Is the Transition to Renewable Energy Consumption Hampered by High Oil Prices?

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ABSTRACT

The article examines the impact of oil price, income and CO_2 emissions on renewable energy consumption in the case of Kazakhstan for the data period from 1992 to 2015, employing FMOLS and CCR methods. Empirical results reached that there is a long-run positive and statistically significant impact of income on the renewable energy consumption whereas a negative effect of oil price and CO_2 emissions in Kazakhstan, for the investigated period. The results of this article might be beneficial for the policymakers and support the current literature for next researches for oil-rich developing countries.

Keywords: Renewable Energy Consumption, Income, Oil Price, FMOLS, CCR, Kazakhstan
JEL Classifications: O13, P28, Q42, Q43

1. INTRODUCTION

The economy of Kazakhstan is the first in Central Asia and it is considered as the second largest economy in the Eurasian Economic Union after Russia. In terms of diversity and volume of natural resources Kazakhstan is one of the world leaders. Moreover, it is in the top ten in the world for the production of hydrocarbons. In 2017, independent experts of the Kazenergy Association estimated the reserves at 39 billion barrels. Previous estimates are lower: 6.42 billion barrels for BP and 8 billion barrels for OPEC (BP, 2018). Kazakhstan has recently completed a new oil price assessment. Proven and probable oil reserves are about 35 billion barrels or 1.7% of world reserves. According to this indicator, Kazakhstan is ranked 12th in the world, which allows the country to earn a stable national income and stay on the path of rapid economic development. Rearding to the World Bank report

for 2019, the country ranks 53rd in the world in terms of GDP. However, the industrial sector is at a high energy level, so carbon emissions are increasing in Kazakhstan. Due to the outdated and inefficient energy infrastructure of the Soviet era, Kazakhstan was ranked 19th in the world in terms of per capita greenhouse gas (CO_2) emissions in 2014 and 25th in 2017 (BP, 2018). About 82% of the waste belongs to the energy sector.

In addition, the process of industrialization and the lack of attention to the environment by government have led to large-scale environmental degradation. Considering the rich natural resources, the Kazakh government plans to significantly increase oil production. More than 80% of the country's oil production is exported. Historically, the government has paid less attention to the development of alternative energy sources, as oil, gas, coal and other natural resources are more important to the country's

economy. Currently, most power plants in Kazakhstan run on natural gas, coal or oil products.

However, the recent crisis in the world economy and the realization of the need to reduce the energy intensity and its environmental impact in the economy forced the country to focus on creating favorable conditions for the use of renewable energy sources (RES). The potential of renewable energy sources in Kazakhstan is very high. However, although the potential of renewable energy sources in Kazakhstan is significant, it has not been taken seriously into consideration for a long time.

However, the real indicators are that today we can observe a decline in demand for energy which leads to a significant decrease in energy prices. The emergence of the COVID-19 pandemic is the main reason that intensified this process. In the period of such fluctuations in energy prices, an increase in commercial production and energy consumption from renewable and inexhaustible sources (RES) is observed in the structure of relative prices in many countries.

Recently, the concept of transition to a "green economy" has been developed. This concept plans to increase the share of alternative energy sources to 6% by 2025, 10% by 2030 and 50% by 2050. One of the priorities in the development of "green energy" in Kazakhstan is the development of renewable energy sources. The country's transition to a "green" path of development is a strategic goal and stated within the principles of "Kazakhstan's Strategy - 2050: New State Policy".

Over the past six years, the installed capacity of RES facilities has increased almost 10 times - from 178 MW in 2014 to 1635 MW in 2020. According to the results of 2020, 3% of the total volume of electricity is fully provided. 1685 RES facilities with a capacity of 116 MW are installed and currently they are used in the energy production process in the country. Based on the results of 2020, it can be stated that the production of green energy reached 3.24 billion kWh. In 2020, 10 wind, 1 hydro and 12 solar power plants were put into use in Kazakhstan. In 2021, it is planned to commission 23 RES facilities with a capacity of 381.1 MW. Over 3 years, from 2018 to 2020, 25 Auctions were held for 1.5 kW RES projects. 172 companies from Kazakhstan, China, Russia, Turkey, Germany, France, Bulgaria, Italy, the United Arab Emirates, the Netherlands, Malaysia and Spain took part in the auction.

As can be seen from literature review, no study has been examined the impact of oil price, income and CO_2 emissions on renewable energy consumption in the case of Kazakhstan, using time-series data analysis. Thus, the aim of this paper is to investigate the effect of oil price, income and CO_2 emissions on renewable energy consumption for Kazakhstan. The main contributions of this paper are below: a) This paper evaluated the efect of oil price on renewable energy consumption in Kazakhstan which has not been investigated, and is a good case for oil-exporting developing country. (b) To the best of our knowledge it is the first study evaluating oil price, income and CO_2 emissions effect on renewable energy consumption in case of Kazakhstan employing time-series data analysis such as, Fully Modified Ordinary Least Squares Method (FMOLS) and Canonical Cointegrating Regression (CCR) techniques.

2. LITERATURE REVIEW

Researchers have long studied the effect of oil price on renewable energy consumption. In this context, we reviewed the studies evaluating the impact of oil prices on renewable energy consumption (REC) in the case of different countries.

Sadorsky (2009) analyzed the impact of oil prices, real GDP per capita and CO_2 emissions on REC performing different panel cointegration techniques in the case of G7 countries. The annual data over the period of 1980-2005 were used for estimation. He found that a positive and statistically significant influence from real GDP per capita and CO_2 to REC whereas oil prices has a negative impact on REC. Salim and Rafiq (2012) analyzed the link between renewable energy consumption, real GDP, and oil price for 6 emerging economies using panel FMOLS, panel DOLS and ARDL techniques. According to the ARDL results, oil price was found to be a negative and statistically significant effect on renewable energy consumption for China and Indonesia while to be found statistically insignificant for Brazil, India, Philippines and Turkey. Also, the results of panel DOLS and FMOLS showed that the impact of oil price is statistically insignificant.

Tuzcu and Tuzcu (2014) evaluated the link between REC, real oil prices, real GDP, CO_2 emission, and the proven oil reserves for 7 OPEC countries. They performed panel data techniques for empirical analysis. The results approved that real oil price does not have a statistically significant effect on REC. Apergis and Payne (2014a) explored the oil price influence on REC using data period from 1980 to 2011 for 25 OECD economies. They reached that a rise in real oil prices results in a rise in REC during the long-term. Moreover, Apergis and Payne (2014b) reached a postive impact from oil price to REC in the 7 Central American countries applying Panel VECM.

Omri and Nguyen (2014) investigated the effect of crude oil price on the REC for 64 countries performing a dynamic system-GMM panel model to annual data period of 1990-2011. The estimation results conclude that there is a negative influence of crude oil price on REC. On the contrary, Omri et al. (2015) conclude a positive effect of oil price on REC in the case of 64 countries using annual data spanning of 1990-2011.

Brini et al. (2017) investigated the impact of oil price on REC in Tunisia using Granger causality test and ARDL technique to annual data from 1980 to 2011. The Granger causality test results revealed a unidirectional relationship from oil price to REC in the short-term. Also, they revealed that there is no cointegration relationship between renewable energy consumption and oil price, when the renewable energy consumption is a dependent variable.

Alege (2018) examined the associations between renewable energy consumption and crude oil prices performing panel cointegration and the pair-wise Granger causality tests for 40 countries in Sub- Saharan African countries. The panel co-

integration test indicated that there is co-integration relationship between REC and oil prices. In addition, the results of estimation reached absence of causality between REC and oil prices. Deniz (2019) reached a positive impact from oil price to REC for oil importing countries and a negative impact for oil exporting countries utilizing GMM and Panel VAR methods. In addition, Mukhtarov et al. (2020a) investigated the impact of oil prices on REC utilizing Structural Time Series Modeling (STSM) in Azerbaijan. They reached negative impact of oil prices on REC. Also, Karacan et al. (2021) found a negative impact of oil price on REC in the case of Russia.

In the case of Kazakhstan, Mukhtarov et al. (2020b) examined the of financial development and economic growth effect on energy consumption and did not use renewable energy consumption.

As can be seen from the literature, no study investigating the impact of oil price on renewable energy consumption in Kazakhstan. Taking into account these facts, the main aim of this article is to fill in this gap by utilizing FMOLS and CCR to see the impact of oil price, income and CO_2 emissions on renewable energy consumption in the case of Kazakhstan.

3. ECONOMETRIC METHODOLOGY AND DATA

3.1. Functional Specification and Data

Following on Sadorsky (2009) and Mukhtarov et al. (2020a), in the current paper renewable energy consumption is modelled as a function of oil prices, real income in per capita terms and per capita CO_2 emissions. Namely, the functional specification used in the current article can be expressed as follow:

$$lnREC_t = \beta_0 + \beta_1 lnOP_t + \beta_2 lnGDP_t + \beta_3 lnCO_{2,t} + \varepsilon_t \quad \text{\#} \quad (1)$$

Where, REC_t denotes renewable energy consumption, OP_t denotes oil price, GDP_t denotes real GDP per capita, $CO_{2,t}$ denotes per capita carbon dioxide emissions, and ε_t is an error term. β_1, β_2, and β_3 refer to the elasticities of renewable energy consumption with respect to oil price, income and $CO_{2,t}$ emissions, respectively.

REC is a dependent variable. It is proxied by renewable energy consumption as percentage of total final energy use. The oil price (OP) is our main independent variables and proxied by US dollars per barrel. CO_2 emissions per capita are measured in kilotons (kt) of carbon dioxide. GDP per capita is proxied in US dollars at 2010 prices. The data for REC, GDP and CO_2 emissions are compiled from World Bank database (WB, 2021). The data for OP is compiled from Federal Reserve Bank of St. Louis (FRED, 2021). All variables are used as logarithmic form. The annual data period from 1992 to 2015 is used.

3.2. Econometric Methodology

As a first step, the variables are tested for stationarity features. For this purpose, The Augmented Dickey Fuller (ADF, Dickey and Fuller, 1981) unit root test is applied. As a second step, we test existence of the long-run co-movement between the used variables. For testing the cointegration relationship Engle Granger (Engle and Granger, 1987), Park' Added Variables (Park, 1992) and Hansen Parameter Instability (Hansen, 1992) tests are employed. The long-run impact of OP, GDP and CO_2 on REC is estimated utilizing the Fully Modified Ordinary Least Squares Method (FMOLS, Phillips and Hansen, 1990) and Canonical Cointegrating Regression (CCR, Park, 1992) methods.

The aforementioned methods are commonly used in large studies, we do not describe them here. Interested readers can refer to Dickey and Fuller (1981), Engle and Granger (1987), Phillips and Hansen (1990), Park (1992) and Hansen (1992), inter alia.

4. EMPIRICAL RESULTS AND DISCUSSION

As initial stage, the stationarity features of the used variables is tested by employing ADF unit root test. Results of ADF unit root test are given in Table 1. As can be seen from Table 1, all the variables are non-stationary at their levels but they are stationary at first difference. As result, the cointegration relationship between used variable can be tested.

For cointegration relationship, the Engle-Granger, Park' Added Variables and Hansen Parameter Instability cointegration tests employed and results are presented in the Table 2. The z-statistics of Engle-Granger rejects the "Series are not cointegrated" null hypothesis while tau-statistics of Engle-Granger test does not reject the null hypothesis of "Series are not cointegrated". In addition, the Park' Added Variables and Hansen Parameter Instability tests confirm that there is long-run cointegration relationship between variables.

Consequently, after approving the presences of cointegration link among the variables, the long-run effect of OP, GDP and CO_2 on REC can be estimated utilizing FMOLS and CCR techniques. The results are depicted in Table 3.

As it can be seen from the Table 3, as both significance and magnitude wise, the long-run coefficients of two techniques are statistically significant and are very close to each other. We give priority to the FMOLS model the results of which are presented in

Table 1: Results of ADF unit root tests

Variable	Panel A: Level	Panel B: 1st difference	Result
	Actual value	**Actual value**	
REC	−1.901150	−4.351000***	I(1)
OP	−1.284666	−3.458102**	I(1)
GDP	−1.534244	−3.108501**	I(1)
CO_2	−1.190461	−3.801526***	I(1)

*, ** and *** accordingly indicates rejection of null hypothesis at 10%, 5% and 1% significance levels; critical values are compiled from the table prepared by MacKinnonun (1996)

Table 2: Results of Cointegration Tests

Park's added variables test		Hansen parameter instability	
Chi-square Engle-Granger	3.0699 (0.38)	L_C statistics	0.5722 (0.17)
Tau-statistics	−3.1469 (0.23)	Z-statistics	−23.639 (0.01)

P-values are in parenthesis

Table 3: The results of FMOLS and CCR

Methods	OP	GDP	CO_2
	Coef. (Std. Er.)	Coef. (Std.Er.)	Coef. (Std. Er.)
FMOLS	−0.62*** (0.109)	1.32** (0.291)	−0.68*** (0.176)
CCR	−0.62*** (0.108)	1.34** (0.294)	−0.70*** (0.178)

The dependent variable is REC; Coef. and SE refer to coefficient and standard error; *, ** and *** denote significance levels at 10% 5% and 1%.

the first row of Table 3. The estimation results indicate that *OP* has a statistically significant and negative effect on renewable energy consumption. The results reveal that a 1% OP reduce renewable energy consumption by 0.62%. It means that an increase in oil prices decreases renewable energy consumption. Our results are consistent with outcomes of Sadorsky (2009) for G7 countries, Salim and Rafiq (2012) for China and Indonesia, and Omri and Nguyen (2014) for 64 countries, Deniz (2019) for oil exporting countries and Mukhtarov et al. (2020a) for Azerbaijan and Karacan et al. (2021) for Russsia. In addition, we reached that there is a positive and statistically significant influence from GDP to renewable energy consumption. It shows that renewable energy consumption responses by 1.32% increase to a 1% rise in GDP. The positive effect from GDP to renewable energy consumption shows that Kazakhstan uses its rising revenues toward transition to renewable sources. This result is appropriate with the traditional expectation. Additionally, a negative and statistically significant impact of CO_2 emissions on renewable energy consumption is concluded. This indicates that 1% increase in CO_2 emissions results in a 0.68% decline in renewable energy consumption.

5. CONCLUSION

The study examines the impact of oil price, GDP per capita and CO_2 emissions on renewable energy consumption. As preliminary step, we checked variables for a unit root, the results concluded their stationarity at first differenced form, thus we can test variables for common long-run trend. The Engle-Granger, Park' Added Variables and Hansen Parameter Instability tests indicated cointegration relationship among oil price, GDP per capita, CO_2 emissions and renewable energy consumption in Kazakhstan. Finally, we performed the FMOLS and CCR approaches to estimate the long-run relationship among these variables. Estimation results of FMOLS indicates that oil price and CO_2 emissions decrease REC in the long-run, namely, a 1% rise in oil price and CO_2 emissions reduce REC by 0.62% and 0.68%, respectively. On the other hand, estimation results showed the positive effect of GDP per capita on REC. The relatively higher and negative impact of oil price on REC implies that Kazakhstan continues to be plagued by high oil prices, which is slowing the transition from traditional to renewable energy sources.

The obtained negative and significant impact of CO_2 emissions on REC also approves the relative unwillingness toward renewable sources, i.e., rise in CO_2 emissions does not impulse Kazakhstan toward the environmentally friendly energy path. The study's results lead to the conclusion that diversifying the economy and achieving sustainable economic development targets should involve increasing the share of renewable energy in the energy consumption portfolio.

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