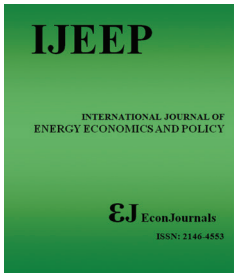

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Urbanization, Oil Price and Pollution in Saudi Arabia

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ABSTRACT

Urbanization and income are usually supported by oil prices and revenues in the oil abundant countries. But, the environmental effect of urbanization and oil prices should not be ignored to ensure the sustainable growth of oil abundant economies. We investigate the role of urbanization and oil prices on the CO_2 emissions per capita of Saudi Arabia using a period 1980-2014 and cointegration test. Urbanization has positive on the CO_2 emissions per capita. So, a rapid and continues increasing urbanization throughout the sample period is found responsible for degrading the environment. Moreover, the oil price is also found responsible for increasing CO_2 emissions in the long run but its effects are found insignificant in the short run. We recommend the Saudi economy to diversify from the oil sector to ensure clean environment.

Keywords: CO_2 Emissions, Oil Prices, Urbanization, Cointegration
JEL Classifications: Q53, P25, Q34

1. INTRODUCTION

Economic growth and urbanization have a strong role to play in the environment and CO_2 emissions condition in a country. The idea of urbanization leading to CO_2 emissions can be justified through many reasons, but one of the most obvious connections is through energy consumption due to population concentration in an urban area. As a country is focusing more on urbanization and development of new and advanced infrastructure in its old and new cities, a huge chunk of those activities is done through activities that require energy consumption. With heavy infrastructure being involved in these operations for longer period, not only are the natural resources of the country used constantly in the form of fuel, CO_2 emissions from their use and wastes go back into the air, soil and water which eventually affects the environment in a negative way.

Saudi Arabia, in the world, is famous for its natural resources in oil and gas. The abundance of natural resources, the exports have accelerated high enough to accumulate sufficient amount of foreign exchange earnings and economic growth resultantly (Maalel and Mahmood, 2018). Here, oil price contributes a very momentous role in determining the oil revenues and income of the country. During increasing oil prices and urbanization, pollution should be considered as one of the most alarming problems for any oil-exporting country with such mentioned accelerated economic growth. Because oil sector of this country is expected to accelerate the pollution level if more focus remained on oil production and oil prices are also increasing and contributing to the oil revenues. Oil production could not be helpful in reducing the pollution levels even if clean technologies are adopted. Therefore, reducing oil-dependence is only solution to this alarming situation. The increasing oil sector of the country may increase pollution emissions and also degrade the environment by

emitting CO_2 emissions. The effects of both oil sector and oil price need a careful study to capture the present effects to guide a package of policies to support a clean environment in the country.

Other than production sectors, urbanization may play a negative role in polluting the environment due to higher energy consumption for a better standard of living in urban areas. Conversely, urbanization may also have pleasant effects on the environment if society is properly groomed up with education of awareness about environment. The rapidly increasing population and consequently rising urbanization may be counted as dangerous for environment due to heavy use of cheap fossil fuel energy in Saudi Arabia. The increasing growth of the country is increasing the transportation and industrial sectors which are the main actors in the environmental deterioration. Further, rising urban concentration is fueling the fire higher.

Overall, oil-exporting country like Saudi Arabia is expected to be victim of environmental problem due to heavy oil production, low domestic energy prices and higher domestic oil consumption. Therefore, it is pertinent to know at first the major drivers of pollution in a country to control the problem of pollution. There is a vast literature to find the effect of financial market and trade on the pollution in the Kingdom and other oil-exporting countries (Al-Mulali and Ozturk, 2015; Farhani and Ozturk, 2015; Mahmood et al., 2018; Mahmood and Alkhateeb, 2017; Zamil et al., 2019). But, testing the urbanization and oil price on the pollution emissions is totally absent in the environment literature of Saudi Arabia.

Any theoretical assumption about the positive or negative environmental effect of any pollution driver is not valid without comprehensive research. It is also important to see the degree and magnitude of relationship between pollution and its major drivers. Therefore, the investigation of the influences of urbanization and oil sector on the pollution emissions may claim for a significant contribution in the Saudi literature. Moreover, the magnitude of the environmental problem from these proposed factors is important for policy framing. This present study is also highly motivated to explore belongings of urbanization and oil price to the pollution emissions in Saudi Arabia using a sample range of 1980-2014 dataset to propose a comprehensive policy to overcome the environmental problem.

2. LITERATURE REVIEW

At first, we are interested to see the influence of oil price (OP) in shaping the economy. The influence of OP on income has been investigated in the many studies and we are discussing few of them at this stage to support our hypothesis. Jimenez-Rodriguez and Sachez (2004) test the influences of OP on the real income of OECD countries and initiate the indication of asymmetrical influences of OP on real income. Further, positive movement of OP has greater influence on real income than that of negative oil price movements. Further, the relationship between oil price and real income has been captured negative and positive in some countries differentiated based on oil trade. Therefore, the expected relationship of these variables is also expected as a positive as Saudi Arabia is net oil exporters.

In case of Saudi Arabia, Mahmood and Zamil (2019) investigate the oil price on personal consumption using a period 1970-2016. They catch a positive effect of OP on consumption. Therefore, increasing personal consumption definitely will increase the energy consumption to fuel pollution. Further, Alkhateeb et al. (2017a) inspect the effect of OP on employment using a period 1980-2015 in Saudi Arabia. They found that OP and income positively contributed to the employment level of the Kingdom. Oil price may not affect economic activities if increasing oil prices could not raise oil revenue due to its inelastic nature.

Chai et al. (2015) explore the asymmetry of OP changes and income in China, USA and Japan. But, they could find long run relationships and claim that income has only been influenced by increasing oil prices in the peak period only in China and Japan. Oil prices also contribute to the employment generation which may increase the economic activities and pollution emissions. To validate this issue, Alkhateeb et al. (2017b) re-investigate the effect of oil revenues including government spending in the model as most of government spending is also supported by oil revenue in the Kingdom. They found that both variables cause income and employment. Fiti et al. (2016) investigate the OP effect on income and business cycles in the linear settings by applying Engle-Granger cointegration. They find encouraging influence of OP on income. They also reported that business cycle is following the oil price movements.

In another approach, Mahmood and Alkhateeb (2018) scrutinize the role of OP and financial development (FD) on the foreign direct investment inflows (FDII) in Saudi Arabia and found that both variables have positive contribution in the FDII of the country. However, domestic investment negatively affected FDI. Ghalayini (2011) investigates oil price – income relationship for a large group of countries. He finds the depressing influence of OP on income in case oil-importing nations and further a positive relationship was observed in case of oil-exporting countries. Further, he finds the feed-effects in case of G-7 countries only and uni-directional relationships were found for most of the countries in the causality analysis. Burakov (2017) investigates and finds relationship in OP and income levels and further causal relationship was also observed in this relationship.

In finding the determinants of CO_2 emissions, Ahmad et al. (2013) examine the effects of population, industry on the pollution in South Asian countries. They found the positive effects of population and industry on the pollution. Mahmood et al. (2019a) investigate the causes of pollution in Egypt using a period of 1990-2014. They found that income has quadratic effect. Moreover, FDI and trade have negative and insignificant effects respectively. Mahmood et al. (2019b) investigate asymmetrical effects of trade. They find the environment Kuznets curve (EKC) in Tunisia and increasing trade had positive effects while decreasing trade has immaterial influence on the pollution.

In the case of Saudi Arabia, Mahmood and Alkhateeb (2017) investigate the effects of income and trade on the CO_2 using data from 1970 to 2016. They find the EKC in the income and CO_2 relationship and the negative influence of trade is also found.

Using data 1971-2014, Mahmood et al. (2018) reinvestigated the EKC including asymmetrical effects of FD in the model. They corroborated again the EKC and reported the negative and positive influences of decreasing energy use and decreasing FD on pollution respectively. However, increasing trends of both variables have insignificant influences.

After reviewing the literature, we can claim the expected relation between OP and income in Saudi Arabia. But, most of the available literature is on the testing of effects of trade and FD on the pollution in Saudi Arabia. Therefore, a gap existed in the Saudi literature to investigate the environmental effects of urbanization and oil price to test magnitude of the effects of these variables. This present study tries to cover this missing literature in the Kingdom.

3. RESEARCH METHODOLOGY

In search of the conventional factors which are responsible for pollution emissions in Saudi Arabia, there is a huge literature available. So, we try to specify our investigation towards missing causes of pollution in Kingdom. To serve purpose, we hypothesize the influences of oil price and urbanization on the pollution in Saudi Arabia through following model:

$$CO_t = f(URBAN_t, OPRICE_t) \quad (1)$$

Where CO_t is carbon dioxide emissions to measure the environmental degradation in Saudi Arabia at time t and it is a proxy for pollution emissions. $URBAN_t$ capture the urbanization expressing the percentage of urban population in total population which is better choice to check the relative trend. $OPRICE_t$ is simply oil price variable. All regressors and regressant are taken into natural log to find the elasticity. Both variables are expected to have positive effects on the pollution emissions as per previous discussions and therefore positive relationships are generally expected.

The increasing oil price definitely increases the oil revenues due to inelastic nature of oil demand world-wide and decreasing oil price may decrease the oil revenues. Therefore, increasing OP and oil revenues are mostly probably contributing positively to the income of the economy. Resultantly, the energy consumption will increase and will contribute to the pollution emissions if a clean or renewable source of energy is not adopted. Most of energy consumption is from fossil fuel which has environmental consequences in the Kingdom. Therefore, a positive relationship is hypothesized initially in the oil price and the CO_2 emissions. In the other debate, the urbanization has increasing trend throughout the period. Increasing urbanization needs more roads construction, houses construction and other infrastructure to meet the demand of urban population. These all activities are required energy consumption to be done and also destroy the natural beauty of non-urbanized land which is going to be urbanized.

In the methodology, we will test the stationarity issue in all of our macroeconomic variables. For the purpose, we utilize the Dickey and Fuller (1981), who proposed the following equations to be tested:

$$\Delta y_t = \beta y_{t-1} + \sum_{i=0}^{p} b_i \Delta y_{t-i} + \zeta_t \quad (2)$$

$$\Delta y_t = \alpha + \beta y_{t-1} + \sum_{i=0}^{p} b_i \Delta y_{t-i} + \zeta_t \quad (3)$$

$$\Delta y_t = \alpha + \gamma t + \beta y_{t-1} + \sum_{i=0}^{p} b_i \Delta y_{t-i} + \zeta_t \quad (4)$$

Above equations might be helpful in testing any y_t variable assuming intercept and trend in equation 4, assuming only intercept in equation 3 and assuming none of intercept and trend in equation 2. After testing the stationarity issue, we will move towards cointegration for equation 1. We are using autoregressive distributive lag (ARDL) model of Pesaran et al. (2001) to serve the purpose. The ARDL of equation 1 might be stated:

$$\Delta CO_t = \delta_0 + \delta_1 URBAN_{t-1} + \delta_2 OPRICE_{t-1} + \delta_3 CO_{t-1} + \sum_{j=0}^{p} \varphi_{1j} \Delta LURBAN_{t-j} + \sum_{j=0}^{q} \varphi_{2j} \Delta OPRICE_{t-j} + \sum_{j=1}^{q} \varphi_{2j} \Delta CO_{t-j} + \psi_{it} \quad (5)$$

After testing the above equation, we may find the long run coefficients after confirming the cointegration in equation 5. Afterwards, our target is to estimate the short-run parameters which may be projected from the following equation:

$$\Delta CO_t = \delta_0 + \sum_{j=0}^{p} \varphi_{1j} \Delta LURBAN_{t-j} + \sum_{j=0}^{q} \varphi_{2j} \Delta OPRICE_{t-j} + \sum_{j=1}^{q} \varphi_{2j} \Delta CO_{t-j} + \tau ECT_{t-1} + \psi_{it} \quad (6)$$

The estimated coefficients of equation 6 are the short-run effects if τ is found negative. This evidence will signify the both long- and short-run association and estimated τ also provide the speed of convergence in the model. To estimate the robust and efficient results of the mentioned model, we will also utilize the Jarque-Bera test to test the normality and suitability of all hypothesized variables in our model. Further, diagnostic tests including heteroscedasticity, multicollinearity, functional form, CUSUM, CUSUMsq and serial correlations tests will also be employed to test the overall econometric health of model and to test the stability and consistency of estimated parameters.

4. DATA ANALYSES AND DISCUSSIONS

Table 1 contains the results of ADF unit root test. CO_t and $OPRICE_t$ variables are not stationary and proved to be stationary at their first differences (Δ). $URBAN_t$ is non-stationary once ADF equation is run assuming none and intercept only. However, it is stationary at a level once ADF equation assumes the both intercept and

Table 1: ADF unit root test results

Variable	C	C and T	None
CO_t	−2.0039(0)	−2.8650(0)	0.0454(0)
$URBAN_t$	−0.4414(7)	−5.8722(7)***	1.1772(7)
$OPRICE_t$	−1.2178(0)	−1.5903(0)	−0.0237(0)
ΔCO_t	−6.5037(0)***	−6.6364(0)***	−6.6015(0)***
$\Delta OPRICE_t$	−4.2443(0)***	−4.9692(1)***	−6.0866(0)***

C and T represents intercept and trend respectively. ***Shows are stationary at 1% level of significance

trend in analysis. Hence, considering both intercept and trend, $URBAN_t$ is leveled stationary and we may conclude it as leveled stationary. Therefore, we ignore its testing on the first difference. In conclusion, our dependence variable CO_t is first difference stationary and independent factors showed a mix-order i.e. $URBAN_t$ is level stationary and $OPRICE_t$ is first difference stationary. With these evidence, we may proceed for the cointegration analysis as ARDL cointegration is based on bound testing procedure assuming lower bound at level stationary and upper bound assuming first difference stationary (Pesaran et al., 2001).

After above investigation, we proceed for ARDL analysis. Table 2 demonstrates that the bound-testing show a low F-value but a negative τ of ECT_{t-1} demonstrated the existence of long-and short-run associations in the estimated model (Pesaran et al., 2001). Further, all parameters are representing the elasticity coefficients. Further, all estimated diagnostic tests show that our model is out econometric possible problems. Moreover, Figure 1 shows that CUSUM and CUSUMsq tests approve the consistency of parameters of our hypothesized ARDL model.

In the long-run, the urbanization has positive influence on the CO_2 emissions with a coefficient 0.4716. It appears that 1%-increase of urbanization would raise 0.4716% of CO_2 emissions in Saudi Arabia. Though the influence of urbanization is inelastic still it contributes to the CO_2 emissions. The urbanization has ever increasing trend throughout the sample period. That way, the urbanization is continually responsible for increasing pollution in the Kingdom. It is crucial to conduct an analysis of these segments because there is a close associated between the aforementioned. Oil prices play a vital role in the energy sector layout of any economy and if it is a country like Saudi Arabia that is a major global player, these prices can help determine the international market strategy for the economy, determine revenues and national income and help devise strategic policies as well. Hence, the role these prices play the Saudi economy should be scrutinized to get a picture. On the other hand, urbanization is something that costs economies something no matter the scale it is being implemented on. Therefore, it is important to see the extent to which urbanization influences the ecological footprint of an economy.

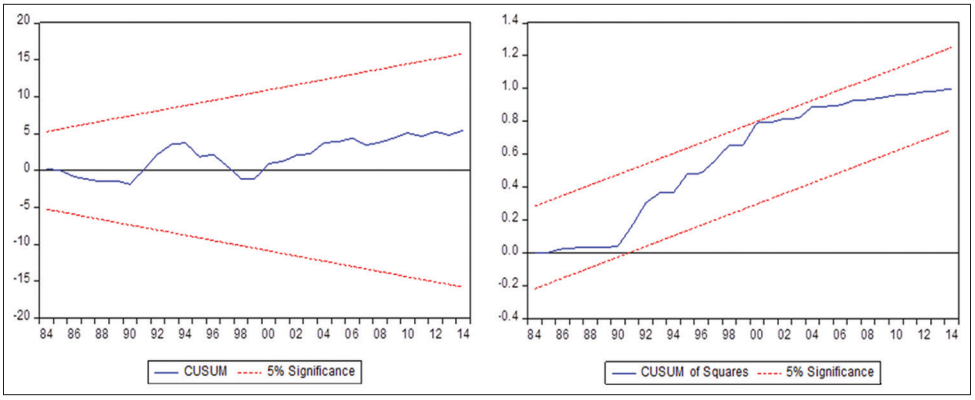
In the OP and CO_2 emissions relationship, oil price has also positive influence. Its coefficient explains that 1% increase in the real oil prices is increasing the 0.1795% of emissions. The Saudi income majorly depends on the oil revenue. Hence, increasing oil price directly increase the oil revenue and income of the Kingdom as oil has inelastic demand due its compulsory type of demand. Here, we use real oil price. Therefore, increasing-price at world level most probably increase the revenues from oil.

The increasing oil price is increasing economic welfare in terms of increasing income and economic activities of the Kingdom. But at same time, oil price is also responsible for increasing pollution levels in the Kingdom. So, Kingdom should consider the negative externalities of oil income once targeting the economic growth policies from the oil revenue. It is necessary to count the net social welfare out of oil income. Looking at it from a bigger perspective, it can be said that the country is in a dilemma where

Table 2: Autoregressive distributive lag cointegration results

Variable	Coefficient	Std. Error	t-statistic	Probability
Long run				
$URBAN_t$	0.4716	0.0846	5.5780	0.0000
$OPRICE_t$	0.1795	0.0949	1.8906	0.0678
Short run				
$\Delta URBAN_t$	0.2021	0.0423	4.7819	0.0000
$\Delta OPRICE_t$	0.0769	0.0499	1.5413	0.1331
ECT_{t-1}	−0.4284	0.0891	−4.8091	0.0000
Diagnostic tests				
Bound test		F-value=2.9128		
Heteroscedasticity		F-value=1.3772		0.2681
Serial correlation		F-value=0.6637		0.5224
Functional form		F-value=0.5890		0.4486
Normality		Chi-square=0.5918		0.7439

Figure 1: CUSUM and CUSUMsq tests



it needs to decide whether higher revenue and income should be given importance or is the environment more important? From an environmentalist's perspective, it is important to keep the ecological side of every decision being made in the economy into account so that the environment is not completely ruined while trying to become economically stable. On the other side, the fact cannot be denied that there is a cost that each country has to pay in order to become economically self-sufficient. If the Kingdom lets go of the social cost of higher oil prices, it might become economically independent enough that more advanced technologies can be invested to cater the limitations on the environmental stability plan which may support clean environment. Nevertheless, it is a decision that the state needs to take and it is always the best idea to keep a balance to ensure that both sides of the coin are being addressed. Additionally, it is also important to keep in mind that a tunnel vision is never great for any economy and it should be kept into account that sustaining an economy is balancing act.

In the short run, the τ of ECT_{t-1} demonstrates convergence-speed from a disequilibrium towards the long-run path of relationship. The results show that any short-run deviation will be adjusted to the long-run path at a speed of 0.4284% a year. Hence, our estimated model requires the 2 years and few months to be set on the path if any short-run divergence occurred. The results further show that $OPRICE_t$ has insignificant influence on the CO_2 emissions in the short run. However, urbanization still shows a positive influence on emissions like long-run result though the short-run effect is lesser than half of the long run effect. Its elasticity coefficient demonstrates that 1%-increase of urbanization would raise 0.2021% of emissions.

5. CONCLUSIONS AND IMPLICATIONS

Saudi Arabia has been gone through rapid urbanization in the past decades and oil income is also a significant part of the total income of the Kingdom. This research estimates both effects of both urbanization and oil price on the CO_2 emissions of Kingdom. We utilize the ARDL bound testing cointegration on a period 1980-2014. We found that urbanization has positive influence on the CO_2 emissions. Though, we found the inelastic influence of urbanization in the Kingdom. But, a rapid and continues increasing urbanization throughout the sample period is found responsible for degrading the environment by emitting CO_2 emissions. Moreover, the oil price is also found responsible for increasing CO_2 emissions in long-run but its effects, in short-run, are found insignificant.

We recommend to Saudi economy to limit the urbanization process up to some optimum level to minimize its environmental effects. It is not suggested that the country completely shuts down all the activities and projects focused on urbanization; but rather keep a balance on both sides so that not only the communities are more advanced and have a more sophisticated architecture, but the environment is clean enough that it complements all the efforts. With a lot of focus being put on urbanization and development, it is high time for the Saudi government to come up with a more sophisticated plan so that it goes a long way. Further, the economy should focus on the non-oil income sources as most of Saudi income is based on the oil revenues and increasing oil price may contribute to the oil revenue and overall income of the country. The urbanization and oil income may have positive welfare effects through increasing consumption and standard of living but their negative spillovers in terms of pollution emissions cannot be ignored to ensure the net positive welfare from these.

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