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INDUSTRIAL PRODUCTION INDEX - CRUDE OIL PRICE NEXUS: RUSSIA, KAZAKHSTAN AND AZERBAIJAN

ABSTRACT: *The study aims to examine the causality between industrial production index and crude oil price for Russia, Kazakhstan and Azerbaijan by using Frequency Domain Causality Analysis. For this purpose, the monthly data of the industrial production index and Brent oil price data over the period 1993-2019 are used. The Frequency Domain Causality Analysis suggests that the uni-directional causality relationship runs from oil prices to industrial production index is valid in the medium run for Russia and Azerbaijan and in the short run for Kazakhstan. However, there is no uni-directional causality linkage between oil prices and industrial production index in the long run for any of the countries. We hope to contribute to the literature by using frequency-domain causality test which examines the interrelation of crude oil prices on industrial production with the periodicity in these countries. The finding of this study is expected to serve as a tool for industrial production policy.*

KEY WORDS: *oil prices; industrial production index; frequency domain causality; Russia; Kazakhstan; Azerbaijan*

JEL CLASSIFICATION: C32, F41, P20

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I. INTRODUCTION

Oil, which is still the primary energy source, has important impacts on all economies as it is the crucial input for production in many sectors. It is this key role that led to immense number of researches in several aspects of crude oil, such as oil price volatility, its impact on macroeconomic indicators, international trade (export/import), etc. A crude oil price increase in countries having a significant share in the international crude oil trade may cause the Balassa-Samuelson effect (Kaplan & Aktaş, 2016) and/or the Dutch Disease effect on oil-exporting and oil-producer countries (Beck et al., 2007). The high price of non-traded goods under the influence of the Balassa-Samuelson effect leads to the expansion of the sector in which the trade is not practiced, and this causes the reallocation of resources toward the non-tradeable goods (Acosta et al., 2009). The Dutch Disease effect involves the decrease in the production of traditional industrial products due to the abundance of natural resources, the increase in industrial product prices, and therefore, the shifting of production factors to the sector that uses natural resources as inputs. As a result of both effects, differences occur in the production amount of the countries' industries or the variety of produced products. The abundance of natural resources is considered as a blessing for some countries, whereas it is perceived as a curse for some other countries (Sachs & Warner, 2001). In countries where it is considered as a blessing, the increase in production due to natural resources results in positive economic growth, while a stagnant economic growth is observed in case of a curse. In the case of resource curse concurrently with the Dutch Disease, stagnant growth emerges along with the contraction of the manufacturing industry (Kutan & Wyzan, 2005).

When it comes to the wealth of natural resources, the oil comes to mind first. Countries with fruitful oil reserves attract attention when crude oil prices tend to rise or fall as well. World Oil Reserves reached 1.664trillion barrels as of December 31, 2018 (Eni, 2019). According to Eni (2019), 49% of the world's proven oil reserves are located in the Middle East; 20% in Central South America; 13% in North America; 7% in Africa; 7% in Russia/Central Asia; 3% in the Asia-Pacific region; and 1% in European Union. Although Russia and Central Asian countries have a limited share of world reserves in terms of crude oil, these countries (especially transition countries) provide a very interesting case of study. Table 1 indicates the oil reserves in Russia and Central Asia by the end of 2019.

Table 1. Russia and Central Asia Oil Reserves (Billions Barrels)

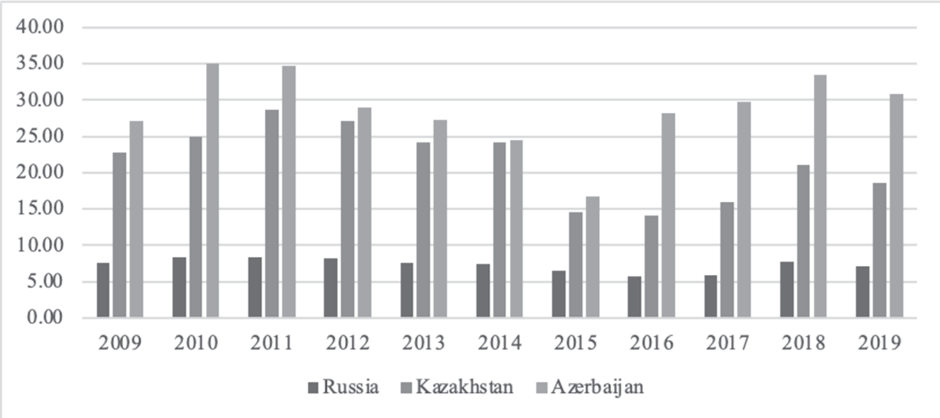
	2000	2005	2010	2015	2016	2017	2018	2019
Russia and Central Asia	**56.384**	**77.228**	**98.320**	**118.333**	**118.329**	**118.301**	**118.301**	**118.301**
Russia	48.573	60.000	60.000	80.000	80.000	80.000	80.000	80.000
Kazakhstan	5.400	9.000	30.000	30.000	30.000	30.000	30.000	30.000
Azerbaijan	1.178	7.000	7.000	7.000	7.000	7.000	7.000	7.000
Turkmenistan	546	546	600	600	600	600	600	600
Uzbekistan	594	594	594	594	594	594	594	594
Kyrgyzstan	43	40	58	64	62	49	49	49
Georgia	37	35	51	56	54	43	43	43
Tajikistan	13	12	17	19	19	15	15	15

Source: Eni (2019)

Upon analyzing Table 1 It is seen that Russia, Kazakhstan, and Azerbaijan have significant oil reserves in the related region. Russia, Kazakhstan and Azerbaijan were a member of Soviet Union. These countries have transition economies due to the collapse of the Soviet Union. During the last two decades, these countries went through significant economic transformations. However, differences in economic transformations between these countries depend on inequalities in natural resource endowments (Philippot, 2010). The crude oil played an important role in shaping the economic structures of the countries. The components of the exporters of countries are an indicator of the country's production structure. Figure 1 illustrates the data regarding the shares of oil exports of Russia, Kazakhstan, and Azerbaijan in terms of the GDP.

Upon examining Figure 1, it is seen that the shares of oil export in the GDP of Kazakhstan and Azerbaijan are quite high, except Russia. But, in the literature, there are studies on the dependencies of Russia, Kazakhstan, and Azerbaijan economies on oil revenues (Benedictow et al., 2013; Perifanis & Dagoumas, 2017; Humbatova et al., 2019; Ross, 2019). For this reason, Russia is considered to be like others in this study.

Figure 1. Oil Export (%GDP)



Source: World Bank Database and Eni (2019).

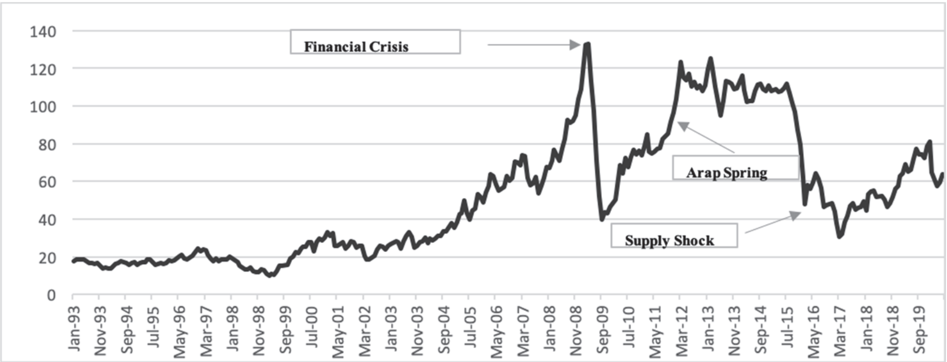
Oil exporting countries are routinely advised to diversify their economies (Ross, 2019). The excessive dependence on the crude oil sector has forced the economies of these countries, especially industrial sectors, to implement a series of economic policies to strengthen them against external shocks. Countries engaged in oil-dependent production and foreign trade are at risk of changing industrial production structures. In this context, the study aims to examine the relationship between oil prices and industrial production index for Russia, Kazakhstan, and Azerbaijan and to determine the role of crude oil price in the industrial production performance of these economies. For this purpose, we use several modern econometric tools.

The rest of the paper is organised as follows. The next section is devoted to summaries of crude oil price and industrial production index in Russia, Kazakhstan, and Azerbaijan. The third section presents a literature review. In Sections 4, econometric methodology and the data are outlined. In Section 5, the empirical findings are discussed, followed by Section 6 on the concluding remarks.

2. CRUDE OIL PRICE AND INDUSTRIAL PRODUCTION INDEX IN RUSSIA, KAZAKHSTAN, AND AZERBAIJAN

Oil exported from Europe, Africa, and the Middle East to the Western regions is particularly priced based on Brent crude oil prices. In this study, Brent crude oil price is accepted as the reference for Azerbaijan, Kazakhstan and Russian crude oil export price. Figure 2 illustrates the graphical change of Brent crude oil in US Dollars throughout the 1993-2018 period.

Figure 2. Brent Crude Oil Prices

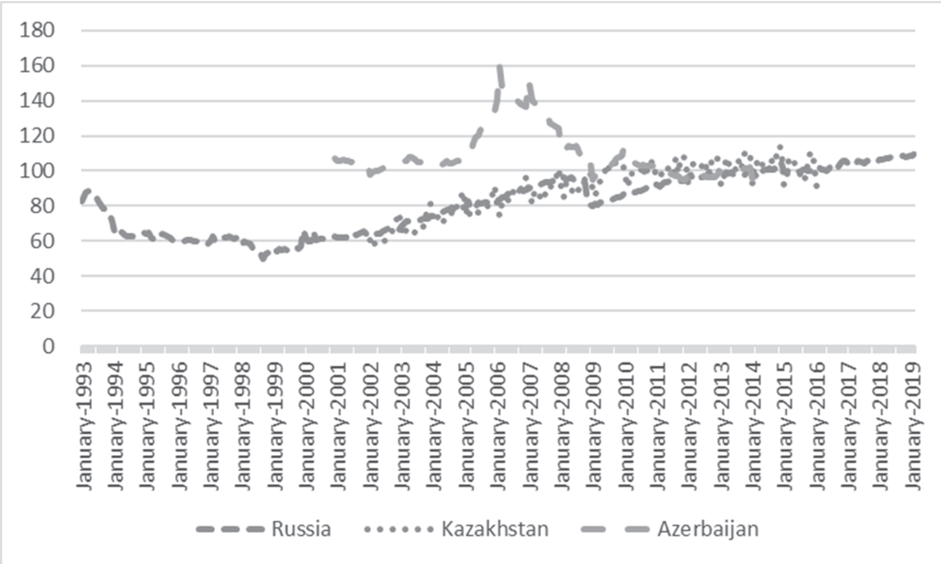


Source: U.S. Energy Information Administration Database

As can be seen in Figure 2, there have been crucial structural breaks in Brent crude oil prices during the course of the historical process. Although Brent crude oil price has increased steadily since 2003, its price increased more than twice the price of January 2004 in April 2006.Demand, supply, and speculative factors, as well as their mutual relationships, led to a steady increase in crude oil prices. The rise in demand for oil in the Far East and India, along with the security risk of the supply of crude oil to international markets, has been effective in increasing the price of crude oil until 2008. Although the global recession concerns following the 2008 financial-economic crisis caused sudden and rapid decreases in oil prices, a rapid increase was observed in oil prices after the dawn of the Arab Spring and political crises that generated a domino effect. Nevertheless, crude oil prices entered a downward trend after 2014, as major oil-producing countries in the Middle East increased their production. The drop in oil prices has led to fiscal hardships in many oil-exporting states (Ross, 2019). Following 2016, the powerful economic performance of Asian countries such as China and India increased their demand for oil, and accordingly, oil prices increased (Hassan & Zaman, 2012).

Countries with fruitful oil reserves during periods of rising oil prices have a high risk of deterioration of their industrial production structures. Because, an excessive amount of foreign exchange inflows from oil exports may increase the real wages in the country and result in the deterioration of the industrial production structure (Broz & Dubravčić, 2011). The movements of industrial production indexes of Russia, Kazakhstan and Azerbaijan over time are illustrated in Figure 3.

Figure 3. Industrial Production Index - Russia, Kazakhstan and Azerbaijan



Source: IMF, Financial Statistics Database and Central Bank of Azerbaijan Database

Upon examining Figure 3, it is seen that the industrial production indexes of Russia and Kazakhstan are in an increasing trend especially after 2002. The industrial production index of Azerbaijan first increased over the period 2005-2006, then decreased over the period 2006-2009, and then became stable after 2009. The fall in 2009 for all three countries is thought to be attributed to the global economic crisis.

Comparing Figure 2 and 3, it looks like there is not co-move between industrial production index and oil price. If we take 2008 as the starting point, there is a sharp divergence. However, we know from the literature that there can be the relationship between the industrial production index and oil price. The rise in crude oil prices increases the real income level by boosting foreign currency revenue in oil-exporting countries and results in the current account surplus. Although this situation seems positive in the short-run, it reflects negatively on the economies of the countries in the long-run (Broz & Dubravčić, 2011). The increase in oil-related revenues may disrupt the industrial structure of the country and may lead to a deterioration of the competitive position of the country's industry in the international market. Another is that the crude oil price decreases, as oil-exporting countries earn a lesser amount of foreign currency per barrel of oil. That can cause depreciation in local exchange rates and create macroeconomic imbalances, such a costly reallocation of capital and labour (Köse & Ünal, 2020). These are a weakness of oil-exporting countries.

3. LITERATURE REVIEW

There are many studies conducted on oil prices in the literature. Research on the economic consequences of oil price can be divided into two categories: those that focus on affect macroeconomic indicators and those that focus on Natural Resources Curse and/or Dutch Disease. Empirical studies conducted on the impacts of changes in oil prices on both of two categories emerged especially after the oil crises observed in the 1970s.

There are also many studies investigating the relationship between the industrial production index and oil prices (Jimenez-Rodriguez, 2007; Ekşi et al., 2011; Bayar & Kılıç, 2014). However, there are a limited number of case of studies on Russia, Kazakhstan and Azerbaijan. The studies conducted on industrial production index and oil revenues for Russia, Kazakhstan, and Azerbaijan are mostly examined within the scope of the Natural Resources Curse and/or Dutch Disease. Among those studies, Merlevede et al. (2009) determined that despite the change in oil prices, the Russian economy was vulnerable to downside price shocks and oil price swings have asymmetric effects. Therefore, Russia should reduce its vulnerability to adverse oil price shocks.

Treisman (2010) found that Russian economy was exposed to the natural resource curse. Benedictow et al. (2013) emphasised that the empirical evidence on the symptoms of the Dutch disease is mixed. While some typicalsigns of the Dutch disease such as a growing service sector and real exchange rate appreciation are observed, they may also stem from other factors (economic restructuring, economic catchingup, etc.). Dulger et al. (2013) point out that the Russian economy displays some symptoms of Dutch disease by examining the real appreciation of the ruble and deindustrialisation. According to them, the diagnosis is not certain, the risk is evident. On the other hand, Tuzova and Qayum (2016) and Kaplan (2016) observed that crude oil price fluctuations had a crucial impact on the Russian economy, and even were a determining factor in the economic contraction. Furthermore, Balashova and Serletis (2020) found domestic oil prices do Granger cause industrial production.

Among the studies conducted for Kazakhstan, Kuralbayeva et al. (2001) asserted that Kazakhstan economy wasprone to the Dutch Disease; Kutan and Wyzan (2005) and Égert and Leonard (2007) indicated that the symptoms of the Dutch Disease are observed in Kazakhstan; whereas Aliev (2015) claimed that low oil prices would harm the Kazakhstan economy if policies were not implemented regarding the Dutch Disease. More so, Köse and Baimaganbetov (2015) have argued that the size of the Dutch disease and the asymmetric effects of real Brent oil price shocks on the industrial production in Kazakhstan. They determined that the negative and positive oil price shocks had impacts on the industrial production index of Kazakhstan, whereas the appreciated exchange rate and worsening of industrial production index would have expanded the impacts of the Dutch disease.

For Azerbaijan, Hasanov (2013) emphasised that the expenditure effect of the Dutch disease is dominant in the country, whereas Aslanli (2015) emphasised that the production of the country's economy should have been diversified to avoid the Dutch disease. Karimov (2015) observed that Azerbaijan's non-oil industry was based on non-industrial sectors such as services, credit activities, construction, communications, and agriculture. Bayramov and Orujova (2017) suggested that vertical diversification should have been made in the diversification of production, which would have also taken the oil derivatives sectors into consideration. Humbatova et al. (2019) detected that Azerbaijan's economy was affected by international oil prices due to its dependence on oil revenues, although the country was a very small oil exporter.

4. METHODOLOGY

4.1 Fourier Unit Root Tests

The unit root tests developed by Dickey and Fuller (DF) (1979; 1981), Phillips and Perron (1988), Kwiatkowksi et al. (1992), Elliott et al. (1996), and Ng and Perron (2001) are considered as conventional unit root tests. The unit root tests with structural breaks came to order along with Perron (1989), and the literature on unit root tests with structural breaks gained momentum with the studies such as Zivot and Andrews (1992), Lumsdaine and Papell (1997), Perron (1997), Ng and Perron (2001), and Lee and Strazicich (2003).

In the unit root test literature, inaccurate determination of the form and number of structural breaks caused significant deterioration in the test results (Enders & Lee, 2012b). Particularly, conventional unit root tests ignore the structural changes occurring in the trend of the current series. Perron (1989) argued that the change in the trend of the series may change the unit root test result of the series. According to Perron (1989), if a series with a structural break is estimated by the conventional unit root, the probability of rejection of the null hypothesis is reduced. In other words, it is concluded that a stationary time-series is not stationary. In such a case, a faulty model created because of the number of breaks in the series, when or how it occurred would cause this break to be ignored and false results to occur. To mitigate this problem, unit root tests using the frequency component of a Fourier function close to the deterministic components of the model have been developed.

The Fourier function approach, which has taken its place in the literature along with Becker, Enders and Lee (2006), allows the accurate modeling of structural breaks when the form of structural breaks is unknown. After using the Fourier approach, the problems of determining the number of breaks and break dates are eliminated. The first test developed with the Fourier approach in the field of time-series is the Fourier Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test proposed by Becker et al. (2006). Later on, Enders and Lee (2012a) developed the Fourier ADF Test, Enders and Lee (2012b) developed the Fourier LM Test, and Rodrigues and

Taylor (2012) developed the Fourier GLS Test. The process of generating data in the KPSS type unit root test in Becker et al. (2006:382-384) is as follows:

$$y_t = X_t^{\wedge}\beta + Z_t^{\wedge}\gamma + r_t + \varepsilon_t \tag{1}$$

$$r_t = r_{t-1} + u_t \tag{2}$$

In Model 1, ε_t denotes the stationarity error term, r_t represents the time-varying deterministic component, X_t denotes a level-stationary process for y_t, Z_t denotes a break in the deterministic term, and u_t denotes an identically and independently distributed error term with variance σ_u^2. Under the null hypothesis $\sigma_u^2 = 0$. Enders and Lee (2012a) proposed a Fourier Dickey-Fuller (FDF) unit root test based on the extended Dickey-Fuller (DF) methodology. Although DF type unit root test is quite easy to use, it has been stated that the test would be useful except for nonlinear situations that result in a significant power loss (Enders & Lee, 2012a: 196). The FDF test statistic is described as follows:

$$\Delta y_t = \mathrm{p} y_{t-1} + \alpha_1 + \alpha_2 t + \alpha_3 \sin\left(\frac{2\pi kt}{T}\right) + \alpha_4 \cos\left(\frac{2\pi kt}{T}\right) + e_t \tag{3}$$

The null hypothesis of FDF type test statistics constituted in Model 3 is $\rho = 0$.

In Model 3, k represents a particular frequency, and T is the number of observations, π = 3.1416 , and e_t is the normally distributed disturbance term. All integer values of the frequency k in the model are estimated between $1 \leq k \leq 5$. The key points for the critical value of this test statistic are the sample size (T) and the value of the frequency k (Enders & Lee, 2012a: 197).

4.2. Fourier Cointegration Test

The notion of the series moving closely together in the long-run has been included in the literature by courtesy of Engle and Granger (1987). The long-term movement of the series, known as cointegration, has been in compliance with the unit root test literature. Structural breaks are considered in cointegration testing studies such as Gregory and Hansen (1999), Johansen et al. (2000), and Hatemi-J (2008), although conventional unit root tests are also taken into account. The weakness of these tests stems from the predetermined number and form of structural breaks. The Fourier approach of Tsong et al. (2016) cointegration is used in adapting the Fourier functions to the FKPSS unit root tests. The general model of the test, in which the null hypothesis suggests the presence of cointegration, is as follows Tsong et al. (2016: 1087);

$$y_t = d_t + x_t^{'}\beta + n_t,\ n_t = y_t + v_{1t},\ \gamma_t = \gamma_{t-1} + u_t,\ x_t = x_{t-1} + v_{2t} \tag{4}$$

In the model, u_t denotes an identically and independently distributed error term with zero mean and variance σ_u^2, whereas γ_t denotes a random walk with zero mean. Since the scalar v_{1t} and p-vector v_{2t} are stationary, γ_t and x_t are all the first difference stationary [I(1)] processes. The deterministic component d_t can be defined in two different ways depending on whether intercept and/or trend exists (Tsong et al., 2016: 1088):

$$d_t = \delta_0 + f_t,\quad d_t = \delta_0 + \delta_1 t + f_t \tag{5}$$

f_t, the Fourier function, is described as follows:

$$f_t = \propto_k sin\left(\frac{2k\pi t}{T}\right) + \beta_k cos\left(\frac{2k\pi t}{T}\right) \tag{6}$$

In the model, *k* denotes the number of the Fourier frequency, *t* denotes the trend, *T* denotes the number of observations. Although the data generating process is the same as in the FKPSS stationarity test, the data generating process procedure in Shin (1994) cointegration test is applied in case of $\propto_k = \beta_k = 0$. Shin cointegration test statistic is obtained as follows (Tsong et al., 2016:1092):

$$CI_f^m = T^{-2}\hat{\omega}_1^{-2}\sum_{t-1}^{T} S_t^2 \tag{7}$$

Here, $S_t = \sum_{t-1}^{T}\hat{v}_{1t}$ denotes the partial sum of the OLS residuals obtained from Model (7), whereas $\widehat{\omega_1}^2$ denotes a consistent estimator for the long-run variance of v_{1t}.

4.3. Fourier Causality Test

The Frequency-domain causality test was developed by Breitung and Candelon (2006) who improved the framework of Geweke (1982) and Hosoya (1991). The originality of this measure is that it can be applied across all periodicities (Bayat et al., 2015: 279). By using frequency-domain causality test, one can get to know exactly for which periodicity (e.g., in the short run, in the medium term and in the long run) one variable can (granger) cause the other.

Breitung and Candelon (2006) analysis is based on 2x2 lagged polynomial model. The model is as follows: For $\theta_{ij}(\mathrm{L}) = \theta_{ij},1\ \mathrm{L}0 + \cdots + \theta_{ij},\mathrm{p\ L\ p}-1\ \mathrm{i},\ \mathrm{j} = 1, 2$ and $[\mathrm{ut},\ \mathrm{vt}]' \sim (0,\ \Sigma)$ given as independent variables, $[\mathrm{xt},\ \mathrm{yt}]'$ VAR(p) model is described as follows:

$$\begin{bmatrix} x_t \\ y_t \end{bmatrix} = \begin{bmatrix} \theta_{11}(L) & \theta_{12}(L) \\ \theta_{21}(\mathrm{L}) & \theta_{22}(L) \end{bmatrix} \begin{bmatrix} x_{t-1} \\ y_{t-1} \end{bmatrix} + \begin{bmatrix} u_t \\ v_t \end{bmatrix} = \begin{bmatrix} \psi_{11}(L) & \psi_{12}(L) \\ \psi_{21}(L) & \psi_{22}(L) \end{bmatrix} \begin{bmatrix} \varepsilon & t \\ \eta & t \end{bmatrix}, \mathrm{t} = 1,\ldots,\mathrm{T}, \tag{8}$$

As to the causality relationship:

$$M_{y\to x}(\omega_0) = log\left[\frac{2\pi f_x(\omega_0)}{\left|\psi_{11}\left(e^{-i\omega 0}\right)\right|^2}\right] = log\left[1 + \frac{\left|\psi_{12}\left(e^{-i\omega 0}\right)\right|^2}{\left|\psi_{11}\left(e^{-i\omega 0}\right)\right|^2}\right]. \tag{9}$$

If $M_{y\to x}(\omega_0) = 0$, there is no causality between y and x.

$$\mathbf{R} = \begin{bmatrix} cos_{(\omega 0)} \cdots & cos_{(\mathrm{p}\omega 0)} \\ sin_{(\omega 0)} & sin_{(\mathrm{p}\omega 0)} \end{bmatrix} \tag{10}$$

Breitung and Candelon (2006) are tested with the equation $M_{y\to x}(\omega_0) = 0$ and the hypothesis $H_0 : \mathrm{R}\beta = 0$.

5. EMPIRICAL FINDINGS

In the study, the causal relationship between the industrial production index and crude oil prices is investigated using the industrial production index (IPI) and the

Brent Oil Price (OP) series of each country. We focus on the relationship between the price of oil and industrial production on the grounds that monthly frequency is likely to be more prevalent in industrial production data than in quarterly GDP data. In addition, we assumed that causality running from crude oil prices to industrial production index. This is because the oil price fluctuations do affect individually industrial production of coutries, otherwise it does not affect.

Industrial production index data are obtained from the International Financial Statistics database of the IMF for Russia and Kazakhstan, and from the Central Bank of Azerbaijan for Azerbaijan. Brent type oil prices are obtained from the U.S. Energy Information Administration database. We assumed that Brent crude oil price is accepted as the reference for Azerbaijan, Kazakhstan and Russian crude oil export price. This is because the european region is particularly priced based on Brent crude oil prices and these countires are in influence area of european energy market.

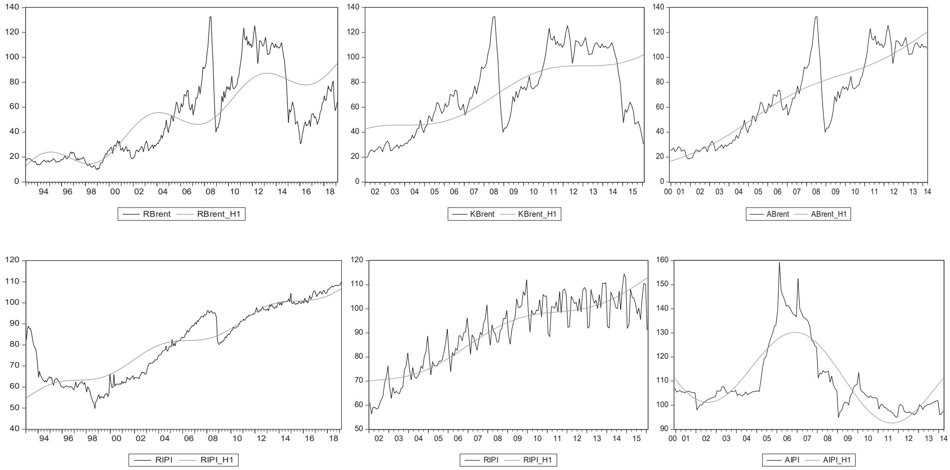
The data used in the analysis are in monthly frequency covering the period between January 1993- February 2019 for Russia, January 2002- January 2016 for Kazakhstan, and December 2000- March 2014 for Azerbaijan. Descriptive statistics are given in Table 2.

Table 2. Descriptive Statistics

Country	Time span	Variable	Mean	Std. dev.	Skewness	Kurtosis
Russia	1993:01-2019:01	RIPI	86.028	10.117	-0.589	2.2829
		RBrent	51.87140	33.603	0.634	2.174
Kazakhstan	2002:01-2016:01	KIPI	88.426	14.310	-0.404	2.188
		KBrent	71.53444	31.237	0.094	1.758
Azerbaijan	2000:12-2014:03	AIPI	110.040	14.701	1.373	3.789
		ABrent	109.6791	14.140	1.490	4.212

Upon examining Table 2, it is seen that the series exhibit a distribution having Kurtosis statistic similar to the normal distribution. The necessary transformations are made to determine the movements of the series according to the Fourier functions. All series are transformed using [sin(2πkt /T), cos(2πkt /T)] functions. All series are illustrated in Figure 4.

Figure 4. Variables and the Fourier Functions



Note: The time-varying intercepts are plotted by red line.

Upon examining Figure 4, it is seen that the Fourier estimates are reasonable and they capture long fluctuations in the series.

Stationarity analyses of the series used in the research model are performed using the Fourier Kwiatkowski-Phillips-Schmidt-Shin (KPSS) Test proposed by Becker et al. (2006) and the Fourier Augmented Dickey-Fuller (FADF) unit root test recommended by Enders and Lee (2012a). Unit Root Test results are given in Table 3.

Table 3. Results for Unit Root Test

Level	Country	Variable	Fourier ADF		Fourier KPSS	
Intercept	Russia	RIPI	-0.49	(2)	5.01	(1)
		RBrent	-3.77***	(1)	0.71	(1)
	Kazakhstan	KIPI	-2.67***	(5)	3.36	(1)
		KBrent	-2.73	(1)	0.97	(1)
	Azerbaijan	AIPI	-3.32	(1)	0.50	(1)
		ABrent	-1.26	(4)	2.90	(1)
Intercept and trend	Russia	RIPI	-2.91	(2)	0.97	(1)
		RBrent	-3.80	(1)	0.41	(1)
	Kazakhstan	KIPI	-3.19	(1)	0.06	(1)
		KBrent	-2.18	(1)	0.42	(1)
	Azerbaijan	AIPI	-3.48	(1)	0.47	(1)
		ABrent	-3.62***	(4)	0.27	(4)
First-differences						
Intercept	Russia	RIPI	-5,58*	(2)	0.02*	(2)
		RBrent	-5.06*	(3)	0.35***	(3)
	Kazakhstan	KIPI	-4.65*	(3)	0.14*	(3)
		KBrent	-3.55*	(1)	0.07*	(1)
	Azerbaijan	AIPI	-5.36*	(1)	0.09*	(5)
		ABrent	-4.66*	(1)	0.01*	(1)
Intercept and trend	Russia	RIPI	-5.58*	(2)	0.02*	(2)
		RBrent	-5.74*	(3)	0.05*	(3)
	Kazakhstan	KIPI	-4.76*	(3)	0.03*	(3)
		KBrent	-4.80*	(4)	0.01*	(4)
	Azerbaijan	AIPI	-5.12*	(5)	0.01*	(5)
		ABrent	-4.88*	(4)	0.01*	(4)

Note: ***, **, and * denote statistical significance at the 1%, 5%, and 10% level of significance, respectively. The values in the parentheses indicate the Fourier numer

According to the unit root analysis results, it is observed that all variables contain unit root in the level values except for the model of ABrent variable with intercept and trend, the model of IPI variable with intercept, and the model of RBrent variable with intercept. For this reason, first-order differences of the series are taken and stationarity analyses are performed again. In the performed analyses, it is observed that all series are stationary in the first-order differences according to the model estimations with intercept and with intercept and trend. The cointegration test is conducted with the idea that the series move closely together in the long-run and the results are presented in Table 4.

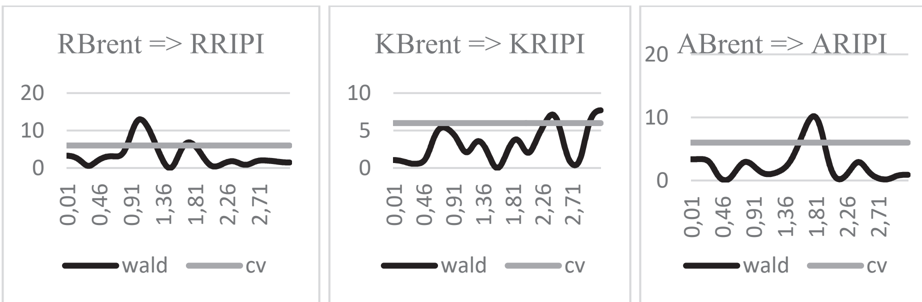
Table 4. Cointegration Test Results

	Frequency	Min KKT	Fourier Cointegration Stat.	C.V.		
				1%	5%	10%
Russia	2	15701.87	0.06*	0.21	0.13	0.09
Kazakhstan	1	4651.00	0.09**	0.13	0.07	0.05
Azerbaijan	3	9855.97	0.08*	0.25	0.14	0.11

Note: ***, **, and * denote statistical significance at the 1%, 5%, and 10% level of significance, respectively.

Table 4 presents the FKPSS cointegration test results. The test results reveal insignificant test statistics for all countries, in other words, cointegration exists between the industrial production index and oil prices. These obtained results indicate that sudden changes in oil prices have a long-term impact on the industrial production index. The causal relationship between the variables is analysed by performing the Frequency Domain Causality test and the results are illustrated in Figure 5.

Figure 5. Frequency Domain Causality Test Results**.**



Note: The lag lengths for the VAR models are determined by SIC. The critical values are plotted by red line.

The test statistics are calculated at a high frequency of wald = 2.5 and wald= 2.0 to examine short-term causality, wald = 1.00 and wald = 1.50 to examine medium-term causality and finally wald = 0.01 and wald = 0.05 to investigate long-term causality. The critical values according to asignificance level of 0.05.

As seen in Figure 5, there is no uni-directional causality relationship in the long run and short run, whereas there is a medium-term causality running from oil prices to the industrial production index in Russia according to the frequency domain causality test results. For Kazakhstan, frequency domain causality is from oil prices to the industrial production index in the short-run, whereas there is no long-term and medium-term uni-directional causality relationship. For Azerbaijan, the medium-term uni-directional causality is directed from oil prices to the industrial production index, whereas there is no short-term and long-term uni-directional causality relationship.

These results imply that there is no uni-directional causality linkage between oil prices and industrial production index on long term period in the case of all countries. On the other hand, the uni-directional causality relationship runs from oil prices to industrial production index is valid in the medium run for Russia and Azerbaijan and in the short run for Kazakhstan. However, the literature mainly considers the effects of crude oil prices on the industrial production in these countries. We hope to contribute to the literature by using frequency-domain causality test which examines the interrelation of crude oil prices on industrial production with the periodicity in these countries

According to The U.S. Energy Information Administration Reports, Russia is third country, Azerbaijan is 24 th country and Kazakhstan is 16 th country in the largest producers of crude oil list. The main use of oil revenues in the fund is public expenditures in these countries (Bradshaw et al., 2019). The public expenditures affect on economic activity, considering industrial production. Increasing in public expenditures increases the industrial production, otherwise the opposite happens. So that, the oil price fluctuation may create macroeconomic imbalances in the medium run for Russia and Azerbaijan and in the short run for Kazakhstan.

6. CONCLUSIONS

Following the oil shock in 1973, there had been a rapid increase in the number of studies investigating the causal relationship between oil prices and macroeconomic variables. Among these, the relationship between oil prices and the industrial production index was examined in a very limited number of studies for transitions countries. Pooling 3 nations together as transitions countries, Russia, Kazakhstan, and Azerbaijan, in one sample is due to their geographical proximity and common past. Along with that, they are at present face very similar political, economic, and social concerns. Current research mainly concentrates on Russia, as a core part of sample with much more available data for analysis. However, data are obtained for Kazakhstan and Azerbaijan, and we investigated.

In this study, in which oil prices and industrial production index are investigated, new conclusions on the subject are drawn. Upon considering the data of Russia, Kazakhstan, and Azerbaijan, it is seen that the series have smooth transitional fluctuations. To obtain robust results from the analysis of the study, very up-to-date econometric methods that take into account the smooth fluctuations of the series are used. In this context, unit root analyses that take the smooth fluctuations of the series into consideration are performed with the FKPSS and the FADF Unit Root Tests, and it is assumed that the variables contain unit root at the level. By taking the first-order differences of the series, these tests are repeated and all series are detected to be stationary. The FKPSS Cointegration Tests, which take into account the smooth transitional structures of the series along with the notion that the series move closely together in the long-run, are performed and it is determined that the series move closely together in the long-run. Consequently, by conducting the Frequency Domain Causality Analysis suggested by Breitung and Candelon, a causal relationship between the series is revealed. The main advantage of frequency domain analysis is to be able to analyze the whole period into different frequencies and it gives more robust results. According to the obtained analysis results, while the medium-term causal relationship from oil prices to the industrial production index is valid for Russia and Azerbaijan, such a causal relationship is valid for Kazakhstan in the short term. Notwithstanding oil exports of Kazakhstan are dependent on international crude oil prices, as well as Russia and Azerbaijan, they differ from the others in terms of the frequency domain causal relationship results.

Upon overall examination, although international oil prices have direct or indirect impacts on national economies, it is seen that the magnitude of such impacts, in general, depends on the countries' dependence on crude oil and/or the shares of crude oil revenues/expenses in national incomes. Although sudden increases in oil prices have a positive impact on the economy in the short-run, conducted studies indicate that such impact is very limited. The countries' policymakers take measures for improving development in other areas of the economy by reducing the dependence on oil and oil-related products. These countries seem to confirm this situation, especially in their strategic plans implemented for the future in recent years.

The results abound in the literature and show that the Russia, Kazakhstan and Azerbaijan economies are vulnerable to large fluctuations in the oil price. Our results are in general consistent with the recent studies. Relative to previous studies on Russia, Kazakhstan and Azerbaijan, this is the first study, to the best of our knowledge, that examine the causality between industrial production index and crude oil price by Frequency Domain Causality Analysis.The finding of this study is expected to serve as a tool for industrial production policy in the medium run and short run in these countries.

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