ESTIMATION OF THE INFLUENCE OF TRANSPORTATIONS IN TRANSPORT SECTOR TO ECOLOGICAL POLLUTIONS IN AZERBAIJAN

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ABSTRACT

The main purpose of this study is to analyze the role of transportations in arising the ecological problems and its importance. The analysis of international researches has been conducted in the similar fields show that it is possible to encounter with the correlation between the increase in the volume of transportation in transport sector and some indicators characterizing the pollution of environment. As it is known transport sector has rapidly developed for the last 10 years. So, the volume of transportations of the goods have increased to 226.4 million tons in 2017. But this development has also been impacting the ecological problem and giving the negative "contribution" to it. It is known that the transportations have significantly importance in Gross Domestic Product of Azerbaijan. In this study it is considered to investigate the relationships between the transportations and ecological pollutions through econometric modelling. Nevertheless, there are a lot of analyses and research in these fields, just definitely the estimation of the influence of transportations in the transport sector to the ecological pollutions have been investigated less in Azerbaijan. From this point of view, the subject of research is considered the problem of to-day and the matter of great urgency.

Keywords: *Ecological pollution, Goods transportation, Passenger transportation, Transport sector*

1. INTRODUCTION

The transport sector is particularly important in the development of society, as well as in the expansion of the state's regional and global relationships and the improvement of people's living conditions. The development of other sectors of the economy has also been achieved through revenues from the oil sector of the Republic of Azerbaijan. Since the end of the twentieth century, the progress in the transport sector has influenced indirectly to the other areas of the economy. According to the Transport Law of the Republic of Azerbaijan, transport terminology includes transportation of state-registered goods and people in the Republic of Azerbaijan. Railroad, automobile, sea, inland water, air, urban and suburban electricity, subway (underground), as well as the main pipelines in the territory of the Republic of Azerbaijan are regarded as types of transport (http://www.e-qanun.az/alpidata/framework/data/15/c_f_15171.htm). According to the State Statistical Committee, cargo transportation is divided into transport and non-transport sectors. Based on the statistical figures, 222 461 thousand tons and 22 941 thousand tons of cargo were carried in the transport amd non-transport sectors respectively in 2016. In the transport sector, 15 479 thousand tons of goods were transported by rail, 5 807 thousand by sea, 160 thousand by air transport, 59 556 thousand tons by pipelineand 141 459 thousand tons were carried by automobile. In the non-transport sector, 15 020 thousand tons of cargo were transported by automobile, 4 129 thousand tons through oil pipelines, 3 792 thousand tons were delivered via railway transport (Statistical Yearbook of

Azerbaijan 2017, pp.599; http://www.stat.gov.az//). Over the last few years, there has been a tendency for freight and passenger transportation to increase. Toxic gases emitted during transportation in the transport industry lead to atmospheric pollution, water pollution, and other complications. It in its turn leads to environmental pollution. The pollution of the environment is one of the global issues of humanity. This is a problem that is directly linked to the population's future demographic and economic growth. Naturally, the formation of healthy future generations is an important issue for everyone to consider. (Dr. Jean-Paul Rodrigue) note that the growth of personal and freight mobility in recent decades have expanded the role of transportation as a source of emission of pollutants and their multiple impacts on the environment. (J. Mikayilov, V. Shukurov and S. Yusifov, 2017) investigated the impacts of the social and economic factors on atmospheric pollutants from road transports in Azerbaijan during 1990-2014 years. Azerbaijan joined to the Sustainable Development Summit of United Nation for 2016-2030 held in September 25-27, 2015. In 2012 "Azerbaijan 2020: Look into the future" concept of development was approved (President.az, http://www.president.az /files/future_en.pdf). Strategy Road Map was written on the perspectives of national economy of Azerbaijan Republic approved by President of the Republic of Azerbaijan on based of Decree dated December 6, 2016. In accordance with the Sustainable Development Purposes of UNO, "Azerbaijan will be faithful to the commitments related with fulfillment of urgent, courageous and transformative measures making the world to be sustainable and stronger" (President.az, http://president.az/articles/21993). Note once more that protection of natural environment and solution of ecological problems assume a great importance for attaining the Sustainable Development Purposes. It means that protection of natural environment and solution of ecological problems have become an actual problem at a global and national levels. At present the positions of the countries are being assessed in protection of environment. That is to say depending on the results of noted measurement it may be taken a certain measure for the countries contributing the planet`s ecological equilibrium. By the way, in the report of 2018 on the (EPİ) environmental performance index characterizing the ecological equilibrium Azerbaijan took the 59-th place (https://epi.envirocenter.yale.edu/2018/report/category/hlt) After investigating the impact of transportation on the environmental pollution in the transport sector, the main factors determining key environmental indicators were emissions of pollutants from automobiles to air, carbon dioxide, water pollution index, growth index in atmosphere pollution. Similarly, passenger and cargo transportation in the transport and non-transport sector, as well as the volume of Gross Domestic Product were used as an explanatory variables and relevant econometric assessments were made. It should be noted that, while studying scientific literature, what I realized is that no research work related to the assessment of the impact of freight and passenger transport on environmental pollution in the transport sector has been conducted. Therefore, I hope that, the proposed article will be the first research paper within scientific sources in Azerbaijan.

2. RESEARCH DATABASE AND PROCESSING

Using the data from the State Statistical Committee of the Republic of Azerbaijan, the relationships between the indicators will be evaluated with the assistance of the econometric modeling method based on timeline data of the indicators given in Table 1. Using the final indicators of 1997-2017 for observation, the following Table 1 has been drawn and econometric models have been set up.

Table following on the next page

Table 1: Statistical basis of models

Year	CTTS (1000 tons)	GDP (mln. AZN)	CO_2 (1000 tons)	PT (1000 unit)	EDPEFAT (1000 tons)
1	2	3	4	5	6
1997	46348	3158.30		780810	459.4
1998	55029	3440.60		85070	313.4
1999	67735	3775.10		854100	342.4
2000	80180	4718.10	148.2	871484	392.7
2001	92648	5315.60	265.2	894520	401.8
2002	98445	6062.50	269.6	893225	403.3
2003	110001	7146.50	293.5	920988	412
2004	117314	8530.20	310.2	954079	435.5
2005	128328	12522.50	353.7	1000278	496.4
2006	145596	18746.20	378.3	1063347	530.9
2007	167533	28360.50	415.8	1148328	584
2008	183093	40137.20	457.4	1242161	642.4
2009	190372	35601.50	496.3	1328073	697.1
2010	196452	42465.00	528.3	1387308	742
2011	203586	52082.00	554.7	1491905	779.1
2012	210862	54743.70	604.7	1617339	849.3
2013	217926	58182.00	655.6	1746106	922.4
2014	221991	58977.80	700.3	1828324	965.9
2015	222373	54380.0	708.1	1891905	977.7
2016	222461	60425.2	678.9	1929685	981.9
2017	226419	70135.1	695.6	1973440	976.4

Source: (http://www.stat.gov.az/source/transport/az/002_1-3.xls, http://www.stat.gov.az/source/system_nat_accounts/az/002-6.xls, http://www.stat.gov.az/source/transport/az/004_1-2.xls, https://www.stat.gov.az/source/environment/az/010_10.xls (Retrieved Date 06.01.2019)) with author calculations.

The descriptions of abbreviations used in table 1 have been given in the following appendix. Table shows that ingredient of removal of pollutants from vehicle transport to atmospheric air is increased equally with the increase of passenger transportation and cargo transportation in the transport sector.

3. SPECIFICATION AND IMPLEMENTATION OF ECONOMETRIC MODELS

3.1. Evaluation of dependence of pollutants emitted from automobile transport on GDP and passenger transportation

GDP and passenger transportation are contributing factors to the increase of pollutants from automobile transport to air. Quantitative characteristics of these factors on the extent to which the impact of ingredients on the volume of pollutants emitted from automobile transport to atmospheric air were assessed based on the data given in Table 1. For the purpose of evaluation of dependence of pollutants emitted from automobile transport on GDP and passenger transportation according to factors (ingredients), the specificity of the regression equation of the logarithmic-linear model has been considered as follows. (Gujarati, 1995, Asteriou, 2016, Hasanli, 2008). It should be noted that the assessment was carried out through EViews 9.0 software package:

$$LOG(EDPEFAT) = C(1) + C(2)*LOG(GDP) + C(3)*LOG(PT) \quad (1)$$

Here, LOG(EDPEFAT) represents the natural logarithm of pollutants emitted from automobile transport to atmospheric air, while LOG(GDP) reflects the natural logarithm of the volume of gross domestic product, and LOG(PT) represents natural logarithm of the passenger transportation. C(1), C(2) and C(3) are the variables and characterize the impact of the appropriate explanatory variables on the EDPEFAT, the resultant (detected) indicator. More precisely, C(1) is a constant boundary and C(2) and C(3) show the semi-elasticity coefficients. Let's note that the coefficients of the factor (or explanatory variables) in logarithmic-linear regression equations indicate the elasticity ratios of the result (or description) of that factor (Eliseeva, I.I. 2014). The results obtained from the evaluation of model (1) are given in Table 2. The extent to which these results are reflected, how reliable these figures are, and other issues should be checked with the implementation of Student T distribution, normal distribution, residual stabilization, heteroskedasticity and other tests. The following results were obtained from the computer implementation through the application software package, based on Table 1 of the Regression Equation (1) EViews 9.0:

Table 2: Parameters on Econometric evaluation, their reliability tests. The main statistical characteristics of the econometric model of GDP and PT variables on EDPEFAT

Dependent Variable: LOG(EDPEFAT)				
Method: Least Squares				
Date: 01/05/19 Time: 23:43				
Sample (adjusted): 2000 2017				
Included observations: 18 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-6.373619	0.592493	-10.75730	0.0000
LOG(GDP)	0.109188	0.016257	6.716537	0.0000
LOG(PT)	0.833948	0.052889	15.76775	0.0000
R-squared	0.996462	Mean dependent var		6.461150
Adjusted R-squared	0.995990	S.D. dependent var		0.352360
S.E. of regression	0.022313	Akaike info criterion		-4.616261
Sum squared resid	0.007468	Schwarz criterion		-4.467866
Log likelihood	44.54635	Hannan-Quinn criter.		-4.595799
F-statistic	2112.168	Durbin-Watson stat		1.288389
Prob(F-statistic)	0.000000			

The evaluation of the main statistical characteristics of the econometric model (1) in Table 2 and the corresponding tests show that the model is adequate. Here, it turns out that the estimated parameters are unbiased and effective.

3.2. Evaluation of dependence of carbon dioxide (CO_2) on GDP and passenger transportation

Passenger and cargo transportation in the transport sector are the contributing factors to the amount of carbon dioxide in the air. The quantitative characteristic of the effects of these factors on the volume of carbon dioxide is estimated econometrically based on the data in Table 1. Specificity of the regression equation of the econometric logarithmic-line model to evaluate the dependence of carbon dioxide (CO_2) on passenger and freight transport in the transport sector is as follows (Gujarati, 1995, Asteriou, 2016, Hasanli, 2008).

LOG(CO2)=C(1)+C(2)*LOG(PT)+C(3)*LOG(CTTS)+[AR(3)=C(4),AR(6)=C(5),UNCOND] (2)

Here, the LOG (CO2) variable represents the natural logarithm of carbon, LOG(PT) reflects natural logarithm of passenger transportation, while the LOG(CTTS) represents natural logarithm of freight transportation. C(1), C(2), C(3) are parameters and describe the effect of the corresponding explanatory variables on the CO_2, which is the resultant (explanatory) indicator. Results of model (2) based on information in Table 1 in EViews 9.0 are the following:

Table 3: Parameters on Econometric evaluation, their reliability tests. The main statistical characteristics of the econometric model of PT and CTTS variables on CO_2

Dependent Variable: LOG(CO_2)				
Method: ARMA Maximum Likelihood (OPG - BHHH)				
Date: 01/07/19 Time: 21:18				
Sample: 2001 2017				
Included observations: 17				
Convergence achieved after 17 iterations				
Coefficient covariance computed using outer product of gradients				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-9.599080	0.140837	-68.15730	0.0000
LOG(PT)	0.638146	0.048669	13.11193	0.0000
LOG(CTTS)	0.561141	0.047425	11.83222	0.0000
AR(3)	-0.733700	0.208575	-3.517687	0.0048
AR(6)	-0.893703	0.088861	-10.05734	0.0000
SIGMASQ	9.72E-05	6.86E-05	1.417363	0.1841
R-squared	0.999177	Mean dependent var		6.142430
Adjusted R-squared	0.998803	S.D. dependent var		0.354163
S.E. of regression	0.012254	Akaike info criterion		-5.100849
Sum squared resid	0.001652	Schwarz criterion		-4.806774
Log likelihood	49.35721	Hannan-Quinn criter.		-5.071617
F-statistic	2670.664	Durbin-Watson stat		2.099053
Prob(F-statistic)	0.000000			
Inverted AR Roots	.78+.60i	.78-.60i	.13-.97i	.13+.97i
	-.91-.37i	-.91+.37i		

Note that, in order to get adequacy in model (2), AR(3) and AR(6) (3th and 6th order autoregression) factors are included to model and those ones caused to the elimination of heteroscedasticity (residual dispersion variation) and created homoscedasticity (White Heteroskedasticity Test). One of the important conditions in econometric modeling is stationarity of Residuals. The main statistical characteristics of econometric Model (2) shown in Table 2 indicates that the model is adequate. Therefore, estimated parameters are unbiasedness and effective.

4. RESULTS OF THE ECONOMETRIC MODELS

LOG(EDPEFAT)=-6.37361855+0.109188120237*LOG(GDP)+0.83394811823*LOG(PT)(3)

The result of the Model (3) shows that when Gross Domestic Product (GDP) and Passenger Transportation (PT) increase by 1%, according to factors (ingredients) the rate of emissions of pollutants from vehicle transport into the atmosphere (EDPEFAT) rise by 0.109% and 0.834%, respectively.

LOG(CO2)= -9.59907987844 + 0.638145874222*LOG(PT) + 0.561141352797*LOG(CTTS) + [AR(3) = -0.733700147012,AR(6) = -0.893702883647,UNCOND] (4)

The result of model 4 shows that 1% rise in passenger transport (PT) and freight transport (CTTS) results in the increase of the amount of carbon oxide by 0.638% and 0.561%, respectively.

5. CONCLUSION

The estimated econometric models show that the elasticity ratio of the amount of pollutants emitted from vehicles into the atmospheric air compared to that of Gross Domestic Product's volume is greater than the elasticity ratio compared to passenger transport. This means that the increase in the volume of production is more likely to affect air pollution than in the transport of passengers. On the other hand, the coefficient of elasticity of carbon dioxide compared to that of passenger transportation's volume is greater than the elasticity ratio compared to freight transportation. Therefore, the effect of passenger transportation is higher on the increase of the amount of carbon dioxide released into atmosphere than that of freight transportation.

LITERATURE:

1. Asteriou D., Hall S.G. (2016). *Applied Econometrics*, Palgrave, New York 518 pp.
2. Dr. Jean-Paul Rodrigue *"The Environmental Impacts of Transportation"* Retrieved 01.01.2019 from https://transportgeography.org/?page_id=5711
3. Eliseeva,I.I. ed. (2014), *Econometrics: a textbook for masters*, Moscow: Yurayt Publishing House, 449 pp.
4. Gujarati, D. N. (1995), *Basic econometrics* (3rd edition), New York: McGraw-Hill Inc.
5. Hasanli Yadulla (2008), *Introduction to econometrics* (e-publishing), Baku, Retrieved 01.01.2019 from http://www.ebooks.azlibnet.az/book/Tn7cj4Yf.pdf
6. https://epi.envirocenter.yale.edu/2018/report/category/hlt Official internet page of Yale University. (Retrieved Date 06.01.2019)
7. Jeyhun Mikayilov, Vusal Shukurov and Sabuhi Yusifov, (June 2017). The Impact of Economic Growth and Population on CO_2 Emissions from Transport Sector. Azerbaijan Case, *Academic Journal of Economic Studies* Volume 3(2), pp.60-67. Retrieved 06.01.2019 from https://www.researchgate.net/publication/316989651
8. http://www.e-qanun.az/alpidata/framework/data/15/c_f_15171.htm About Motor Transport the law of the Republic of Azerbaijan (Retrieved Date 06.01.2019)
9. President.az. The Official webpage of the President of Azerbaijan. Retrieved from "Azerbaijan 2020: Vision to the Future" Development Conception. Retrieved 02.01.2019 from http://www.president.az/files/future_en.pdf
10. President.az. The Official webpage of the President of Azerbaijan. "Strategic Roadmap for the National Economy Perspective of the Republic of Azerbaijan". Retrieved 06.01.2019 from http://president.az/articles/21993
11. *Statistical Yearbook of Azerbaijan 2017*. State Statistical Committee of the Republic of Azerbaijan. Baku, 2017, 814 pp.
12. The Official webpage of the State Statistical Committee of the Republic of Azerbaijan. Retrieved 06.01.2019 from http://www.stat.gov.az//
13. The Official webpage of the State Statistical Committee of the Republic of Azerbaijan. Retrieved 06.01.2019 from http://www.stat.gov.az/source/transport/az/002_1-3.xls
14. The Official webpage of the State Statistical Committee of the Republic of Azerbaijan. Retrieved 06.01.2019 from http://www.stat.gov.az/source/system_nat_accounts/az/002-6.xls
15. The Official webpage of the State Statistical Committee of the Republic of Azerbaijan. Retrieved 06.01.2019 from http://www.stat.gov.az/source/transport/az/004_1-2.xls
16. The Official webpage of the State Statistical Committee of the Republic of Azerbaijan. Retrieved 06.01.2019 from https://www.stat.gov.az/source/environment/az/010_10.xls

APPENDIX

The definition of Variables:
CTTS: Cargo transportation in transport sector, ths. tons
GDP: GDP, current mln AZN[1]
$C0_2$: Total of carbon oxide, ths. tons
PT: Passenger transport, per ths. person
EDPEFAT: According to factors (ingredients), emissions of pollutants from automobile transport to atmosphere, ths ton.

[1]1USD =1.70 AZN