offers the optimum method of using transportation facilities and assets to meet the transportation needs in certain times and places and maximize the positive effects of transportation in different transportation sectors and minimize its negative effects (Mahmoodi, 1997).

The production and distribution are among important economic reactions which necessarily reveal the demand for transportation, thus demand for transportation is not separate from transportations services and transportations networks are special physical items that are formed inside and around big economic hubs. There is a direct relationship between the increase in transportation demand and changes in living standards, new industrial policies, farming and utilizing local raw resources. Transportation demand is divided mainly into two parts, transportation of passenger and transportation of loads. This paper attempts to estimate the passenger rail demand function in Tehran province using an appropriate model.

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## Theoretical framework

According to the definition, the demand for a product or service includes various quantity of a product or service that a buyer is willing or capable of buying at different prices, assuming that the rest of the factors are fixed, over a period of time. The overall form of the demand function for the good X can be expressed as follows:

$$Q_X = f(P_X, I, P_Y, T, E, A, \ldots) \quad (1)$$

Where:

$Q_X$ = Demanded quantity (or the purchased amount) for the good X

$P_X$=Price of the good X

I= Purchasing power (Income) of consumers

$P_Y$= price of the goods related to the good X

T= Taste of consumers

E= Consumers' expectation factor

A= Advertisement factor

Therefore, the function of demand for transportation may be considered to be similar to the function of demand for other products and services. Nowadays, due to the wide range of research methods of quantitative estimation in the humanities, including the principles of econometrics, linear programming, nonlinear programming and etc., an appropriate model can be applied to estimate any scientific hypothesis, given the nature and ultimate purpose of the research and statistical information available

The study conducted by Fitzroy and Smith provide a theoretical framework for the model used in the current study. They attempted to estimate the rail transportation demand using the time series data for 14 European countries and estimated the effect of variables such as GDP(Gross Domestic Product)per capita, the price of rail transportation, route density ( the ratio of kilometers of railways to square kilometers of the country), frequency ( the ratio of kilometer-train to length of the rout) and oil Prices on demands.

## Review of the literature

In this section the results of some studies are presented, which are explicitly or implicitly related to the present study, so they may be used as guidelines in other sections of the study.

Craft (1963) estimates road transportation demand using cross sectional data in his study, in which the elasticity of traveling by bus with respect to the train ticket prices was negative and the elasticity of traveling by train with respect to bus tickets price was estimated as 2.3 .

Quandt and Baumol (1966) estimated the transportation demands model using the data of 20 pairs of cities in California in America. Variables such as population of the city, the average income of the city, bank deposits of the city, minimum cost of traveling between the two cities, the relative cost of traveling between the two cities considering the means of transportation, the best travel time between the two cities and the relative duration of travelling between the two cities were entered to the function. The demand income elasticity of the two cities were 1.75 and 3.71 and demand price elasticity was -0.99.

Alkali (Alkali, 1967) estimated the function of demands for road travelling from Los Angeless to some big cities based on attraction model using regression method and an average distance for each route and entered variables such as travel demand, population of the city and the length of the route. The elasticity of value of travel demand with respect to independent variables of the model were 0.98, 1.03 and -2.25 respectively.

Fisher (1975) used linear models to estimate the function for rail transportation demand in Boston-New York rout. In addition to transportation cost, Fisher entered the time by the means of transportation, bus fares and the amount of car ownership. Then estimated cost elasticity of demands for railway services as -1.3.

Domenkish and Craft (1979) estimated the sensitivity of means of transportation to transportation cost and travel time in Boston to motivate private cars owners to use the public transportation such as metro and bus. Variables such as cost and travel time, cost and travel time of an alternative means of transportation and social variables such as population, employment and income were also entered into the function. The results indicated that the demands for metro and bus transportation were almost not elastic.

Kaemmerle (1989) estimated the demand for airway services in small towns in America. Variables such as the total annual flights, the income of the whole city 'i', the attraction criteria to reach to the connecting center, the number of weekly direct flights from the city 'i' to all the airports, an criteria indicating the services with more than 30 seats and the criteria of central airport were entered to the function. Income elasticity of transportation supply and demand was estimated as 1.197 and the used parameters in the model were significant ( Ghane Basiri, 2003).

Using the data from 1976-1997 of 34 city pairs in California, Owen and Starki (1997) estimated a model in which variables such as price, population, income, local and cultural influences , and political and governmental factors are used. In order to estimate the model, they considered transportation demand and supply concurrently and applied Two Stage Least Squares (2SLS) method to estimate the model. The estimation showed that the parameters used in the model were significant and elasticities were also calculated.

At Public Administration Training Centre in 1998, A. Ghafurian in his master's thesis titled as 'investigating transportation demands in Rasht province' investigated urban transportation systems and the problems related to the transportation system in Rasht city ( Ghafurian, 1998). Various variables such as the number of employed travelers, the purpose of travels including occupational, educational, shopping, going to agencies, receiving services, transporting people, eating, accompaniment, meeting friends, having fun and exercising were entered into the study. The results showed that going to agencies was estimated as 9.21 which was higher than other variables.

In his masters' thesis at faculty of Economics and Accounting, Islamic Azad University, Central Tehran Branch in 2001, S. Mehdizadeh estimated the function for rail services demand in Iran (Mehdizadeh, 2001). The results of the estimation showed that the demand for traveling using railways is influenced by national income and population of the country. T-statistic showed that coefficients of income and population variables were significant.

In their paper titled as 'Travel demand prediction using economic models in rail transport' at Sharif University of Technology in 2003, A. Rezaiee Arjroudi and P. Bazdar Ardebili estimated rail transportation demand using Vector Auto Regression Model and cointegration method for the years 1971-2009 ( A. Rezaiee Arjroudi and P. Bazdar Ardebili, 2003).Using Vector Auto Regression Model, this paper predicted traveling demand variables of per capita income, train ticket price and length of main railway lines. The results indicated that train ticket price and length of main railway lines were exogenous. It means that traveling demand is more affected by income than other variables of the model.

**Introducing variables and estimating the model**

As mentioned earlier, the present paper investigated the effect of various factors on rail transportation demand. In so doing, first we introduced the variables and the structure of the model and then estimated the model and presented the results.

Introducing variables

The variables of the model were:

GDP/POP = Gross Domestic Product at constant prices 1997=100 (Billion rials) / Population (millions) = The per capita income

TD/POP = Transportation Demand (millions) / Population (millions) = Trips per capita

P = Price of train tickets = Transportation price index with constant price 1997=100 / triff of kilometers per person

X = Length of railway lines (km)

The variables were extracted and used from statistical yearbook of Tehran Province from the Statistical Centre of Iran for the years 1999-2010 with quarterly status.

Model structure

Choosing a functional form (linear, logarithmic, semi-logarithmic, etc.) plays an important role in interpreting the estimated coefficients. In case there is a strong theory, it may be used, otherwise an official and accurate test needs to be applied. In cases the dependent variables of both models are the same, the model with higher $R^2$ will be chosen. But if the dependent variables of the two models are not the same, choosing only $R^2$ criterion is not enough and the dependent variable should be scaled in a way that the both models can be compared. This method is based on the work of COX and BOX and is known as COX-BOX.

Considering the study conducted by Fitzroy and Smith regarding rail transportation demand and based on COX-BOX test and lower value of RSS (residual sum of squares) in a logarithmic model, the model is determined as follows: ( L=Logarithm)

$$LTD/POP = \beta_0 + \beta_1 LGDP/POP + \beta_2 LP + \beta_3 LX + u_t \qquad (2)$$

Stationary

One necessary step in estimating the regression model and avoiding the false regression is to test the stationarity of these variables using the Philips-Perron test, and the results are provided in table 1.

**Table 1- Results for variable's stationarity test**

| Variable | Philips-Perron | |
|---|---|---|
| | First difference | |
| | Statistic | Critical values |
| LTD/POP | -7.32 | -3.59 |
| | | -2.93 |
| | | -2.60 |
| LGDP/POP | -2.66 | -3.59 |
| | | -2.93 |
| | | -2.60 |
| LP | -2.62 | -3.59 |
| | | -2.93 |
| | | -2.60 |
| LX | -1.64 | -2.61 |
| | | -1.94 |
| | | -1.61 |

Source: Test results

According to these results all the variables were stationary during the first difference, and they are alright. But it is needed to assure that there is long run and equilibrium relationship between these variables.

Investigation of cointegration among variables

The cointegration of the desired variables was investigated using the resulted error terms. The results is presented in table2

**Table 2. Results for error term stationarity test**

| Error term | Augmented Dickey-Fuller (ADF) Statistic | Critical Values | | |
|---|---|---|---|---|
| | | %1 | %5 | %10 |
| Income per capita, train ticket price, the length of rail line | -6.34 | -2.62 | -1.94 | -1.61 |

Source: Test results

In based on the results of mentioned table , the error term is stationary for three assurance level : 90% , 95 % , 99% . So we can concluded that cointegration relationship are in the Engle Granger method between pattern variables .

Serial Correlation LM test

In the fact , this test is the Breusch – Godfrey test which was for determining and lack of the serial correlation problem , the error terms are used .The Durbin – Watson statistic is used for investigating first difference serial correlation that in this regression , the current statistic presents the lack of this problem in this pattern . And also , we can use the Breusch – Godfrey test for investigating serial correlation in the highest difference. The second difference of serial correlation is not in this regression in based on this test and according to F ,nR2 statistic and quantities of prob calculated ( prob = 0.14 and prob = 0.12 ).

ARCH LM test

One of the commen tests in variance heteroskedasticity is the ARCH LM test .In this test by using error terms squares of an auxiliary regression is estimated. And then by using two statistic F, nR2 , we judge about existence and non- excistence of this issue , according to the results and amounts of calculated Prob ( Prob = 0.19 , Prob = 0.18 ) H0 is accepted. In the end , we can say that this pattern does not have variance heteroskedasticity problem .

**Model estimate**

Model in ordinary least squares method means OLS , then the serial correlation was removed by using the first difference Moving – Average Model ( MA (1)) according to the below pattern has been estimated in the form of logarithm linear.

$$LTD/POP = \beta_0 + \beta_1 LGDP/POP + \beta_2 LP + \beta_3 LX + u_t \qquad (3)$$

$$LTD/POP = -7.41 + 0.82LGDP/POP - 2.22LP + 2.75LX + u_t \qquad (4)$$

t: (-11.15) (2.94) (-3.73) (8. 84)

$R^2 = 0.91 \qquad \bar{R}^2 = 0.91 \qquad D.W = 1.55$

It is necessary to explain that in based on logarithm models , the obtaining coefficients for every independent variables show the transportation demand elasticity relative to that variables. So the transportation demand elasticity relative to length of rail lines, income and train ticket price are 2.75 , 2.94 , -2.22 marshal .

**Conclusion**

Regarding done calculations and remarks which reported in the mentioned model , the below results were achieved .

1-Model variables were stationary in the first difference. The existence of long run and equilibrium relation in cointegration test was confirmed by using Engle Granger method

2-The results coincide with theoretical and statistical expectations. So that, the variables of rail lines length and income have positive and meaningful relationship with transportation demand, but the variable of train ticket price has negative and meaningful relationship with transportation demand.

3-The calculations show $R^2 = 0.91$ . It means that 91 percent of transportation demand changes have been explained by independent variables model .In econometrics discussions , the high level of $R^2$ coefficient is one of the best indexes of value model . We had used the first difference Moving – Average Model (MA (1)) for removing serial correlation .The Durbin – Watson (D.W ) equals 1.55 and the serial correlation problem has been removed .

4-Regarding the mentioned pattern is a logarithm linear regression , the coefficients present the elasticity of transportation demand relative to the independent variables .

5-For assuring from non-existence of serial correlation and variance heteroskedasticity problem in the pattern , we have proceeded to two issues .The results are reported that two mentioned problems are not in the pattern .

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