

DOES URBANIZATION BOOST POLLUTION FROM TRANSPORT?

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Abstract

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The study examines the impacts of urbanization, energy consumption and real GDP on atmospheric pollution from automobile transport in Azerbaijan in the STIRPAT framework. Since the study uses time series variables the unit root properties of employed variables are tested for non-stationarity. Stationarity of the data is tested using conventional Augmented Dickey-Fuller test. The study employs Autoregressive Distributed Lags Bounds Testing (ARDLBT) approach to co-integration. This method is one of the most preferable approaches among alternatives in the case of small samples. Estimation results indicated that the variables are cointegrated, in another word there is a long-run relationship among them. In order to test the quality of the model residuals of the model are tested for the serial correlation, heteroskedasticity, and normality. The model is checked for model misspecification and stability. The results of all abovementioned tests are found to be adequate. The highest impact on pollution among the variables belongs to urbanization which is found to be positive and statistically significant. Energy consumption also has a positive and statistically significant impact on emission. The results also confirm that sustainable development can be reached only keeping the balance among environmental, social and economic factors. Findings of the study may be useful in making appropriate decisions in the fields of diminishing atmospheric pollution from automobile transport caused by urbanization related issues.

Keywords: atmospheric pollution from transport; Azerbaijan; energy consumption; real GDP; population; STIRPAT; urbanization

INTRODUCTION

Apart from being the stimulating strength of the economy, energy is considered as the main factor in the economic and social development. However, energy consumption, particularly the use of fuel as an energy source has negative effects on the environment. Therefore, in order to avoid the side effects of energy consumption and economic development subject to serious damage

to people, environment, and natural resources, precisely, its unflattering effects on nature and society should be eliminated, the balance between the economic elements should be maintained, in other words in order to ensure sustainable development resources should be used efficiently and with the minimum level of environmental effects.

One of the biggest reasons of atmospheric pollution, especially in developing countries, is the process of rapid urbanization. In parallel with industrialization and economic progress, urbanization is the process of migration of population from villages (agriculture-based economic life) to cities (industrialization based). Along with globalization, in the process of urbanization, the number of people living in cities has increased rapidly. Thus, according to the statistics of UN, the number of the population in urban areas being 1.76 billion in 1976 will reach to 4.6 billion in 2030. As it is known, more than half of the world's population lives in cities and they tend to consume more than 50% of energy use (Muhammad, Loganathan, Muzaffa, Ahmed & Jabran, 2016, p. 83). Though massive energy use is a necessity for the population settled in the city centers, reckless consumption causes fundamental damage to the environment.

High urbanization, fast economic and social development have turned cities into the main producer of carbon emission, and the city transport into the main formation source of carbon emission (Fengyan & Yalin, 2015). On the grounds of the statistics of UN, cities own 75% of carbon emission, 17.5% of which is shared by traffic (Li, Song & Liu, 2014). Among environmental pollutants, carbon dioxide quantitatively has an important part that shares 60% of the CO₂ concentration in the formation of global warming.

Apparently, envision of the current economic sector without transport is impossible, as the profit of the transport on the economy is invaluable. If to imagine economy as a living organism, the transport sector would be the circulatory system of that body. The acceleration of economic growth in developing countries leads to the income growth, precipitation of urbanization, and development of the international trade, what directly increase the requirement for transport services. The demand for transport services from 2002 to 2020 is supposed to increase 3.6% annual speed in developing countries, and 1.5% in developed countries (Roger, 2002, p. 9). Including all these benefits, the negative effects of the transport developing quantitatively and qualitatively on the ecosystem is undeniable. The unflattering effects of transport are thoroughly noted on every component of the ecosystem such as atmosphere, hydrosphere, biosphere, soil cover and etc. The effect of the transport on the atmosphere depends on the level of development of the transport types, including a variety of impacts of various transports. The analysis of the pollution levels of different types of transportations indicates that surface vehicles, especially cars are remarkable.

In the result of the researches done by UN, several factors influencing emission by the transport sector has been identified, and the necessity of applying effective strategies in this direction have been claimed. Determined factors are numerousness of the vehicles, the age of the used cars and

technologies, the low level of the technical service and unsuited fuel use (Roger, 2002, pp. 3–8).

The exploration of the most effective ways reducing the level of the atmospheric pollutants is considered to be the most important common measure of the countries. However, the differences between the developed and developing countries, as well as the differences between countries at the same development level, require the preparation of the specific activities for each country. Consequently, modeling the relationship between the main factors causing atmospheric pollution and environmental impacts is a priority for all states. This is an essential issue for Azerbaijan as well. The environmental impacts of energy consumption and economic development related to other countries have been studied in a number of publications. However, these investigations have revealed distinctive results. These differences are welded from various periodicals, econometric methodologies and the application of several variables.

There is no information about the impulsive forces of the atmospheric emission from transport for Azerbaijan in the previous studies. Taking into consideration the mentioned gap, this research paper is not investigating the impacts of urbanization and economic development on carbon-dioxide emissions, but the impacts of the pollutants released into the atmosphere from road transport.

The Impacts of Urbanization on Environment

Throughout the history, people have been in search of better life opportunities. In this purposes, humanity has moved from wildlife to rural, forth from rural to urban. In the past ages, these replacements were taking place passively and physical extent of cities grew slowly. However, in the beginning of 18th century 3 percent, by 19th century 14 percent, and by the middle of the 20th century, 30 percent of world population started living in the urban areas (Nations, World Urbanization Prospects; The 2007 Revision, 2008). Since the expansion and population growth in urban areas world have been introduced to the term of urbanization. According to Nyambod (2010) and Nsiah-Gyabaah (2003) urbanization is not only about shift from a rural to an urban population, as it is defined in Cambridge and Oxford dictionaries, but also it refers to the concentration of human populations into discrete areas, leading to transformation of land for residential, commercial, industrial and transportation purposes. Therefore, urbanization has direct impact on socio-cultural, economic, political development and growth in scientific and technological areas (Poumanyvong, Kaneko & Dhakal, 2012). In other words, as a product of modernization and industrialization, urbanization evokes local and global economic and social changes (Rafiq, Salim & Nielsen, 2016). As it is mentioned by D. E. Einstein (1999)

urbanization begins when people move towards manufacturing hubs in cities to obtain jobs in factories and agricultural jobs become less common, and it can cause densely population of city centers, as well as their adjacent peri-urban or suburban fringes. Although, in today's lifestyle cities are seen as better places with high standards it has disadvantageous sides as well (Bhatta, 2010). Starting from the word urbanization process and its rapid growth and spread from the 19th century, environmental problems have been being appeared. Urbanization and human activity within an urban system produce many destructive and irreversible effects on natural environments such as climate change, air pollution, sediment and soil erosion, increased flooding magnitude, and loss of habitat (Wang, Chen & Kubota, 2016). According to the investigations by K. Li and B. Lin (2015) urbanization within the industrialization has a positive effect on CO₂ emission which arises in the result of the use of transportation, energy, fuel, living fuel, appliances and domestic waste. CO₂ in its return, together with less vegetation and open soil causes raise in city temperatures by 2 to 10 degrees Fahrenheit (Wang, Chen & Kubota, 2016). It is predicted that by 2030 world population will increase to 4.6 billion, more than 60 percent of which will live in urban areas, which means 60 percent of CO₂ production (Shahbaz, Loganathan, Sbia & Afza, 2015). Unfortunately, leading to the environmental degradation and global warming cannot be deniable.

In some of the recent studies, there are underlined differences between environmental impacts of urbanization in developed and developing countries (Sadorsky, 2013). It is believed that in developed countries negative effects of urbanization are being eliminated through a number of environmental protection aimed activities. In developed regions, the awareness of citizens about environmental issues is higher and they try to defend environment by cutting off pollution, and planting of greenery (Li & Lin, 2015). Nowadays, in the developed countries suburbanization and counter-urbanization i.e., movement away from cities, which may be driven by transportation infrastructure, or some social factors, has been observed, which means the decrease in population of big cities. While, in developing countries, because of some social and infrastructural activities, such as logging, deforestation, and building, and laying tracks urbanization is the great stressor for natural environment (Sadorsky, 2013). To be more specific quick industrialization and urbanization in many developing as well as non-developing countries in the world simplifies and speeds up the energy transition which leads to more energy use and as a result more problems of environmental degradation (Belloumi & Alshehry, 2016).

Nowadays ranking representatives are analyzing the ways of eliminating harmful impacts of urbanization by investigating its main factors.

In this aspect STIRPAT model, which was first proposed by Dietz and Rosa in 1994, is being used to estimate the connections between environmental degradation, economic development, industrialization and urbanization (Lin & Du, 2015). Using the analysis of the relationships between urbanization and energy consumption it has been ensured that in order to cut down environmental degradation and CO₂ emission it is necessary "... to promote the innovation, research and development of decentralized wind power, decentralized photovoltaic power generation and hydropower by exploiting local resources" (Wang Q., 2014, p. 338). In a number of developed countries aiming to find a solution of above-mentioned problems, the use of vehicle transportation is being limited by replacing it with less air damaging vehicles such as cycling (Belloumi & Alshehry, 2016).

In its turn, rapid population growth has reduced the forested area globally as a result of human-facilitated developments such as the building of factories, industries and houses. Consequently, it caused terminating the vegetative cover on our Earth which has a vital role in our life. In addition to urbanization is also linked with political conflicts, thus many neighborhood and non-neighborhood countries are in quarrel because of competitiveness (Al-Mulali & Ozturk, 2015). Likely, wars have been causing destructive damages to the environment which needs decades to be recovered.

Sohag *et al.* (2017) studied the impact of industrialization on CO₂ emissions for the group of countries, including Azerbaijan. Employing the recently developed econometric methods, they concluded that in middle-income economies energy use and growth of industrial and service sectors positively explain CO₂ emissions.

Mikayilov *et al.* (2017) employing the ARDLBT approach to the Azerbaijani data studied the impact of economic growth, population and energy use on CO₂ emissions. The results of the study shown that, energy use and population has significant impact on CO₂ emissions, while the impact of GDP found to be insignificant.

Ahmed *et al.* (2016) investigated the relationship between CO₂ emissions, economic growth, technological innovation and biomass energy for the panel of 24 European countries. The study shown that for the investigated countries technological innovation facilitates reduction of CO₂ emissions.

Shahbaz *et al.* (2014) utilizing the ARDLBT and Vector Error Correction Model (VECM) in case of Tunisia, investigated the CO₂ impacts of economic growth, energy consumption and trade openness and concluded that they are in a long-run relationship. The study also validated the EKC hypothesis for the Tunisian case.

Mamun *et al.* (2014) employing data for the 136 countries investigated the impact of economic growth on CO₂ emissions and concluded that EKC

I: The denomination and units of measurement of variables included in the model

| Variables | Formula | Eviews | Units of measurements |
|---|---------|-----------------|-----------------------------|
| Pollutants emitted into atmosphere from road transports | pol | logpollution | kilogram |
| Energy Consumption | enuse | logenergyuse | kilograms of oil equivalent |
| Real GDP | gdp | loggdp | US dollars 2005 |
| Urbanization | urb | logurbanization | person |

Source: Table has been prepared by the authors on the basis of statistical data

hypothesis is a general case across the world except the high-income countries.

As it can be seen from reviewed studies, there is not a individual time series study investigating the impact of economic growth, urbanization and energy use on the CO₂ emissions from the transport sector.

Econometric Methodology and Data

Statistical data for evaluation of the effects of transport sectors on atmospheric pollution in Azerbaijan has been taken from two sources. The real Gross Domestic Product (GDP), the population of Azerbaijan, and total energy consumption in Azerbaijan has been taken from the base of "World Development Indicators" presented by World Bank on 12th of November, in 2015 (WB, 2015). Note that Hasanov, Hunt and Mikayilov (2016) discuss that since the Azerbaijani economy is highly dependent on oil sector and this sector is exogenous to the rest economy, non-oil GDP can be used as a measure of economic activity. However, we do not consider non-oil GDP here as it starts only in 1995 and thereby makes number of observations smaller. While the data for emitted transport pollutants into the atmosphere is taken from the State Statistical Committee of Azerbaijan Republic (State Statistical Committee of Azerbaijan, 2016). The employed annual data covers 1990–2014-time span. Real GDP is indicated with US dollars in 2005, the population of persons, energy consumption with equivalent kilograms of oil, and emitted transport pollutants into the atmosphere are shown with kilograms.

In the Table1 the denomination of variables is presented in formulas and "Eviews 9" software program, as well as its units of measurement that hereupon the nomenclature will be presented in this way.

Methodology to be applied

In order to indicate the long-run relationship between the pollutants emission from road transport and GDP, energy consumption and urbanization in Azerbaijan the following specification will be used:

$$pol = b_0 + b_1 enuse + b_2 gdp + b_3 urb + u \quad (1)$$

Here, "pol" is the pollutants emitted into the atmosphere from transport in Azerbaijan,

"enuse" – energy consumption, *gdp* – real GDP, *urb* – is urbanization, *u* – error term, *b*₀, *b*₁, *b*₂ and *b*₃ are regression coefficients for the parameters of the long-run period. The coefficients *b*₁, *b*₂ and *b*₃ are expected to have the positive signs.

The STIRPAT (Stochastic Impacts by Regression on Population, Affluence, and Technology) framework was put forward by Rosa and Diets based on IPAT (Impacts of Population, Affluence and Technology) (Dietz & Rosa, 1997). While, IPAT, was first suggested by Ehrlich and Holdren (Enrlich & Holdren, 1971). According to IPAT model, environmental impacts (I) are equal to the product of the population (P), affluence (A), and technology (T) (Fang, Miller & Yeh, 2012).

$$I = P \times A \times T \quad (2)$$

IPAT model is identity; therefore, assuming the proportional changes does not allow carrying out hypothesis tests. It is impossible to figure the impacts of population, affluence, and technology being at the same scale. At least, because the energy consumption, environmental, demographic and economic characteristics of the countries are quite different. Therefore, IPAT cannot be applied in these circumstances. By adding stochastic terms, Diet and Rosa (1997) changed the above-given equation and STIRPAT emerged eventually. In general, STIRPAT can be stated as follows:

$$I = a \times P^b \times A^c \times T^d \times e \quad (3)$$

Here, *a*, *b*, *c*, and *d* – are coefficients to be estimated econometrically, and *e* – the stochastic error term. Taking logs of both sides of the equation can easily lead to the following picture:

$$\text{Log}(I) = q + b \times \text{Log}(P) + c \times \text{Log}(A) + d \times \text{Log}(T) + \omega \quad (4)$$

Here Log – natural log sign. While "q" and "ω" are accordingly, *a*'s and *e*'s natural logarithms.

In order to identify the long-run relationship among the included variables, we will use the Autoregressive Distributed Lag Bound Test (ARDLBT) approach suggested by Pesaran and Shin (1999) and broaden by Pesaran *et al.* (2001).

The ARDLBT approach in comparison to other methods has some advantages

(Oteng-Abayie & Frimpong, 2006): First, it is possible to apply to the set of regressors I(0) and I(1). Also, for the models with small number of observations, this approach can give much more adequate results. Henceforth, ARDL approach proposed by Pesaran and Shin (1999) gives more robust results than other cointegration approaches in the small sample case (Pesaran *et al.*, 2001).

As Pesaran *et al.* (2001) describe, the approach has the following stages:

(a) Construction of an unrestricted Error Correction Model (ECM).

$$\Delta y_t = c_0 + \theta_{yy}y_{t-1} + \theta_{yx}x_{t-1} + \sum_{i=1}^n \omega_i \Delta y_{t-i} + \sum_{i=0}^n \phi_i \Delta x_{t-i} + u_t \quad (5)$$

where y is a dependent variable, while x is an explanatory variable; u_t denotes white noise errors; c_0 is for a drift coefficient; θ_i' indicate long-run coefficients, while ω_i and ϕ_i are short-run coefficients.

Note that one of the main issues in the ARDL estimations is to correctly specify the lag length of the first differenced right-hand side variables, as finding a cointegrating relationship between variables is sensitive to this (Pesaran *et al.* 2001, p. 23). Following Pesaran *et al.* (2001), among others, the optimal lag length can be specified by minimizing the Akaike and Schwarz information criteria, whilst removing the serial autocorrelation of residuals. In small sample cases, it is advisable to rely on the Schwarz information criterion (Pesaran and Shin 1999; Fatai *et al.* 2003).

(b) Once an unrestricted ECM is constructed, the existence of a cointegrating relationship can be tested. The Wald-test (or the F-test) on the coefficients above is performed for this purpose.

The null hypothesis of no co-integration is stated as:

$$H_0: \theta_{yy} = 0, \theta_{yx} = 0 \quad (6)$$

while an alternative hypothesis of cointegration is:

$$H_1: \theta_{yy} \neq 0, \theta_{yx} \neq 0 \text{ or } \theta_{yy} = 0, \theta_{yx} \neq 0 \text{ or, } \theta_{yy} \neq 0, \theta_{yx} = 0 \quad (7)$$

If the computed/sample F-statistic is greater than the upper bound of the critical value for a given significance level, then the null hypothesis of no cointegration can be rejected. In the same vein, the null of no cointegration cannot be rejected, if the sample F-statistic is smaller than the lower bound of the critical value for a given significance level. As a third case, the sample value may fall between critical values of upper and low bands, and in such a case, the test results are inconclusive.

It is important to note that the F-statistics in the ARDL cointegration test have a non-standard distribution. Therefore, the conventional critical

values of F-distribution are not valid anymore, and critical values of the F-distribution have to be taken from the table, which is developed by Pesaran and Pesaran (see Pesaran and Pesaran, 1997, or Pesaran *et al.*, 2001).

If θ_{yy} is statistically significant and negative, then it can be concluded that the cointegrating relationship is stable. In other words, short-run deviations from the long-run equilibrium path are temporary and converge towards it.

(c) The long-run coefficients can be estimated/calculated, if the cointegrating relationship found among the variables is a result of the previous stage. Note that these coefficients can be calculated based on Equation (5) by either applying a Bewley transformation (Bewley 1979) or manually setting $c_0 + \theta_{yy}y_{t-1} + \theta_{yx}x_{t-1}$ to zero and solving it for as follows:

$$y = -\frac{c_0}{\theta} - \frac{\theta_{yx}}{\theta}x + u \quad (8)$$

When variables included in the model are I(2) or have higher order of integration the solidness of the bound test becomes questionable. Henceforth, before using ARDL approach, it is necessary to test the stationarity of variables through the unit root test in advance. Checking of the stationarity covers several tests such as Augmented Dickey Fuller (ADF) test, Phillips-Perron (PP) test, Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test and others (Dolado, Jenkinson & Sosvilla-Rivero, 1990). In this study we will use the conventional test – ADF (Dickey and Fuller, 1979).

RESULTS AND DISCUSSION

The unit root test results are given in Tab. II. On the basis of ADF test, GDP seem to treat as stationary variable. Energy consumption and pollution indicators could only avoid unit root problem in the 1st difference. However, urbanization have no stationarity even at first difference case. On the basis of the results of ADF test, it is I(2).

Note that, we have checked the stationarity of variables using Philips and Perron (PP) test. According to the results of the PP test, at the 1% significance level *gdp* and *pop* variables found to be I(2), while *pol* and *enuse* to be I(1). Only *urb* on the basis of PP test at the 5% level gets I(2). From the conducted analysis by Hasanov *et al.* (2016), it can be concluded that, population and urbanization variables in Azerbaijan demonstrate unit root problem in the 1st difference during the long term period. Hence, it is possible to be grounded that in our model due to the small number of the observations *pop* and *urb* variables have unit root in the 1st difference, that is I(2). In the case of large sample, population and urbanization indicators for Azerbaijan can be assumed having stationarity at the 1st difference. Taking this into account, as a research decision, *pop* and *urb* variables to be used in our model considering I(1), but not I(2), we

II: ADF test results

| Variable | Panel A: Level | | Panel B: 1st difference | | Panel C: 2nd difference | | result |
|----------|-------------------|--------------|----------------------------|--------------|----------------------------|--------------|--------|
| | k | Actual value | k | Actual value | k | Actual value | |
| pol | 1 | -2.44 | 0 | -8.70*** | | | I(1) |
| enuse | 0 | -2.29 | 0 | -4.78*** | | | I(1) |
| gdp | 1 | -6.33*** | | | | | I(0) |
| urb | 1 | -1.36 | 1 | -2.92 | 1 | -4.27** | I(2) |

Notes: Maximum lag number is taken 2 and optimum lag is indicated with (k) Schwarz criteria; *, ** and *** accordingly indicates rejection of null hypothesis at 10%, 5% and 1% significance levels; critical values are taken from the table prepared by MacKinnon (1996). Time period: 1990-2014.

Source: The results of calculations conducted through "Eviews 9" software package

III: Results of the Bounds cointegration test

| | |
|------------------------------|-----------------|
| F-statistic | 13.44 |
| Critical Value Bounds | |
| Significance | II Bound |
| 10% | 3.77 |
| 5% | 4.35 |
| 1% | 5.61 |

Source: The results of calculations conducted through "Eviews 9" software package

will continue all other calculations in this manner (Hasanov, Bulut & Suleymanov, 2016).

Employing equation (5), we test cointegration between variables (Pesaran, Shin & Smith, 2001). In the Tab. III described below, the results of the Bounds cointegration test are given. As it is seen, calculated F-statistics values are higher than critical values at all levels. Here we reject the no cointegration of null hypothesis and conclude that there is a long-run relationship among road transport emission, GDP, energy consumption and the urbanization.

As a next step, since the variables are cointegrated we run the model and test the quality of the estimated model before interpretation of the estimation results.

In order to check whether residuals of the model satisfy the Gauss-Markov assumptions, we have employed appropriate tests the results of which are given below.

The residuals of the model were tested for serial correlation.

According to the Breusch-Godfrey (Breusch, 1978; Godfrey, 1978) LM test, H₀ hypothesis indicates no serial relationship among the residuals, and alternative H₁ hypothesis expresses residuals having autocorrelation. *p*-value being bigger than 0.05 for the model rejects the existence of the autocorrelation among residuals.

To test the heteroskedasticity of the residuals Breusch-Pagan-Godfrey (Breusch and Pagan, 1979; Godfrey, 1978) test has been used.

Null hypotheses for the test indicates residuals do not have heteroskedasticity problem. *p*-values

of the test are higher than 0.05, hence there is no heteroskedasticity problem.

In order to test the normality of the residuals we use Jarque-Bera goodness-of-fit test (Bera and Jarque, 1981). Due to the Jarque-Bera test H₀ indicates the normal distribution of the variable, and on the basis of the test results for Jarque-Bera coefficient *p*-value being more than 0.05 indicates the normal distribution of the residuals.

To test whether or not the model suffers from the misspecification problem the Ramsey-Reset test (Ramsey, 1969) has been employed. Zero hypothesis of the test indicates that there is no misspecification problem in the model. The *p*-value being 0.17 concludes the rejection of the alternative hypothesis and no misspecification problem in the model.

Summarizing all the above-mentioned tests, the model has desirable results and the coefficients of the model can be interpreted. The estimation results of the employed ARDL model are given separately for the short-run and long-run.

The long-run estimation results are given in the Tab. IV. The coefficients of the energy use and urbanization variables of the model are economically significant in the long-run. The coefficient of the GDP variable is statistically insignificant.

According to the long-run estimation results, the 1% increase in energy consumption leads to 0.8% increase in emissions from transport, while this number for urbanization is 2.7%. The effect of economic growth is found to be insignificant (*p*-value is 0.11).

The short-run estimation results are given in the Tab. V.

IV: Long-run coefficients of the Model

| Variable | Coefficient | Standard Error | t-Statistic | Probability |
|--------------|-------------|----------------|-------------|-------------|
| <i>enuse</i> | 0.80 | 0.18 | 4.47 | 0.00 |
| <i>gdp</i> | 0.13 | 0.08 | 1.71 | 0.11 |
| <i>urb</i> | 2.71 | 0.59 | 4.61 | 0.00 |
| <i>c</i> | -43.12 | 10.38 | -4.16 | 0.00 |

Source: The results of calculations conducted through “Eviews 9” software package

V: The short-run estimation results

| Variable | Coefficient | Standard Error | t-Statistic | Probability |
|---------------------|--------------|----------------|-------------|-------------|
| <i>d(enuse)</i> | 0.32 | 0.33 | 0.97 | 0.35 |
| <i>d(enuse(-1))</i> | -0.64 | 0.27 | -2.35 | 0.03 |
| <i>d(gdp)</i> | -0.39 | 0.23 | -1.66 | 0.12 |
| <i>d(urb)</i> | 3.77 | 1.01 | 3.74 | 0.00 |
| SOA | -1.39 | 0.21 | -6.69 | 0.00 |

Notes: d stands for the first difference operator, SOA is speed of adjustment coefficient

Source: The results of calculations conducted through “Eviews 9” software package

VI: The indicators of the Model

| | | | |
|----------------------------------|-------|--------------------------|-------|
| R-squared | 0.96 | Mean dependent variable | 20.08 |
| Adjusted R-squared | 0.95 | S.D. dependent variable | 0.33 |
| S.E. of regression | 0.08 | Akaike info criterion | -2.00 |
| Sum squared residuals | 0.09 | Schwarz criterion | -1.61 |
| Log likelihood | 31.03 | Hannan-Quinn criteria | -1.90 |
| F-statistic | 55.56 | Durbin-Watson statistics | 2.12 |
| Probability (F-statistic) | 0.00 | | |

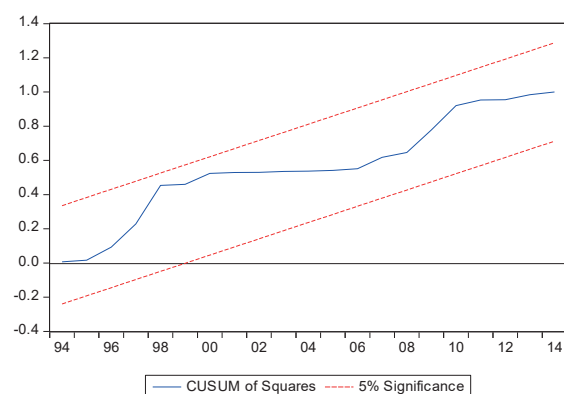
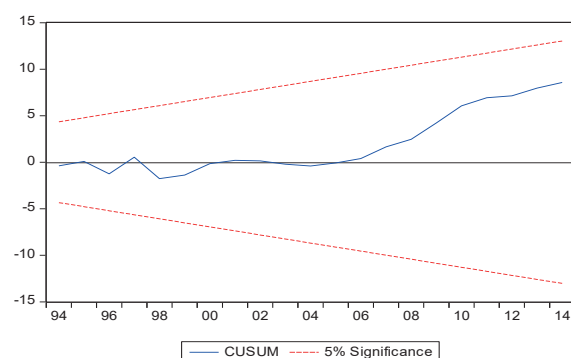
Notes: S.E. stands for standard error, S.D. stands for standard deviation

Source: The results of calculations conducted through “Eviews 9” software package

As depicted in Tab. V, based on the estimation results the impact of energy consumption and economic growth in the short-run are found to be insignificant. Urbanization has statistically significant impact on emission from transport in the short-run. The speed of adjustment (SoA) parameter is found to be statistically significant. Based on the estimated SoA parameter (-1.38%) we can say that the short-run deviation from

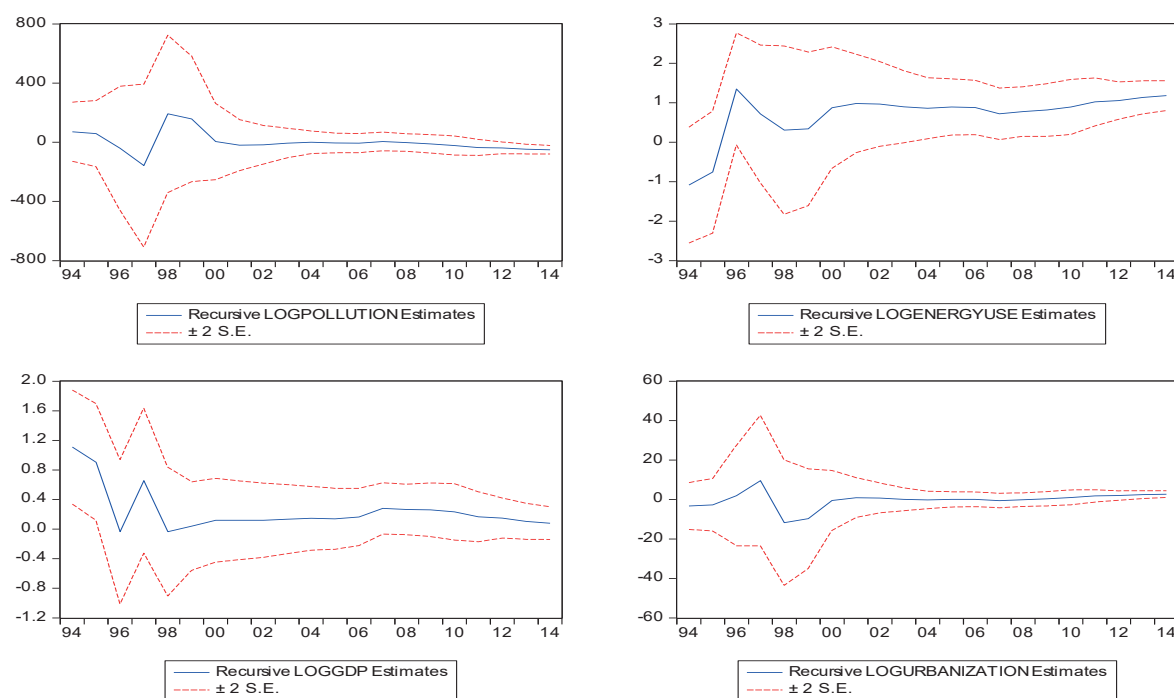
the long-run equilibrium path can be corrected less than a year.

In the Tab. VI, the *p-value* of F-statistics being less than 0.05 indicates the joint significance of the coefficients of *pol*, *enuse*, *gdp* and *urb*. Durbin-Watson test statistics value (2.12) also shows that there is no first order serial correlation among the residuals.



1: Results of CUSUM and CUSUMSQ tests

Source: The results of calculations conducted through “Eviews 9” software package



2: Results of stability test of the Model's coefficients

Source: The results of calculations conducted through "Eviews 9" software package

The results of the CUSUM and CUSUMSQ tests checking the stability of parameters for equation (1) are given in Fig. 1, and the results of the stability test of coefficients are given in Fig. 2. As it can be seen

from the Figs. 1 and 2, according to the test results estimated parameters are stable over the period of estimation, which indicates the robustness of the model.

CONCLUSION

The causing reason for many global-ecological problems is atmospheric pollution and this problem is getting worse year in year out which stipulates the fight against atmospheric pollution at an international level. The topicality of contamination of the atmosphere is observed by implementing protocols and legislations internationally in order to decrease the broadness of this area, and the level of acuity. The ecological problems that economic growth brought have resulted in impartial and strict administrative activities in developed countries that caused many large multinational companies to evict polluting sectors to economically developing countries to avoid high taxation and legal expenses. The share of atmospheric pollution in developing countries has prevailed developed countries because of both reasons that we have mentioned above, and non-transparency or gaps in legislations. The case of presented remarks for developing countries makes it essential for Azerbaijan to take serious measures against atmospheric contamination.

In this study, the impacts of social and economic factors on pollutants emitted into the atmosphere from road transports in Azerbaijan during 1990–2014 have been investigated. The impacts of Real GDP, energy consumption and population size on emission within the long run and short run periods have been studied through the implementation of ARDLBT approach.

Based on the estimation results 1% increase in the long-run, energy consumption and urbanization increases by 0.8% and 2.7% the amount of road transport emissions. As the estimation results shown, urbanization has quite higher impact on the emissions from transport in both the long-run and short-run.

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