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Road energy consumption, economic growth, population and urbanization in Egypt: Cointegration and Causality analysis

Abstract

The study investigates the causal relationships between road energy consumption, economic growth, and urbanization and population growth in Egypt over the period (1980-2011). I use Johansen cointegration approach, vector error correction model (VECM), generalized impulse response functions and variance decomposition technique. The results show the existence of long run relationship between the variables. Moreover, the results indicate the existence of unidirectional long-run causality running from road energy consumption per capita to urbanization and from road energy consumption per capita to economic growth which implies the existence of growth hypothesis in the long run. Also, there is bidirectional short-run causality between road energy consumption per capita and economic growth, which indicates the existence of feedback hypothesis in the short run. These results imply that road energy consumption determines economic growth in the both short run and long run and economic growth causes road economic growth in the short run. And according to these results, several policy implications will be suggested for policymakers. They should take into consideration while implementing energy conservation policies, the possible negative effect on economic growth and have to concentrate on technological development policies and to make a shift towards using clean alternative fuel as natural gas and focus on investment in renewable energy resources.

1 Introduction

Transport sector is one of the main sectors in the economy that contributes significantly to economic and social development. Nevertheless, it is one of the major energy consuming and pollutant emission sectors as it is responsible for about a quarter of global carbon dioxide emissions (El-Dorghamy et al. 2015). And as concluded by world Energy Council (2011), the transport sector will depend heavily on gasoline, diesel and jet fuel between 2010 and 2050, where the demand for these three fuels will increase between 10% and 68%. Moreover demand for fuel for developing countries is expected to increase by 51% in freeway where the demand for diesel will be between 200% and 900%.

In Egypt, during the last three decades increased passengers and freight activities resulted in enormous increase in energy consumption by transport sector and accordingly pollutants emissions. Annual average growth rate for total transport petroleum energy consumption is 4.8% between (1981/1982) and (2012/2013) where gasoline and diesel fuel have showed the largest average annual growth with average annual growth rate of 5% and 5.2% respectively (ESCWA 2014). Moreover, transport sector in Egypt is responsible for approximately 26% of all greenhouse gases (GHG) emissions according to the Egypt Second National Communication for the United Nations framework Convention for Climate Change (UNFCCC) (El-Dorghamy et al. 2015). And although government devoted about 26000 million dollars on subsidies for fossil-fuel in 2012, on which the share of the transport sector from these subsidies was approximately 45%, but since July 2014, government started decreasing fossil-fuel subsidies by about 22% (EIA 2015).

Road sector is considered the main sector for transport in Egypt and an important one in affecting trade, as it accounts for about 97 % of freight movements mainly private, and also more than 55% of domestic passenger transportation (Ragab and Fouad 2009). In addition, road sector is responsible for about 90% of transport energy consumption according to United Nations Statistics (2013).

Therefore, the study aims at examining the causality relationship between road energy consumption and the main drivers for road energy consumption in Egypt which are economic growth, population growth and urbanization as there is a lack in investigating this causal relationship in Egypt.

The paper conducts Johansen cointegration approach and Granger causality to examine the relationship between road energy consumption per capita, economic growth, population growth and urbanization for time series data of 1980-2011 and this time series period is chosen depending on data availability. In addition the paper employs generalized impulse response functions to check the effects of shocks on the adjustment path of the variables and variance decomposition technique to detect the contribution of exogenous shock to the forecast error variance of each variable.

The rest of the paper is divided into 4 sections. Section 2 is concerned with providing a brief review of the literature. Section 3 explains the empirical model, data and methodology. The empirical results are discussed in section 4 and finally in section 5 conclusion for the paper and suggested policy implications are discussed.

2 Literature review

Various studies have investigated the energy or electricity consumption –economic growth nexus, beginning with Kraft and Kraft (1978). Then following Kraft and Kraft (1978) various researchers investigated the causality between energy consumption and economic growth in one single country and the results showed the existence of causality (Soytas et al. 2001; Tang 2009; Belloumi 2009; Bekhet and Othman 2011; Ahmed et al. 2013; Aslan et al. 2014; Banafea 2014; Hwang and Yoo 2014; Kargi 2014; Lin and Jr 2014; Lin and Jr 2014; Kyophilavong et al. 2015).

Other researchers investigated energy consumption-economic growth or electricity consumption-economic growth nexus through multiple-country analysis, and the results mainly find causality between energy consumption / electricity consumption and economic growth but differ between the directions of causality between countries (Yu and Choi 1985; Masih and Masih 1996; Salim et al. 2008; Rafiq and Salim 2009; Alam 2013; Azam et al. 2015). Beside single and multiple country analysis, there exists panel data studies, (Narayan and Smyth 2008; Costantini and Martini 2010; Joyeux and Ripple 2011; Narayan and Popp 2012; Liddle and Lung 2015; Pala 2016).

Moreover, various researchers explored the causality relationship between energy consumption, economic growth and carbon dioxide emissions and they concluded different direction of causalities. Ang (2007) examined the causality relationship between real income, commercial energy use and carbon dioxide emissions per capita in France and he found unidirectional long run causality running from real income to carbon dioxide emissions and from real income to commercial energy use. Also, he concluded unidirectional short run causality running from energy use to economic growth. Halicioglu (2009) explored the causal relationships between commercial energy use per capita, carbon emissions per capita, real income, and trade openness in Turkey and he found long run and short run bidirectional causality between real income and carbon dioxide emissions. Acaravci and Ozturk (2010) explored the causality relationship between carbon dioxide emissions, real income and energy consumption for nineteen European countries and they found causality differ across countries. Iwata et al. (2010) found unidirectional causality relationship running from electricity production from the nuclear source and real income to carbon dioxide emissions per capita.

In addition, some scholars focus on the causality relationship between energy consumption and urbanization. Halicioglu (2007) found long-run causality from urbanisation rate, real income per capita, real residential electricity price to residential electricity consumption per capita. Liu (2009) concluded that urbanization causes total energy consumption in both short run and long run in China while examining the causality between real gross domestic product, total energy consumption, population growth and urbanization. Hossain (2011) investigated the dynamic causal relationships between real income per capita, energy consumption per capita, carbon dioxide emissions per capita, trade openness and urbanization using panel data for newly industrialized countries, and he concluded the existence of unidirectional short run causal relationship running from trade openness to urbanization, from trade openness to real income per capita, from real income per capita to energy consumption per capita, from urbanization to real income per capita, and from real income per capita and trade openness to carbon dioxide emissions per capita. Zhang and Lin (2012) investigated the relationship between carbon dioxide emissions, energy consumption and urbanisation in China and they found that urbanisation increases carbon dioxide emissions and energy consumption. Solarin and Shahbaz (2013) explored the causal relationship between real income per capita, urbanisation and electricity consumption per capita using VECM Granger causality test and they found bidirectional causality between urbanisation and electricity consumption per capita and between electricity consumption per capita and real income per capita. Al-mulali et al. (2013) explored the relationship between carbon dioxide emissions, energy consumption and urbanization in Middle East and North African countries and the results indicate the existence of long-run bidirectional causality between the three variables. Liddle and Lung (2014) examined long-run causality between urbanisation and electricity consumption using heterogeneous panel methods and they found that electricity consumption causes urbanisation. Liddle (2014) in summarizing cross country studies found that urbanisation is positively correlated with energy consumption and carbon dioxide emissions.

Yazdi and Shakouri (2014) found unidirectional causality running from energy consumption per capita, real income per capita, urbanization and financial development to per capita carbon emissions. Also, Shahbaz et al. (2016) concluded the existence of bidirectional relationship between carbon dioxide emissions on one hand and real income and energy consumption and unidirectional causality from trade openness to carbon dioxide emissions in both short run and long run. Moreover, unidirectional causality running from urbanization to carbon dioxide emissions was found in long run.

Other studies focus on energy consumption in the transportation sector and its causal relationship with economic growth and other variables as environmental degradation and urbanization. Samimi (1995) detected cointegrating relationship between road energy consumption, output and prices in Australia and he concluded the existence of bidirectional causality between output and road energy consumption and unidirectional causality from road energy consumption to prices. Ramanathan (2001) examined the long-run relationship between variable for transport performance (passenger-Kilometres and tonne kilometres) and macroeconomic variables (economic growth and urban population to total population). Liddle (2009) examined the causal relationship between number of registered vehicles per capita, real income per capita, real gasoline price income, per capita vehicle-miles (proxy for mobility demand) in the United States. He concluded the existence of a mutual causal relationship between per capita vehicle-miles and the rest of variables. Pradhan (2010) investigated the causality relationship between energy consumption, transport infrastructure and economic growth in India and he found a unidirectional causality running from transport infrastructure to economic growth and energy consumption and also a unidirectional causality running from economic growth to energy consumption. Liddle (2012) examined causal relationships between real income per capita, per capita motor gasoline consumption, car ownership and real gasoline price using panel data for OECD countries. The results were that the existence of unidirectional causality from real gasoline price to per capita gasoline consumption and from real income per capita and per capita gasoline consumption to car ownership.

Liddle and Lung (2013) examined the causality between per capita transport energy consumption real gross domestic product per capita (GDP) and concluded the existence of unidirectional causality from real GDP to transport energy consumption. Chandran and Tang (2013) concluded bidirectional causality between real foreign direct investment per capita, road energy consumption per capita and carbon dioxide emissions per capita in Malaysia and Thailand and bidirectional causal relationship between real GDP per capita and per capita carbon dioxide emissions in Thailand and Indonesia. Ben Abdallah et al. (2013) explored the causal relationship between road energy consumption per capita, transport value added per capita, road infrastructure per capita, carbon dioxide emissions and fuel price they detected the existence of long run bidirectional causality between road energy consumption per capita, transport infrastructure, carbon dioxide emissions and transport value added and also unidirectional causality from fuel price to road energy consumption per capita existed. Saboori et al. (2014) examined the long-run relationship between road energy consumption, economic growth and carbon dioxide emissions in Organization for Economic Cooperation in Development Countries (OECD), and their findings showed the existence of long-run long run bidirectional causal relationship between economic growth on the one hand and carbon dioxide emissions and road sector energy consumption on the other hand and between economic growth and road sector energy consumption in all OECD countries.

Other researchers concentrated on the relationship between economic growth and transportation infrastructure. Fedderke and Bogetic (2006) used panel data for South Africa to examine the direct impact of infrastructure on output per worker and the indirect effect of infrastructure on the total factor productivity. Pradhan and Bagchi (2013) examined the causality relationship between infrastructure investment, transportation infrastructure (rail and road) and economic growth in India using vector error correction model. They found bidirectional causality between economic growth and road transportation and between road transportation and infrastructure investment. They also found unidirectional causality running from rail transportation to infrastructure investment and economic growth. Also, Achour and Belloumi (2016) explored the causality relationship between transportation infrastructure (rail and road), gross capital formation per capita , transport value added per capita, transport carbon dioxide emissions per capita and transportation energy consumption per capita in Tunisia over the period 1971-2012 using Johansen Cointegration approach, generalized impulse response functions and variance decomposition technique. They concluded various causality relationships in both short run and long run.

3 Econometric specification and methodology

For the purpose of investigating the long run relationship between road energy consumption, economic growth, population growth and urbanization a log-linear equation is as follows:

$$roadec_t = \beta_0 + \beta_1 y_t + \beta_2 pop_t + \beta_3 ur_t + \varepsilon_t \quad (1)$$

Where $roadec_t$ is road energy consumption per capita (Kg of oil equivalent), y_t is real GDP per capita (constant 2005 US$), pop_t is population growth (annual percentage of population growth) . ur is urban population(percentage of total population) and ε_t is the random error term. All the variables are in their natural logarithms form. The data cover the period 1980-2011, and they are obtained from World Bank indicators (World Bank, 2015).

The study will investigate the relationships between road energy consumption, economic growth, population growth and urbanization by employing Johansen and Juselius (1990) maximum likelihood estimation procedure to test for the presence of multiple cointegrating vectors.

But examining stationary will be employed as a first step, as in time series analysis and according to Engle and Granger (1987) most variables may have trends so that they are non-stationary variables, and in case of existence of time series non-stationary at level, then cointegration and vector error correction model can be conducted. Thus, Augmented Dickey-Fuller (ADF) test is employed for testing univariate analysis and examines the existence of unit roots in each series.

Johansen and Juselius (1990) maximum likelihood estimation procedure will be applied to test for the presence of multiple cointegrating vectors, and Johansen (1988) test for multivariate cointegration produces two different likelihood ratio tests which are trace test and maximum eigenvalue test.

If two or more variables are cointegrated then VECM can be conducted to specify the direction of Granger causality among variables and reveal the short run and long run relationships among the variables. This can be represented by equations (2)-(5), where in every equation the dependent variable is illustrated by itself, the others independent variables and the error correction term.

$$\Delta roadec_t = \omega_1 + \sum_{i=1}^{\rho} \gamma_{11i} \Delta roadec_{t-1} + \sum_{i=1}^{\rho} \beta_{12i} \Delta y_{t-1} + \sum_{i=1}^{\rho} \beta_{13i} \Delta pop_{t-1} + \sum_{i=1}^{\rho} \beta_{14i} \Delta ur_{t-1} + \alpha_1 ect_{t-1} + \varepsilon_t \quad (2)$$

$$\Delta y_t = \omega_2 + \sum_{i=1}^{\rho} \gamma_{21i} \Delta y_{t-1} + \sum_{i=1}^{\rho} \beta_{22i} \Delta roadec_{t-1} + \sum_{i=1}^{\rho} \beta_{23i} \Delta pop_{t-1} + \sum_{i=1}^{\rho} \beta_{24i} \Delta ur_{t-1} + \alpha_2 ect_{t-1} + \varepsilon_t \quad (3)$$

$$\Delta pop_t = \omega_3 + \sum_{i=1}^{\rho} \gamma_{31i} \Delta pop_{t-1} + \sum_{i=1}^{\rho} \beta_{32i} \Delta roadec_{t-1} + \sum_{i=1}^{\rho} \beta_{33i} \Delta y_{t-1} + \sum_{i=1}^{\rho} \beta_{34i} \Delta ur_{t-1} + \alpha_3 ect_{t-1} + \varepsilon_t \quad (4)$$

$$\Delta ur_t = \omega_4 + \sum_{i=1}^{\rho} \gamma_{41i} \Delta ur_{t-1} + \sum_{i=1}^{\rho} \beta_{42i} \Delta roadec_{t-1} + \sum_{i=1}^{\rho} \beta_{43i} \Delta y_{t-1} + \sum_{i=1}^{\rho} \beta_{44i} \Delta pop_{t-1} + \alpha_4 ect_{t-1} + \varepsilon_t \quad (5)$$

Where Δ is the difference operator, ε_t is the error term and ect is the error correction term. Moreover the coefficient of independent variables β_i demonstrated the short run effect, while the coefficient of error correction term α specified the tendency for the endogenous variables to return back to long run equilibrium.

4 Empirical results and discussions

This study focuses on examining the causality relationship between road energy consumption, economic growth, urbanization and population growth during the period 1980-2011, and this will be done through the following main steps. 1) Augemented Dickey-Fuller (ADF) test will be conducted to test for order of integration for each variable. 2) Examining the presence of long-run relationship among the variables using Johansen's Maximum Likelihood multiple cointegration test. 3) Vector error correction model will be employed to examine the causality relationship between the variables in case of the existence of long run relationship. 4) Generalized impulse response functions and variance decomposition technique are conducted to check the effects of shocks on the adjustment path of the variables and to determine the contribution of every type of exogenous shock to the forecast error variance of each variable respectively.

The first step is concerned with examining Augmented Dickey-Fuller (ADF) test for all the variables under consideration, where the null hypothesis to be investigated is that the series is non-stationary and the alternative hypothesis is that the series does not have, and it is done on the time series in levels and first differences, and the optimal lag is determined automatically depending on Schwarz information criterion. The results are shown in **Table 1**.

Table 1 Results of unit root test

Variables	Test value (level form)	Test Value (First Differenced form)
Roadec	-3.090159	-5.489272***
Y	-1.647994	-3.443861 **
Pop	-0.969294	-2.552509 **
Ur	-1.477429	-5.47722***

** and *** indicate the rejection of the null hypothesis of ADF test at 5% and 1% level of significance respectively.

The above results show that road energy consumption per capita, real economic growth per capita, population growth and urbanization are integrated of order 1 as they are non-stationary at levels.

Before investigating the second step which is concerned with application of Johansen maximum likelihood cointegration test, there is a prerequisite step which is detecting the appropriate lag length by employing a vector auto regression (VAR) model on the basis of Schwarz criterion LR criterion and HQ criterion, and it is found that the appropriate lag length is one as presented in **Table 2**.

Table 2 Selection of lag length

Lag	AIC	SC	LR	HQ
0	-13.55527	-13.36495	NA	-13.49709
1	-21.47130	-20.51972*	208.3544*	-21.18039*
2	-21.62817	-19.91534	24.69495	-21.10454
3	-21.80332*	-19.32923	19.77004	-21.04697
4	-21.70645	-18.47109	11.50583	-20.71737

Then in the second step Johansen test for multivariate cointegration is conducted to determine the number of cointegrating vectors of equations. As shown in **Table 3** based upon trace statistics it is concluded that there exists one cointegrated equation at 5% significant level, and this means that there exists a long-run relationship among the variables.

Table 3 Results of Johansen cointegration test

	Rank test (Trace)				**Rank test (Maximum Eigenvalue)**		
Hypothesized No. Of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**	Max-Eigen statistc	0.05 Critical Value	Prob.
None*	0.561903	59.74139	54.07904	0.0144	24.75948	28.58808	0.1430
At most 1	0.462086	34.98192	35.19275	0.0527	18.60169	22.29962	0.1518
At most 2	0.299139	16.38022	20.26184	0.1574	10.66338	15.89210	0.2777
At most 3	0.173505	5.716841	9.164546	0.2138	5.716841	9.164546	0.2138

** indicates the rejection of null hypothesis of no cointegration at 5% significant level.

Depending upon cointegration test results, the VECM shown in equations 2 to 5 is conducted as third step to detect the direction of causality using Granger causality tests and the results are shown in **Table 4**. The significance of the coefficient of error correction term using t-test indicates long run causality, while short run causality is detected using Wald statistics.

The coefficient of the error term in equations 3 and 5 are statistically significant at 1% level where the dependent variables are GDP per capita and urban population respectively. These results indicate the existence of unidirectional long-run causality running from road energy consumption per capita to economic growth and from road energy consumption per capita to urbanization. Also, there is bidirectional long run causality between economic growth and urbanization.

The results of Wald statistics indicate the existence of bidirectional short-run causality between road energy consumption per capita and economic growth and between urbanization and economic growth. Granger test results imply that road energy consumption per capita determines economic growth and urbanization in the long-run, which means that growth hypothesis exists in the long run. In addition, there exists interdependence relationship between road energy consumption and economic growth in the short run, where feedback hypothesis exists. The results of bidirectional causality between road energy consumption and economic growth in the short run and unidirectional causality from road energy consumption to economic growth in the long run in Egypt is not surprising, especially that the road sector is considered the main sector for transport in Egypt and a vital one in affecting trade, as it accounts for about 97 % of freight movements mainly private (Ragab and Fouad 2009). So, it is considered an important factor in achieving economic growth both in the short run and long run. Also, road energy consumption causes urbanization in Egypt, as people migrate from rural areas to urban areas aiming at working in industrial sectors that depend heavily on energy consumption in general and on road energy consumption for transportation and trade in specific. In addition, the existence of short run and long run bidirectional causality between urbanization and economic growth is consistent with the Egyptian case where industrial sectors in urban areas attract people to migrate from rural areas aiming at achieving better life and increasing their incomes.

Table 4 Results of causality tests

Dependent variable	Source of causation (Short-run)				Source of causation (Long-run) ECT
	Δroadec	Δy	Δpop	Δur	
Δroadec	-	2.819996*	0.224625	0.391294	-0.075780
		(0.0931)	(0.6355)	(0.5316)	[-1.06552]
Δy	18.09828***	-	0.114647	16.16983***	-0.044549**
	(0.0000)		(0.7349)	(0.0001)	[-2.57136]
Δpop	0.373180	0.270754	-	2.242952	-0.015480
	(0.5413)	(0.6028)		(0.1342)	[-0.35338]
Δur	1.276058	6.561673**	5.308352**	-	-0.015974***
	(0.2586)	(0.0104)	(0.0212)		[-3.07507]
Diagnostic tests	**Test-statistics**	**p-value**			
Serial correlation LM	10.34229	0.8482			
Heteroskedasticity	94.30320	0.3574			
Normality test	2.106587	0.3488			
Structural breakpoint tests	18.94920	0.1451			

Numbers in square brackets are t-statistics while those in parentheses are p-values.
*, ** and *** indicate 10 %, 5% and 1% level of significance respectively.

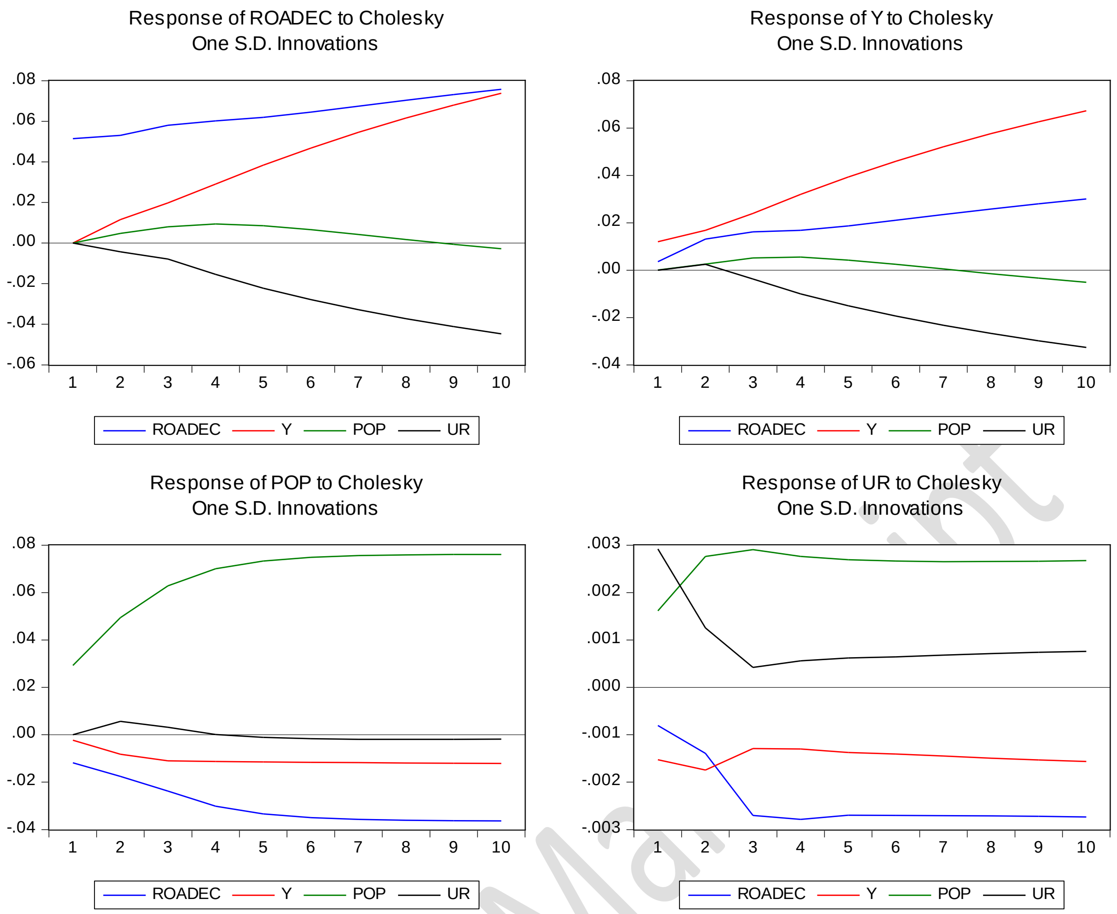

Fig. 1 Results of generalized impulse response functions

Generalized Impulse response functions are conducted to show the effects of shocks on the adjustment path of the variables so they can specify every variable's effect to one shocks or innovations on both current and future values. So, these functions detect how endogenous variable reacts to shock on the error term in the vector error correction term (Achour and Belloumi 2016). The results of generalized impulse response functions for road energy consumption per capita, economic growth per capita, population and urbanization are shown in **Fig. 1**. As a result of shock stemming in road energy consumption per capita, it is shown that economic growth per capita is increasing which is consistent with the findings. As for urbanization, it is negative over the horizon and although this contradicts the results but it may be attributed to the problem related to urbanization and bad quality of life in urban areas. As urbanization is considered one of the severe problems that Egypt suffer from especially in Cairo, as urbanization led to enormous increase in Cairo's population; about six times more in the previous sixty years (Howeidy, A. 2009) and it is characterised with poor planning system where road transportation system is inefficient and is heavily using fuel which is responsible for about 20% of carbon dioxide emissions (CAPMAS 2016). This bad quality of life with its negative health implications may affect negatively urbanization. In addition, population increases positively then decreases then stagnates. Moreover, the response of road energy consumption to economic growth is positive and increasing which is consistent with the Egyptian case.

Table 5 Variance decomposition analysis

Period	S.E	roadec	Y	pop	ur
Variance decomposition of roadec					
1	0.051396	100.0000	0.000000	0.000000	0.000000

5	0.142047	80.66271	14.08603	1.222307	4.028954
10	0.266377	57.80866	30.81964	0.449357	10.92234
Variance decomposition of y					
1	0.012520	8.196164	91.80384	0.000000	0.000000
5	0.071248	21.27682	70.28335	1.599833	6.839992
10	0.169238	15.46431	70.36053	0.447396	13.72776
Variance decomposition of pop					
1	0.031658	14.01913	0.526919	85.45395	0.000000
5	0.145113	14.40636	2.140538	83.25024	0.202861
10	0.238453	16.64848	2.033416	81.21264	0.105465
Variance decomposition of ur					
1	0.003754	4.582394	16.52526	18.44590	60.44644
5	0.008947	31.13259	13.24727	41.91549	13.70466
10	0.012880	37.24012	13.08169	41.55724	8.120955

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Variance decomposition method based on the vector error correction model is analysed to determine the contribution of exogenous shock to the forecast error variance of each variable. It is shown in **Table 5** that 57.808% of road energy consumption per capita is explained by its own innovative shocks. Moreover, the contributions of real economic growth per capita, population and urbanization to road energy consumption per capita are about 30.819%, 0.449% and 10.922% respectively.

These results indicate that economic growth is the most important variable that causes energy consumption in road sector. And these results are consistent with Egypt, as economic growth and industrialization increase the demand on road energy consumption. In addition, the contribution of road energy consumption per capita to real economic growth per capita, population and urbanization are 15.46%, 16.64% and 37.24% respectively. This result indicates that the significant contribution of road energy consumption to real economic growth and urbanization which is also consistent with the results of VECM.

Finally, problems of autocorrelation, heteroskedasticity of errors are also checked, and as shown at the bottom of Table 4, there is no existence for autocorrelation and heteroskedasticity. Also, unknown structural break points have been checked and as pointed out by Salim and Rafiq (2008) and Salim and Bloch (2009) that structural break points tests are important to be conducted as a preliminary step. And as shown at the bottom of Table 4, the results indicate the robustness of the model.

5 Conclusions and policy implications

This study aims at examining the long-run and the causality relationships between road energy consumption economic growth, urbanization and population growth. This is done by conducting Johansen cointegration approach, generalized impulse response functions and variance decomposition technique. The study concluded the existence of long run relationship between the variables. Moreover, the results indicate the existence of unidirectional long-run causality running from road energy consumption per capita to economic growth and from road energy consumption per capita to urbanization. Moreover, there is long run bidirectional causality between urbanization and economic growth. Also, there is bidirectional short-run causality between road energy consumption per capita and economic growth and between urbanization and economic growth. In addition, the results of generalized impulse response functions are consistent with the results of vector error correction term.

These results have a number of policy implications for Egypt, first there is bidirectional causal relationship between road energy consumption and economic growth in short run and this confirms the existence of feedback hypothesis, where there exists interdependence relationship between road energy consumption and economic growth in the short run. While in the long run, growth hypothesis exists; where road energy consumption causes economic growth. Therefore, government can impose restrictions and regulations to limit road energy consumption but should take into consideration that those energy conservative policies (i.e. imposing fuel taxes and emissions standards) aiming at reducing pollution, especially carbon dioxide emissions, will not harm and deteriorate economic growth. Also, as economic growth enhances road energy consumption, then policies must be directed towards devoting resources for improving the usage of environmental technology aiming at using fuel in more efficient way to increase energy efficiency. Second, the existence of unidirectional long run causality from road energy consumption to urbanization and the existence of short run and long run bidirectional causality between urbanization and economic growth, make it important for policy makers to slow the rapid increase in urbanization and focus on the policies that make urbanization a positive force in enhancing economic development. Third, there must be a quick and fast movement towards the usage of renewable energy resources, so policy makers should provide incentives to attract investment in an alternative clean fuel as natural gas and renewable energy resources especially that Egypt has abundance of renewable energy resources as sun.

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