The Dynamic Relationship Among Economic Growth, Energy consumption and Environment In Iran

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ABSTRACT

In recent decades, environmental risks and hazards are more visible. These damages caused by a combination of factors such as population growth, economic growth, energy, and industrial activities. This study discusses long-run equilibrium relationship, short-term dynamic relationships and causal relationships between energy consumption, economic growth and the environment (carbon dioxide emissions) in Iran, by using time series data during 1971-2009, through Co integration test.

Co integration test demonstrates that a long-run relationship exists among the three variables. It is obvious that carbon dioxide emissions will be increased by positive shock of energy consumption and economic growth, by a one percent increase in energy consumption and economic growth, carbon dioxide emissions will increase 55 and 43 percent respectively. The result of this study is important because of reducing carbon dioxide emissions from energy use and economic development matters. In other words, to reduce carbon dioxide emissions, the government should reduce the amount of Petroleum products in energy consumption, and it also improves the efficiency of using energy.

1. INTRODUCTION

Generally there is a mutual reaction between economics and environment. Firms using economic resources such as materials and energy, produce goods and services, in which some of the input used in the production process return to the environment as wastes. These wastes are mainly like carbon monoxide, carbon dioxide, sulfur dioxide and solid waste and wastewater, causing pollution or imposing external costs on society.

Over the past three decades, hazards and environmental damages are more revealing. Damage has been caused by a combination of factors such as population growth, economic growth, energy and industrial activities. On the other hand, the relationship between economic development and the environment is a complex and important issue. In the context of sustainable development, if economic and environmental activities are combined, the environment and economic development will be complementary factors that cause ecological balance and economic activities will not be the imbalance factor.

Since any economic activity requires energy, the energy is perceived as a driving factor for economic- social development, and the quality of human life improvement. On the other hand it causes environmental pollutants, especially if energy is coinciding with inefficiency, pollutant emission process exacerbates.

Due to Iran is a developing country and blessed with a rich and extensive energy and is a sample of growth pattern within pressure on natural resources, it is essential to study the environmental effects of energy consumption and economic growth considering the high economic growth maintaining environment approach. This study, investigates the relation between economic growth, energy consumption and environment. According to the current discusses on environmental

problems and air pollution, better perception of the relation between economic growth, energy consumption and environment can help the policy makers and planners to determine and approve the environmental policies.

2. THEORETICAL

The economic literature indicates strong correlation between the economic activities (economic growth) and energy, since energy is a driving force of the most productive activities and services and has a specific status in economic growth and development. Economists such as Nair and Ayres suggest that in the biophysical growth model, energy is the only and greatest factor of growth, since they consider labor and capital as intermediate factors which need energy to use.

Neoclassic economists approach such as Berndt and Denison are mostly opposed to ecological economists. They believe that through the effect on labor and capital, energy affects the economic growth indirectly and has no direct effect on economic growth. Most of neoclassical economists believed in the principle that energy has a small role in economic production and is an intermediate input and the essential factors are labor, capital and land[1].

But, Excessive consumption of energy, especially fossil fuels to achieve the economic growth goals and further weakness in consumption efficiency cause environmental pollution increase, so that the most important factor of air pollution, is the carbon dioxide emissions, which is one of the major greenhouse gases and is the fossil fuel consumption result in manufacturing, trade, service and housing sectors[2].

Mayer and Kent indicate the relationship between energy consumption and environment demolition, however, after the industrial revolution, especially in recent decades using more energy, causes an increase in average productivity, but using energy through its pollutant impacts, causes the environment demolition. The main part of greenhouse gas emission in the world is a carbon dioxide, which is the result of fossil fuel consumption. Thus, energy sector has the greatest share in economical qualification changes; therefore energy policy and environmental policy are closely related[3].

In the neoclassical framework Stern and Cleveland[4] have expressed the relationship between energy consumption and economic activity as a following production function:

$$(Q_1,\ldots\ldots,Q_m)= F(A, X_1,\ldots,X_n ,E_1 ,\ldots,E_p)$$

Q_i: goods and services Production, X_i: various inputs of production such as capital, labor, E_i: different energy inputs such as oil, coal and ... A is the technology status or a productivity index of all factors. In this function, the relationship between energy and total production is affected by factors such as substitution between energy and other inputs, technological change, changes in the energy factors combination and the combination of the products. Changes in other inputs combination, - for example switching labor intense economy to a capital intense economy- can also affect the relationship between energy and production. X variable inputs may also affect the total factor productivity. However In new growth theories, energy has entered the model, but its importance is not identical in different models.

Energy cargo's Consumption and increasing efficiency will affect economic activities in the present world; so we can state that the rapid process of economic and industrial development in recent decades is largely influenced by it. Consequently, energy cargo's consumption analysis has a critical importance.

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[1] Stern, (1993), pp 144
[2] Alam,(2007). P 828
[3] Shim, (2006). P 3
[4] Stern and Cleveland, (2004)

3. EMPIRICAL STUDIES

In the last two decades, several studies evaluated the relationship between energy consumption, GDP and environmental pollutant which can be divided into two groups: the first group analyzes the economic growth relation with environmental pollution.

Most of these studies of this, the environmental Kuznets hypothesis has been used to analyze the relationship between variables. The first study in this group pointed out Grossman and Krueger (1991). Applying the Environmental Kuznets Curve hypothesis, they researched the economic growth effect on environmental pollutants and obtained an inverse U relationship between per capita income and other pollutants. Other studies in this context are shfick and Banydiopady (1992) Shfick (1994), Hill and soden (1999) Roca (2001) Fridel and Jentezner (2003) Dynda and Kando (2006) and Manjy and Jenna (2008) Mohammad Fotros and Meysam Nasrindoost. (1388), and Mansour Zibaee (1388), and Jamshid Pajuyan and Niloofar Morad hasel (1386) and Iraj Saleh and Hamed Rafiee (1387) can be cited.

In the second group, the relationship between energy consumption and economic growth is discussed. Numerous studies are in this group .In most of these studies the causal relationship between energy consumption and economic growth variables using various econometric techniques have been studied. Initial study was conducted in 1978 by Kraf. Then several experimental studies are written by other researchers, most notably of them in recent years, are studies by the Christ (1996), Young (2000), Raphael (2006) Stallion and Singh (2007) and stallion et al (2008).

Some researchers also combining above equations have studied the relationship between 3 variables, energy consumption, economic growth and environmental pollution in the form of a model. A few studies are in this group, some of them are mentioned below.

Ang (2007) in his study discussed the dynamic causal relationship between carbon dioxide emissions, energy consumption and production in France during the 2000-1960 period. Results also showed that economic growth is the long term casue of energy consumption and environment pollution, and there is a short run, one way casual relation from energy consumption to production growth. Also, the results indicate that increasing in energy use and an increases carbon dioxide emissions.

Tul and et al (2006) in their study, examine the long term relationship between energy consumption and carbon dioxide emissions in America during 1850- 2002. The main results suggest that in this period, carbon dioxide intensity emissions increases by increasing fossil fuels, and population growth, economic growth and electricity consumption growth also influence the carbon dioxide emissions.

Suveytas and et al (2006) examined the relationship between energy consumption and carbon dioxide emissions in America. In their article, in addition to the above variables, labor and capital variables are also entered the model as a production input. They concluded a significant positive relationship between carbon dioxide emissions and energy consumption while there is not a relationship between income and carbon dioxide emissions. Hence, they reported that income growth in America itself is not a good solution for environmental problems in the country.

James (2007) in an article examined the relationship among carbon dioxide emissions, energy consumption and GDP in France during 2000-1960 period. He used the econometric methods based on vector error correction model (VECM) and Auto regressive Distributed Lag model (ARDL). He concluded that there is a relationship between the variables in the long run, but the relationship between energy consumption and production is just established in the short run.

Suveytas (2007) analyzed and examined the causal relationship among three variables; energy consumption, carbon emissions and economic growth for Turkey. He used labor, capital, economic growth and carbon emissions to examine how the economic growth and carbon dioxide emissions are related. Results indicated the existence of a one-way relationship of carbon dioxide emissions to energy consumption in Turkey. But it did not conclude such a relationship between carbon dioxide emission and national income and deduced that reduced carbon dioxide emissions do not lead to decrease in economic growth in turkey.

Halych Acemoglu (2008) in an econometric study examined the relationship among carbon emissions, energy consumption, income and foreign trade in Turkey during 2005 – 1960. using both integration test and econometric ARDL models, to examine the relationship between these variables. The results obtained in this paper, confirmed two types of long-term relationship among the variables. In the first type, carbon dioxide emissions from energy consumption, income and foreign trade is explained, and in the second type, income by carbon dioxide emissions, energy consumption and foreign trade are determined.

Iota and et al (2009) by empirical study, examine the existence of environmental Kuznets curve in France, once considering the nuclear energy and then considering the foreign trade. The EKC hypothesis developed model is used in this study and the auto regressive distributed lags econometric method (ARDL) is used to estimate the model. The results suggest that there is an environmental Kuznets relation in France While there is a one way relation from other variables to CO_2 emission. Also based on a one way relation from nuclear energy to CO_2 emission it is indicated that nuclear energy can help to reduce more CO_2 emissions. Abdul Jalil and Mahmoud (2009) in their study examined a long-term relationship among the CO_2 release, energy consumption, domestic income and foreign trade in China, during the 2005-1975 periods. The main objective of this paper is to examine the long-term EKC curve and ARDL econometric methods for empirical analysis.

Internal studies in this context have been limited and it is mostly assessing the relationship between energy consumption and GDP. The most important studies in this field, such as silk and Mostafaei (1380), Arman and Zare (1383) Najarzadeh and A. M. (1383), Sadr Abadi et al (1386), Arman and Zare (1388), amade et al (1388) can be noted. In these studies the causal relationship between energy consumption or variety of energy cargoes with GDP or economic growth has been evaluated through various methods (e.g. Hsiao, Toda-Yamato, Granger causality and error correction). Most of these studies concluded a one-sided relationship of energy consumption to GDP. In some studies the relationship between environmental pollution and GDP has been examined, they are mentioned below.

Saleh et al (1386) studied the relationship between CO_2 emission and GDP during 1339-1387 in Iran, Due to the obtained results, the Environmental Kuznets Curve were analyzed in Iran.

In this paper, the Granger Causality Test and Hsiao causality test and the environmental Kuznets curve are used to estimate by OLS method. Consequently, this paper suggests a one-way relationship between CO_2 emissions and GDP. In this paper EKC curve has not been approved in Iran conditions.

Sharrzei and Haqqani (1388) studied the Granger causality relationship between energy consumption, national income and carbon emissions associated with labor and capital in the period 1384 to 1353. The results obtained in this paper suggest that there is a causal one way relation from national income to energy consumption. But the causal relation between income and CO_2 emissions has not been approved.

Fotros and Nasrindoost (1388 investigated the causal relationship among variables and tested the existence of the environmental Kuznets hypothesis. Their results pointed out that there was a causal relationship from CO_2 emission to per capita income and energy consumption and one way relation from energy consumption to water pollution. Also, in this paper, the environmental Kuznets hypothesis for per capita income, energy and water pollution is not approved but about CO_2 emissions and energy consumption is confirmed.

Mohammad Bagheri (1389) in an article investigated the short and long term relationship between GDP, energy consumption and carbon dioxide emissions using data for 1965-2008. He applied ARDL econometric method. Results indicate that carbon dioxide emissions to GDP ratio is inelastic, but it's elasticity is more in the long term than the short term. According to the results, also, Carbon dioxide elasticity on energy consumption is closely identical in short-term and long-term. In addition, an inverted U-shaped curve is not approved in Iran's environmental conditions.

4. METHODOLOGY

In this paper, in order to modeling the three variables, energy consumption, economic growth and carbon dioxide emission in Iran, Auto regressive and Error correction models and annual data during 1971-2009 applied. Data derived from WDI[5]. Notably, in order to better modeling and obtaining desirable results we used the natural logarithm for all data.

In order to find a long-run relationship between the variables, Johansson Juselius Co-integration method (Cointegration) is used in this study. After the long-term relationships between variables determined, using vector error correction model (VECM) to examine the short term relationship between variables. Co-integration is the long term relationship between two variables, which were instable. Furthermore, integrated variables have an error correction model that represent short-term relationships between them. Co-integration method can be used by various methods such as Engel-granger but the Johansson Juselius Co-integration method as the best, can determine and define long term relations between two or several variables[6]. It is based on a vector auto regression (VAR), in which the number of vectors determined via Maximum Likelihood Co-integration.

To estimate VAR models first the stability of variables and optimum lags should be determined. According to importance of variables stability, we can state that if the variables are stationary, then using a simple VAR model would be appropriate. But if the variables were instable, an unrestricted VAR model with differenced variables should be used. The Augmented Dickey - Fuller statistics applied to study stability and instability of variables to determine the optimal number of lags. In the case of instability, long-term relation among variables disappeared and lead to research efficiency reduction with limited samples. Since variables were integrated the short term dynamics tension of variables to equilibrium can be studied through Error Correction Model.

The vector regression model with endogenous variables, N, and lags, L, for each variable are shown below. In this model, X represents a vector of endogenous variables and it's lags.

$$X_t = \Pi_1 X_{t-1} + \Pi_2 X_{t-2} + 000 + \Pi_L X_{t-L} + U_t \tag{2}$$

Determining the long-term equilibrium relationship between variables is obtained by using a Vector Error Correction Model and Johansson – Juselius method. Identifying and estimating Co-integration vectors (coefficients of long-run equilibrium relations) between variables obtained by using Vector Auto Regression coefficients of variables. To obtain long-term behavior of equilibrium values X, vector autoregressive model can be stated in terms of the Vector Error Correction Model, as presented below.

$$\Delta X_t = \forall_1 \Delta X_{t-1} + \forall_2 \Delta X_{t-2} + 000 + \forall_{L-1} \Delta X_{t-L+1} + \forall_L \Delta X_{t-L} + U_t \tag{3}$$

$$\forall_i = -I + \Pi_1 + \Pi_2 + \pi_3 + \cdots + \Pi_i \qquad i = 1,2,...,L \tag{4}$$

$$\Pi = -(I - \Pi_1 - \Pi_2 - \cdots - \Pi_L) \tag{5}$$

Π matrix represents the long-run equilibrium relationship between the variables in the model. Indeed, $\Pi = \alpha\beta$, where α represents the in-equilibrium adjustment coefficients and adjustment speed to long term balances and β is the long term coefficient matrix and I is a unit matrix.

5. DATA

PGDP: natural logarithm of real GDP per capita (constant 2000 US$)
EC: natural logarithm of energy consumption per capita (kg of oil equivalent)
CO_2: natural logarithm of carbon dioxide emissions (Kt)

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[5] World Development Indicators
[6] Enders (1995)

6. RESEARCH FINDINGS

6-1) Unit root test

Before co-integration test, applied variables in the model should be tested in terms of stationary and the unit root hypothesis must be examined. This test can be performed in three models; no intercept and trend, intercept and trend, intercept and no trend. This research was conducted in three modes and the minimum Schwartz statistics given us an optimum model. Unit root results for the level and first- difference variables is given in Table 1.

Table 1: Unit root test results

variable	Dickey - Fuller	Critical value in significant level			Stationary/ non stationary
		1 percent	5 percent	10 percent	
PGDP	-0.86	-4.27	-3.56	-3.21	No
EC	-2.81	-4.23	-3.54	-3.20	No
CO_2	-1.41	-4.23	-3.53	-3.20	No
ΔPGDP	-4.28	-4.25	-3.55	-3.21	Yes
ΔEC	-5.18	-4.24	-3.54	-3.20	Yes
Δ CO_2	-5.73	-4.23	-3.54	-3.20	yes

Source: Calculations of research

Results in Table 1 show that τ statistics for each variable (energy consumption, economic growth and carbon dioxide emissions) even at a 10 percent significance level is larger than the critical values, thus, the unit root test the hypothesis that there is a unit root in time series not rejected. In other words, level variables applied in the model are instable. But the results indicate that first differenced variables are stable at all significant levels. Therefore unit root hypothesis in time series rejected. According to above mentioned subjects, it can be stated that variables applied in the model are all first degree convergence I(1). Thus, existence of one or more Co-integration relationship between variables is possible.

6-2) Residual unit root test

Residual unit root results are as follows and indicate the stationary of error term at the level. So, the results are reliable and there is an integrated relation among variables.

Table 2: Residual unit root test

	T statistic	Prob
Dickey - Fuller	68.-2	00.0
level 1%	62.-2	
Level 5%	95.-1	
Level 10%	61.-1	

Source: Calculations of research

6-3) Granger causality test

Granger causality test results are usually checks the variable sensitivity to their lags, so various lags are tested. If the results are identical for different lags, the result will be invoked. Five lags; 1, 2, 3, 4, 5, is used for time series in the model. Granger causality results reported in table 3. Results show

that in (1), (2), (4) and (5) lags, energy consumption is the granger cause of carbon dioxide emission. Also according to the table, we can also infer other relationships, which include the relation between economic growth and energy consumption that in the lag (1) economic growth is the granger cause of energy consumption and in lag (4) energy consumption is granger cause of economic growth and in lags (1), (2) and (5) economic growth is the carbon dioxide granger causality.

Table 3: Granger causality test results

H_0 hypothesis test	Prob in significant level 5 percent	Lag				
		1	**2**	**3**	**4**	**5**
EC is not granger causality of PGDP		0.66	0.15	0.43	0.70	0.14
PGDP is not granger causality of EC		0.04	0.16	0.42	0.64	0.41
CO_2 is not granger causality of PGDP		0.33	0.63	0.86	0.93	0.75
PGDP is not granger causality of CO_2		0.06	0.01	0.10	0.15	0.90
EC is not granger causality of CO_2		0.03	0.04	0.27	0.60	0.40
CO_2 is not granger causality of EC		0.40	0.55	0.33	0.61	0.75

Source: Calculations of research

6-4) Optimum lag length determining

As discussed Johanson Cointegration model requires a VAR equations system estimation and obtaining the optimum lag length is the first step to estimate the model. Whereas determination of appropriate lags ensures the stationary or I(0) of error terms of equations.

Based on the output of the software, optimal lag length according to Schwartz- Bayesian Criteria (SC), Hannan Quinn (HQ) and likelihood ratio (LR) is equal to two. Consequently, we first estimate the VAR equation system with two optimum lags and then determining integrated vectors. Obtained VAR equations with lag(2) and intercept as follows:

CO_2= -0.13+0.64PGDP(-1)–0.71PGDP(-2) + 0.19EC(-1)–0.13EC(-2) +0.63CO_2(-1) +0.24CO_2(-2)

t: (0.19)   (2.07)   (-2.45)   (0.78)   (0.57)   (2.63)   (1.00)   (7)
Adjusted R^2: 0.92

PGDP= -0.16+1.42PGDP(-1) – 0.60PGDP(-2) + 0.26 EC(-1) +0.28 EC(-2) – 0.6 CO2(-1) + 0.15 CO_2(-2)
t: (1.51)   (7.37)   (-3.39)   (1.80)   (2.02)   (-0.41)   (1.05)   (8)
Adjusted R^2: 0.90

EC= 1.02 -0.04 PGDP(-1) – 0.15PGDP(-2) + 0.64 EC(-1) + 0.17 EC(-2) + 0.08CO_2(-1)+ 0.26CO_2(-2)
t: (2.12)   (-0.22)   (-0.07)   (3.63)   (1.07)   (0.44)   (1.53)   (9)
Adjusted R^2: 0.97

Since all variables are all static after first differencing and have identical integrated degree, possibility of long term integrated relation exists so we perform cointegration test.

6-5) Co-integration test

Cointegration between variables can be determined by Juhanson method and trace statistics λ_{Trace} and maximum likelihood statistics λ_{Max} tests.

$$\lambda_{Trace}(r) = -T \sum_{i=r+1}^{n} \ln(1 - \hat{\lambda}_i) \tag{10}$$

$$\lambda_{Max}(r, r+1) = -T \ln(1 - \hat{\lambda}_{r+1}) \tag{11}$$

Results reported in Table (4):

Table 4: Johansen Co-integration test

hypothesis	P value	λ_{Trace}	Significant level 5 percent	
			Critical value	prob
NONE	0.018	35.193	39.045	0.500
AT MOST 1	0.263	20.262	14.830	0.199
AT MOST 2	0.123	9.165	7.071	0.183

Source: Calculations of research

As the results show, at last there is one Co-integration relationship at level 5 percent among three variables over the period 2009-1971. Co-integration equation is as follows:

$$Co_2 = 2.55 + 0.55EC + 0.43PGDP \tag{12}$$
(4.06)   (7.25)   (2.37)

The equation shows that in long term equilibrium, energy consumption and economic growth has a positive and significant effect on carbon dioxide emission in Iran. According to the above equation, assuming all other things equal, as energy consumption increases, air pollution increases 0.55 percent and as economic growth increases by one percent air pollution increase equal to 0.43 percent.

6-6) VECM results

Using Co-integration test, long-run relationship between the variables obtained, in order to obtain short-term relationship between the variables, we use error correction model. Restrictions imposed on CO_2, Error Correction Model (ECM) estimated and adjusted coefficients endogenous variables are measured. The first step to estimate the Vector Error Correction Model, is determining the appropriate lag, given that the number of VECM lags in differenced variable relevant to the number of level variable lags in VAR, knowing the optimum lag in this model, number of differenced variable lags would obtain in VECM model. Since the optimum lag in VAR model is 2, the variables differencing lag in VECM model will be 1. Obtained relations in vector Error Correction Model, study the net effects of each explanatory variables on dependent variables, separately and in other words co-linearity between variables in long run have been frustrated in the estimated model. The results of the estimating error correction model, imposing restrictions on carbon dioxide emissions are as following equations:

D(CO$_2$)= -1/03ECM + 0/22D(PGDP(-1)) +0/79D(PGDP(-2)) 0/04–D(EC(-1)) 0/31–D(EC(-2)) – 0/05 D(CO$_2$(-1))+0/03D(CO$_2$(-2))   (13)

D(PGDP))= -0/22ECM +0/47D(PGDP(-1)) +0/55D(PGDP(-2)) -0/06D(EC(-1)) +0/06D(EC(-2)) + 0/27 D(CO$_2$(-1)) -0/22D(CO$_2$(-2))   (14)

D(EC)-0/6 ECM 0/26-D(PGDP(-1))+0/19D(PGDP(-2))– 0/15D(EC(-1))–0/35 D(EC(-2))–0/58D(CO$_2$(-1)) +0/13D(CO$_2$(-2))   (15)

ECM coefficient obtained from the vector error correction model is equal to -1.03, which is in accordance with theoretical expectations, negative and its absolute value is approximately equal to one. Negative sign of ECM indicates short run deviations adjustment in long run and its value approximately close to one indicates high adjustment speed, so the adjustment can be in a period.

7. CONCLUSIONS

The **first step** is to conduct appropriate indexes for 3 variables, energy consumption, economic growth environment in order to test the paper hypothesis.

In the **second step** since we dealing with time-series variables, each variable stationary evaluated with augmented dickey fuller test. Results indicate that energy consumption, economic growth and carbon dioxide are instable at level but are stable at first differenced levels of 1, 5 and 10 % significant levels.

The **third step** is to investigate the Granger causality test between the three variables, energy consumption, economic growth and carbon dioxide emissions. Results of the tests show that the at lags (1), (2), (4) and (5) energy consumption is a Granger causality of carbon dioxide emissions. According to these results, we can say that a reduction in carbon dioxide emissions is the Granger causality of pollution and carbon dioxide emission reduction. also, we can point out the relation between economic growth and energy consumption, in which economic growth is the granger causality of energy consumption and energy consumption is the granger causality of economic growth in lag (1) and (4) respectively.

The **fourth step** in order to estimate the VAR model initially we should determine optimal interval. Using Eviews, Schwartz, Hannan Queen and the likelihood ratio statistics suggests optimum lag 2 in VAR model. The model estimated with intercept. As defined at the first and second lags all variables have a significant effect on carbon dioxide emissions. Adjusted R2 statistics indicate that variables have a high explanatory power for dependent variable. But since the variables used in the model were instable, results point out short run relations between variables are not reliable. As all variables become stable after first differencing and have identical integration, existence of a long run integration is probable so the co-integration test has performed.

The **fifth step** is to assess the long-run relationship between the variables. Since the time series integrated at degree one, using linear regression is not appropriate. However, according to co-integration theory, linear instable combination of variables may be sustained. Usually this type of variables called Cointegrated. If the variables were not co-integrated, there may be a long-run equilibrium between variables. Based on the results obtained in the study, there is a long-term Cointegration relationship between energy consumption, economic growth and carbon dioxide emissions. The co-integration equation shows that energy consumption and economic growth in the long-run equilibrium have a significant positive effect on carbon dioxide emissions in Iran. According to the equation derived by assuming all other things equal, a percentage increase in energy consumption, CO$_2$ emissions, increase 0.55 percent. If the economic growth increases by one percentage, air pollution will increase 0.43 percent.

The **sixth step** is the VECM model estimation, actually obtained relations in this section indicates intermediate relations between variables. The results of these tests indicate that the first order difference variables lags on each of the variables mostly have no significant effect. But

obtained error correction coefficient in 3 equations are significant i.e. the adjustment speed of variables is so high.

Resources

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