

# An Econometric Assessment of the Dependence of Main Indicators of Transport Sector on Factors Affecting Them

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**Abstract**—In this research, the dependence of the main factors of the transport sector for the Azerbaijan economy on factors affecting them was studied. For this purpose, firstly, to determine the share of key production factors in production, the production function for the transport sector was established based on the country's statistical indicators. The article also evaluates the impact of freight transportation on the value-added of the transport sector, and the impact of the number of vehicles and, separately, trucks on net profit.

**Keywords**—transport, value-added, net profit, freight, the number of vehicles, trucks

## I. INTRODUCTION

Transport is one of the main sectors of the economy. This sector is important for the production process to be happened by carrying necessary raw materials to factories and also, without this sector it would be impossible to supply finished goods to consumers. In this regard, the development of the transport sector is an important issue for each country. The transport sector is also one of the important areas in Azerbaijan. The chart below shows the share of transport in GDP.

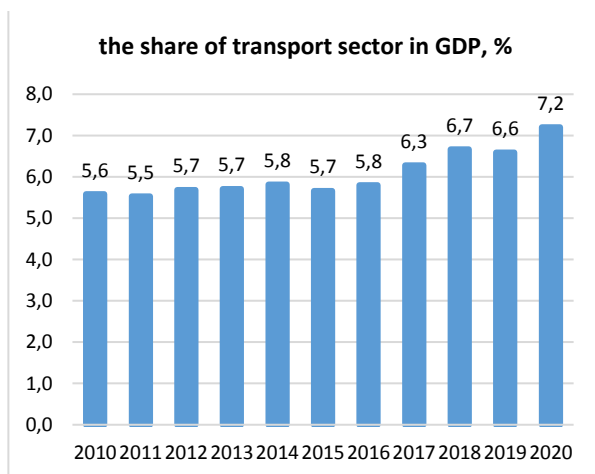


Fig. 1. The share of transport sector in GDP (%)

As can be seen from the Figure 1, the share of transport sector in GDP has mainly increased during the period, and in 2020, this share has been equal to 7,2% [8].

The oil and gas sector has been the main sector in Azerbaijan's economy after its independence. Oil products constitutes more than 90% of the country's export. During recent years, this sector has had a 33-50% share in the total GDP of Azerbaijan, depending on prices. Because the export of energy was the main source of revenue for the country, creating the system of transport corridors to export this energy was chosen as one of the basic policies [9]. Moreover, to reduce the dependence on the oil and gas sector, the development of the non-oil sector has been in the spotlight. Therefore, the country has been directing foreign direct investments from the oil and gas sector to the non-oil sector. For this, a number of sectors have been identified to support the sustainable development of the country, and due to its convenient position, one of these selected sectors is the transport sector. Creating the necessary infrastructure is an ongoing process. However, given the risk of being dependent on one sector, there is a need to diversify the national economy. In 2009-2019, the volume of investments in the transport sector of the country amounted to 20% of investments in all sectors of the economy [1]. However, to use these investments properly, it is relevant to research the efficiency of expenditures and to determine preferred areas to be developed. Therefore, this article evaluates the factors affecting the main indicators of the transport sector.

## II. METHODOLOGY

### A. Production function analysis of transport sector

Production is the process of transforming production factors into goods and services during a certain time. The relationship between the volume of products obtained at the end of a production process and the production factors used in that process is described through production functions. In other words, production functions reflect the relationship between the production of an enterprise, a production sector or the economy of a country as a whole, and production factors. Obviously, the most important condition for the

economic growth of a country is to increase its production, and to achieve this, to use effectively existing production factors. In this regard, since economic development is the main economic goal of countries in the present as in the past, the rational use of production factors and therefore the importance of constructing production functions is one of the relevant topics to be studied. Because production functions can give important information about the production process for the economy or a sector of the economy [11].

Production functions mathematically express the relationship between production factors and the result of production. In general, we can write the production function as following [15]:

$$Y = F(X_1, X_2, \dots, X_n), \quad (1)$$

One of the most common production functions is the Cobb-Douglas production function. In the Cobb-Douglas production function, the relationship between the volume of production and production factors that affect it is considered as follows:

$$Q = AK^\alpha L^\beta, \quad (2)$$

Here Q is the volume of production, K- is capital used to produce that volume of production, and L – is labour.  $\alpha$  and  $\beta$  are the elasticity coefficients of K and L, respectively.

To evaluate this function, we will use least squares method in Eviews software [5]. For this, firstly having considered  $\alpha + \beta = 1$ , we can write equation (2) as following:

$$Q = AK^\alpha L^{1-\alpha}, \quad (3)$$

If we divide both side of this equation into L, we can get the following equation:

$$\frac{Q}{L} = A\left(\frac{K}{L}\right)^\alpha, \quad (4)$$

In the equation (4),  $\frac{Q}{L}$  – is the volume of production produced by one worker, and  $\frac{K}{L}$  – is the capital per worker. If we log both sides of this equation, we can write:

$$\log \frac{Q}{L} = \log A + \alpha \log \frac{K}{L}, \quad (5)$$

And if we mark  $\log(A)=c(1)$ , and  $\alpha =c(2)$ , then we will can estimate the following equation in Eviews using least squares method [4]:

$$\text{LOG}(Q/L) = C(1) + C(2)*\text{LOG}(K/L), \quad (6)$$

#### B. Assesment of the dependence of value added and net profit of transport sector on factors affecting it

To assess the dependence of value added and net profit of transport sector on the freight transportation and the number of vehicles we will estimate the following equation in Eviews, using least squares method:

$$\text{Log}(VA)=C(1)+C(2)*\text{Log}(FT), \quad (7)$$

$$\text{Log}(NP)+c(1)+ C(2)*\text{Log}(NoV)+C(3)*\log(NoT), \quad (8)$$

Here, VA- is the value added of transport sector Np – net profit of transport sector, NoV – the number of vehicles, , FT- freight transportation, and NoT –the number of trucks in the country.

### III. DATABASE OF THE RESEARCH AND ITS PROCESSING

Statistical indicators of The State Statistical Committee of the Republic of Azerbaijan (SSCRA) [8] related to the transport sector were used as the information base of the research. To analyze the transport sector with production functions, the Cobb-Douglas production function of this sector was established. For this purpose, (5) regression equation was evaluated in the eviews software package. In the study, we took the value-added of the transport sector as Q, the value of fixed assets of the transport sector as K, and the number of employees in this sector as L. It is known that the use of nominal indicators in the assessment is problematic. Therefore, the value-added of the transport sector and fixed assets were converted to real prices using the deflator, and all 3 input variables of the model were expressed as a percentage. So, the input data of the econometric model to construct the production function are obtained as in the table 1.

TABLE 1. VALUE ADDED, FIXED ASSETS AND LABOUR FORCE IN TRANSPORT SECTOR OF THE AZERBAIJAN ECONOMY

years	VA	K	L
1998	100	100	100
1999	95,1	101,6	92,7
2000	121,7	96,9	86,2
2001	114,2	98,7	82,5
2002	120,4	93,4	79,8
2003	134,8	94,5	90,5
2004	135,7	97,6	91,5
2005	127,5	101,5	92,7
2006	149,1	102,4	99,1
2007	227,1	99,2	105,9
2008	227,8	86,5	118,7
2009	331,3	121,2	121,8
2010	284,1	119,5	122,1
2011	260,3	112,7	123,4
2012	256,3	135,7	127,6
2013	243,5	148,4	133,1
2014	255,0	153,2	130,8
2015	341,7	189,8	138,5
2016	374,6	186,1	134,7
2017	373,2	171,5	137,2
2018	347,3	187,0	138,0
2019	343,9	193,9	142,3
2020	393,3	211,7	153,1

In addition, the article assesses the dependence of value-added and net profit of the transport sector on the main factors affecting these indicators. The impact of several indicators was assessed during the study, but only the results of adequate models were included in the article. These indicators are the

volume of freight transportation, the number of vehicles, including the number of trucks. The input data of these established econometric models are shown in Table 2.

TABLE 2. THE VOLUME OF FREIGHT TRANSPORTATION, THE NUMBER OF VEHICLES AND TRUCKS FOR AZERBAIJAN

	VA	NP	FT	NoT	NoV
1998	324	131	55029	79934	392789
1999	315	105	67735	69685	409301
2000	453	229	80180	78566	438626
2001	436	224	92648	77142	451642
2002	474	250	98445	76928	457442
2003	563	287	110001	79019	511460
2004	614	268	117314	80918	554031
2005	670	275	128328	90852	612069
2006	872	394	145596	97395	690012
2007	1 607	908	167533	110391	773318
2008	2 060	1270	183093	113088	860047
2009	2 431	1541	190372	117378	925866
2010	2 369	1576	196452	118460	982553
2011	2 659	1813	203586	122182	1037626
2012	2 694	1724	210862	130019	1135936
2013	2 569	1466	217926	133637	1232678
2014	2 656	1386	221991	141126	1291008
2015	3 242	1860	222373	141273	1322610
2016	4 076	2162	222461	141525	1330551
2017	4 719	2935	226419	142857	1342324
2018	4 928	3137	230144	147343	1370574
2019	4 867	3055	235288	150547	1418404
2020	5 144	3229	188629	154659	1473563

#### IV. FINDINGS AND RESULTS

##### A. Assessment of production function for Azerbaijan's transport sector

The study evaluated the Cobb-Douglas production function of the transport sector based on the indicators of Table 1 using the equation (5). For this purpose, the least squares method was used in the eviews software package. As a result of the implementation of the model, the dependence of the value-added of the transport sector on capital and labor, which are the main factors of production, is obtained as follows:

$$\begin{aligned} \text{LOG}(VA/L) &= 0.520698800487 + 0.543779053821 * \\ \text{LOG}(K/L) &+ [\text{AR}(1) = 0.90502379848, \text{UNCOND}, \\ \text{ESTSMPL} &= "1998 2020"], \end{aligned} \quad (9)$$

The main statistical characteristics of the model are given in Table 3.

In addition to these statistical characteristics, other important tests have been performed to test the Gaussian Markov conditions in Eviews, and the results suggest that this model is adequate [3]. By performing simple transformations using the model parameters, we can write the Cobb-Douglas production function for the Transport Sector as follows:

$$Q = 1,6K^{0,54}L^{0,46}, \quad (10)$$

It should be noted that, in general, the share of labor in production more than the share of capital, however, for Azerbaijan case the share of capital is higher. This can be considered normal for oil-rich countries [13]. Thus, in countries rich in natural resources, there is a rapid inflow of capital into the country using natural resource revenues.

However, especially in developing countries, the existing workforce is not skilled enough to mobilize this capital [6,7].

TABLE 3. THE MAIN STATISTICAL CHARACTERISTICS OF THE MODEL (9)

Dependent Variable: LOG(VA/L)				
Method: ARMA Maximum Likelihood (OPG - BHHH)				
Sample: 1998 2020				
Included observations: 23				
Convergence achieved after 11 iterations				
Coefficient covariance computed using outer product of gradients				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.5206	0.241047	2.160153	0.0437
LOG(K/L)	0.5437	0.272272	1.997191	0.0603
AR(1)	0.905	0.114512	7.903313	0.0000
SIGMASQ	0.0195	0.005034	3.874793	0.0010
R-squared	0.7835	Mean dependent var		0.70523
Adjusted R-squared	0.7493	S.D. dependent var		0.30694
S.E. of regression	0.1536	Akaike info criterion		-0.6769
Sum squared resid	0.4487	Schwarz criterion		-0.4794
Log likelihood	11.785	Hannan-Quinn criter.		-0.6272
F-statistic	22.923	Durbin-Watson stat		1.61129
Prob(F-statistic)	0.0002			

##### B. Assessment of the dependence of value-added and net profit of transport sector on factors affecting it

The results of the eviews estimation of the dependence of value-added on the volume of freight were as follows:

$$\begin{aligned} \text{LOG}(VA) &= -4.7222345876 + 0.847265836236 * \text{LOG} \\ \text{(FT)} &+ [\text{AR}(1) = 0.691662196775, \text{UNCOND}, \text{ESTSMPL} = \\ &"1998 2020"], \end{aligned} \quad (11)$$

TABLE 4. THE MAIN STATISTICAL CHARACTERISTICS OF THE MODEL (11)

Dependent Variable: LOG(VA)				
Method: ARMA Maximum Likelihood (OPG - BHHH)				
Sample: 1998 2020				
Included observations: 23				
Convergence achieved after 20 iterations				
Coefficient covariance computed using outer product of gradients				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-4.722235	3.788891	-1.246337	0.2278
LOG(FT)	0.847266	0.319844	2.648996	0.0158
AR(1)	0.691662	0.232509	2.974770	0.0078
SIGMASQ	0.023402	0.009408	2.487346	0.0223
R-squared	0.895660	Mean dependent var		5.345884
Adjusted R-squared	0.879185	S.D. dependent var		0.484231
S.E. of regression	0.168311	Akaike info criterion		-0.540939
Sum squared resid	0.538242	Schwarz criterion		-0.343462
Log likelihood	10.22080	Hannan-Quinn criter.		-0.491274
F-statistic	54.36570	Durbin-Watson stat		1.776698
Prob(F-statistic)	0.000000			

The statistical characteristics and other relevant tests of the model show that the model is adequate.

According to the model, a 1% increase in freight transportation across the country increases the value-added of the transport sector by 0.8%.

The article then econometrically assessed the dependence of the transport sector's net profit on the number of vehicles. In this case, to consider the effect of the number of trucks on the net profit separately, the effect of both trucks and other vehicles other than trucks on the net profit was evaluated in the same regression equation. The results of the assessment were as follows:

$$\text{LOG(NP)} = -33.4018053347 + 0.875219456361 \cdot \text{LOG(NoV-NoT)} + 2.43953953068 \cdot \text{LOG(NoT)} + [\text{AR}(4) = -0.428306106271, \text{AR}(1) = 0.447875709336, \text{UNCOND}], \quad (12)$$

TABLE 4. THE MAIN STATISTICAL CHARACTERISTICS OF THE MODEL (12)

Dependent Variable: LOG(NP)				
Method: ARMA Maximum Likelihood (OPG - BHHH)				
Sample: 1998 2020				
Included observations: 23				
Convergence achieved after 28 iterations				
Coefficient covariance computed using outer product of gradients				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-33.40181	5.340561	-6.254363	0.0000
LOG(NoV-NoT)	0.875219	0.476068	1.838434	0.0835
LOG(NoT)	2.439540	0.985106	2.476424	0.0241
AR(4)	-0.428306	0.218950	-1.956179	0.0671
AR(1)	0.447876	0.194177	2.306535	0.0339
SIGMASQ	0.027345	0.009397	2.910143	0.0098
R-squared	0.9774	Mean dependent var	6.7052	
Adjusted R-squared	0.9708	S.D. dependent var	1.12533	
S.E. of regression	0.192345	Akaike info criterion	-0.1822	
Sum squared resid	0.628945	Schwarz criterion	0.11405	
Log likelihood	8.094804	Hannan-Quinn criter.	-0.10769	
F-statistic	147.2102	Durbin-Watson stat	1.4438	
Prob(F-statistic)	0.000000			

The statistical characteristics of the model (12) show that the model is adequate.

According to the model, a 1% increase in the number of trucks increases the net profit of the transport sector by 2.4%, and a 1% increase in the number of other vehicles increases the net profit of the transport sector by 0.87%. As can be seen, the increase in the number of any type of vehicle, in general has a positive effect on the net profit of the transport sector, but the effect of the increase in the number of trucks is higher than other vehicles.

## V. CONCLUSIONS

The article evaluates the dependence of the main indicators of the transport sector of Azerbaijan on the factors affecting them econometrically. To this end, to determine the share of key production factors in production, the production function

for the transport sector was first established based on the country's statistic indicators. It has been found that the share of capital in the value-added of this sector is predominant, and this is due to the inflow of high-value capital into the country using revenues from natural resources, however, at the same time, the lack of skilled labor to mobilize this capital. In addition, the article provides an econometric assessment of the effect of the volume of freight transportation in the value-added and, the effect of the number of vehicles and, in particular, trucks in the net profit of the transport sector. It was found that the effects studied were positive. Also, when assessing the impact of the number of vehicles on the net profit indicator, it was found that an increase in the number of trucks increases profits more than that other vehicles increases it. Thus, as a result of the study, it can be said that the balance of factors of production should be taken into account when making decisions for the development of the transport sector, and increasing the skill of workers should be promoted.

## REFERENCES

- [1] Azerbaijan, B. (2021). Importance of investing in the development of transit and transport services in Azerbaijan.
- [2] C.W.Cobb, P.H.Douglas, A theory of production. *The American Economic Review*, 18(1), 139-165, 1928.
- [3] Dimitrios Asteriou, Stephen G.Hall, (2016), "Applied Econometrics", Third edition, pp. 74-77, 275-286.
- [4] Eviews 9, "User's guide I" and "User's guide II".
- [5] Hasanli, Y. & Hasanov, R. (2002). Application of Mathematical Methods in Economic Research. Baku: Elm.
- [6] Hasanli, Y. (2013). The evaluation of mutual substitution elasticity of capital and labor factors by application CES function for economy of Azerbaijan. *The Journal of Economic Sciences: Theory and Practice*, 70(19), 77-96.
- [7] Hasanli, Y., Musayev, T., Rahimli, G., & Ismayilova, S. (2021). Assessment of CES Function Parameters in Oil-Rich CIS Countries.
- [8] <http://www.stat.gov.az>
- [9] Ibrahimov, R. (2010). AZERBAIJAN ENERGY STRATEGY AND THE IMPORTANCE OF THE DIVERSIFICATION OF EXPORTED TRANSPORT ROUTES. *Journal of Qafqaz University*, (29).
- [10] Ibrahimov, R. (2016). The Development of the Transport Sector in Azerbaijan: The Implementation and Challenges. *Human Development*, 5(1), 45.
- [11] Imanov, G. Hasanli, Y. (2001). Socio-economic models of Azerbaijan economy. Macroeconomic analysis. Baku, Azerbaijan: Elm.
- [12] Kontorovich G.G., (2002), "Time Series Analysis", *Economic Journal*, HSE, №1, pp.85-116.
- [13] Lederman, D., & Maloney, W. F. (2007). Neither curse nor destiny: Introduction to natural resources and development. *Natural Resources*, 1, 1-396
- [14] Magnus Y.R., Katyshev P.K., Peresetsky A.A., (2004), "Econometrics. The initial course.", 6-th edition, Moscow, pp.32-112.
- [15] Songu, M. & Sarac Elmas, F. (2017). Cobb-Duglas, CES, VES ve Translog Üretim Fonksiyonlarının Tahminleri Üzerine Genel bir Değerlendirme. *Bulletin of Economic Theory and Analysis*, 235-278