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Econometric Analysis of Effect of Oil Price Change, Trade Balance and other Variables on Inflation

Serikbay Ydyrys[1]*, Malika Munasipova[2], Kanat Ydyrys[3], Mariyam Ydyrys[4], Lyazzat Mukhambetova[5], Guldana Temirbayeva[6]

[1]Department of Economics and Finance, Akhmet Yassawi International Kazakh-Turkish University, Turkistan, Kazakhstan, [2]Department of Economics and Finance, Akhmet Yassawi International Kazakh-Turkish University, Turkistan, Kazakhstan, [3]Department of International Relations, Akhmet Yassawi International Kazakh-Turkish University, Turkistan, Kazakhstan, [4]Graduate School of Public Policy, Nazarbayev University, Turkistan, Kazakhstan, [5]Kazakh University of Economics, Finance and International Trade, Turkistan, Kazakhstan, [6]Department of Management, Akhmet Yassawi International Kazakh-Turkish University, Turkistan, Kazakhstan. *Email: serikbay-s@mail.ru

ABSTRACT

In this paper, we study the impact of fluctuations in global oil prices on inflation. For the purpose of finding out the effect of oil price on inflation rate, we have compared the data for the US and Russia by controlling for exchange, interest and growth rates, imports and exports, and money supply. The analysis covers quarterly data for period between 1999Q1 and 2014Q4. Ordinary least squares and FGLS models are used by estimating them with Newey-West standard errors. The expected statistically significant positive effect of oil price on inflation rate was observed only for the US. However, the estimated effect for Russia was negative, though it was statistically insignificant. For the US, we found that a 10% increase in global oil priceincreases domestic inflation by about 3 percentage point. The impact of oil price shocks, however, has declined over time due in large part to a better conduct of monetary policy.

Keywords: Econometric Analyses, Oil Price, Trade Balance, Inflation, USA, Russia
JEL Classifications: E31, Q37, Q4

1. INTRODUCTION

Oil price has experienced significant fluctuations from the start of the millennia leading to changes in international economies, because its effect is not limited to energy markets. Oil price affects the cost of production, which in turn influences employment level, output and inflation through prices. There are significant amount of literature that studied the empirical relationship between oil price and important macroeconomic variables, such as inflation. Nevertheless, the results have been often contradictory and inconclusive . The goal of this research is to add to the literature in the area, by empirically investigating the effect of changes in oil price on inflation for the United States and Russia. Also, the effect of oil price shock will be compared with effects of other variables such as exchange rate, import and export. For this purposes, time series Ordinary least squares (OLS) and FGLS models were used. The analysis covers quarterly data for period between 1999Q1 and 2014Q4.

Inflation time series is among the most scrutinized macroeconomic series in economic research literature. This is natural considering the fact that inflation rate is crucial for macroeconomic policies. Inflation rate characterizes the general health and competitiveness of a country's economy (Charfeddine and Guegan, 2005). Number of studies confirms that there are observable changes in inflation process in the world in recent decade due to more effective monetary policies and increased effect of global factors, which encompass imports and oil price level (Simionescu, 2015). So, it is crucial to identify valid explanatory variables for the time series regression analysis.

2. LITERATURE REVIEW

Oil price fluctuation can be a severe supply shock affecting macroeconomic variables. Changes in oil prices may affect inflation through different channels. Oil is an important input in the economy. It is heavily used in many sectors of economy such as transportation, manufacturing. Subsequently, changes in the price of input, which is oil in our case, will affect cost of production. This cost can be passed on to consumers, and reflected in change of consumer price index (CPI) (Neely, 2015). The significant effect of oil price change on inflation was identified by a lot of researchers (Cunado and Gracia, 2004). Among other studies, Simionescu (2015) identifies oil price as an important determinant of inflation for post 2008 crisis period through stochastic search variable selection. Neely (2015) argues that daily oil price changes explain quite large variation in breakeven inflation.

According to historical data, during the 1970s the price of crude oil rose from $3/bbl to $40/bbl. This resulted in increase of CPI in the US from 41.10 to 86.30. Similar significant effect on inflation level was followed by oil price shock happened in the 2000s, when oil price rose from $15/bbl in 1998 to $140/bbl in 2008 (Sek et al., 2015). However, there was not any strong correlation between oil price movement and inflation rate in mid 1980s in the US (Sek et al., 2015). That is, the relationship between oil price and inflation is not constant and may change over time. Also, the effect of oil price shock on inflation is different for different countries. Castro et al., 2016) state that oil prices' inflationary effect reduced since 1980s for Eurozone. Several studies endeavored to explain the issue of non-constant relationship between oil price shock and inflation. Blanchard and Gali (2007) state that the relationship between oil price shock and inflation may weaken due to low oil production share, better execution of monetary policies, "flexible labor markets." The other reason for weak correlation may be that the production has become more energy efficient Sek et al., 2015.

Different studies employ different methodologies to model the relationship between inflation and oil price. Modeling inflation for India, Saxena and Singh (2015) tested data for unit root, performed Granger Causality test to identify if explanatory variables are good at forecasting inflation, and run OLS regression. Karadzic (2014) also uses OLS technique on time series data to estimate inflation in Montenegro. The author used unemployment rate, gross domestic product (GDP), import to export ratio as explanatory variables. After performing stationarity, co-integration tests, she uses differenced log of GDP and level units for other variables for regression. Among diagnostic tests, RESET, serial correlation tests were run. Many other researches use more sophisticated models such as vector autoregressive model (VAR), transfer function model (Castro et al., 2016). Also, unit root and granger causality tests, co-integration tests are widely in the relevant literature.

The literature on the effect of oil price shock on inflation for the US and OECD countries far outnumber studies on this topic for other regions (Cunado and Gracia, 2004). So, the relationship is little investigated for Russian Federation. Russia and the USA are among top oil producers in the world, producing 10.4 and 11.11 million barrels per day, respectively. Regarding imports, Russia import 16380 billion barrels per day, while the US imports 9.21 billion barrels daily, which is more than 500 times higher than Russia. The US exports 41640 barrels and Russia export 4.69 million barrels per day (110 times more than US) (CIA World FactBook). This makes the USA net importer of oil, and Russia net exporter of oil. This is one of the reasons for this particular choice of the two countries for examination. It will help us to compare the effects for net importer and exporter of oil. Also, both countries display high levels of oil consumption, which is 3493 K. barrels per day for Russia and 18961 K. barrels per day) (US Energy Information Administration, 2013).

3. METHODOLOGY AND DATA

For the purposes of the current research, we will estimate single equation model by OLS method. We estimate the model on quarterly data. Time series data for the period 1999–2014 was used. For the period under examination, Russian experienced a transition towards market economy, which had a significant effect on many macroeconomic variables.

$Y=f(x_1, x_2, x_3, x_4, x_5, x_6, x_7, x_8)$

The definitions of variables are presented in Table 1.

Explanatory variables selection was based on the results of the following studies. First, we referred to a study by Simionescu, which identified "the unemployment rate, the exchange rate, crude oil prices, the trade weighted U.S. Dollar Index and the M2 Money Stock" as significant determinants for the US inflation rate (2015. p. 171). Secondly, we selected among the explanatory variables presented in the studies by Saxena and Singh (2015) and Karadzic (2014). In this study, we focus our analyses on comparing the

Table 1: Variables

Variable Name		Data Source
Dependent Variable		
Y - Growth rate of consumer price index (CPI)	inf	Data.oecd.org
Explanatory Variables		
X_1 - Crude oil price in USD per barrel (WTI)	oilprice	research.stlouisfed.org
X_2 - Unemployment rate,	unem	Data.oecd.org
X_3 - GDP growth rate (% per year),	gdpgrowth	Data.oecd.org
X_4 – Exports (in US dollars)	exp	research.stlouisfed.org
X_5 - Imports (in US dollars)	imp	research.stlouisfed.org
X_6 – Money supply (M2) (in national currency)	m2	research.stlouisfed.org
X_7 - Nominal exchange rate,	fxrate	research.stlouisfed.org
X_8 - Short term Interest rate	intrate	Data.oecd.org

effects of oil price changes on domestic inflation between high-income OECD countries versus high-income non OECD country.

4. EMPIRICAL RESULTS

4.1. Testing for Stationarity

Unlike cross-sectional data, the data involving time series is increasingly susceptible to problems arising from the persistent nature of some series over a long period. Two strongly dependent time series tend to be closely related to each other in spite of being independent of one another, thereby grossly overestimating the value of R^2 and resulting in both inconsistent and biased estimations. To avoid this spurious regression problem, any highly persistent process must be identified and transformed into a weakly dependent time series, as conventional OLS inference procedures are valid and justified only under the assumption of weakly dependence. Along with many other time series that could be characterized by strong dependence, inflation can be considered as a highly persistent time series. To check whether it is the case, the First Order Autocorrelations of the inflation rates and all the explanatory variables are derived (Table 2).

Table 3 illustrates very strong persistence for all of the variables listed except GDP growth rate. This is not surprising given the fact that macroeconomic indicators change only slightly between consecutive quarters. As both dependent and independent variables (except GDP growth rate) are clearly characterized by random walk, the analysis involving these variables in the original forms will result in a spurious regression. Though correlation for inflation rate is not as high as for the other variables, its size is not negligible and it is unlikely that the series involving inflation rate is weakly dependent.

Table 2: First Order Autocorrelations of the inflation rate and the explanatory variables for the USA and Russia.

	USA	Russia
Variable	First Lag	First Lag
Inflation rate	0.7407	0.9365
Oil Price	0.9344	0.9344
Unemployment rate	0.8286	0.9696
GDP growth rate	0.3719	0.6095
Exports	0.9910	0.9792
Imports	0.9828	0.9503
Money Supply (M2)	0.9995	0.9989
Foreign Exchange rate	0.9236	0.8459
Interest rate	0.9728	0.8310

Assuming that inflation rate is an integrated of order one I(1) process, we may infer that the first difference of the series is weakly dependent and stationary. Therefore, we can use the first difference of inflation rate as a dependent variable and the first differences of the explanatory variables except the GDP growth rate to run the regression model that is slightly more easier to interpret than the first difference model:

$$cinf=\beta_0+\beta_1 coilprice+\beta_2 cunem+\beta_3 gdpgrowth+\beta_4 cexp+\beta_5 cimp+\beta_6 cm^2+\beta_7 cfxrate+\beta_8 cintrate$$

Despite being easy to interpret, the estimated model does not take into account the serial correlation that might be present in the errors. Therefore, though we have found that the effect of first difference of oil price on first difference of inflation is statistically significant, the inference may be false if the errors are serially correlated. To check if there is serial correlation, we need to estimate the same model using Newey-West standard errors (Table 4). We conclude that errors include serial correlation if the two different standard errors estimated will differ considerably from each other.

From Table 5, estimated Newey–West standard errors are smaller than the ones estimated using previous model. As standard errors decreased, t-statistics increased considerably; hence, increasing statistical significance of the effect of oil price on inflation rate. The difference between the two standard errors suggests that, indeed, there is a serial correlation. In this case FGLS estimation is used to correct for the serial correlation present. Prais-Winsten method is used to derive the estimates corrected for the serial correlation. Though t-statistics and statistical significance as a whole of the variables slightly decreased compared to the OLS estimation, we prefer to rely more on the estimates of the Prais–Winsten estimation. This is due to the fact that in the presence of serial correlation the conditions under which estimators are normally distributed asymptotically are no longer satisfied. Hence, we place greater value on the ability to make statistical inference relying on the approximate normal distribution of the estimator.

We use the same estimation techniques to estimate the effect of oil price on the inflation rate. First having found the first order autocorrelation for all of the variables, we have decided to use first difference of inflation rate as a dependent variable and take the first difference of all of the variables except GDP growth rate (Table 6).

Table 3: Results of OLS Estimation: US case

cinf	Coefficient	St. error	t-statistic	p-value	R-squared	Number of obs	F (8, 50)
coilprice	0.0305868	0.0112218	2.73	0.009	0,5876	63	9.62
cunem	0.0707398	0.0641886	1.10	0.275			
gdpgrowth	-0.0143916	0.1611629	-0.09	0.929			
cexp	-1.22e-11	1.81e-11	-0.68	0.501			
cimp	3.21e-11	1.00e-11	3.19	0.002			
cm2	2.17e-12	1.27e-12	1.71	0.093			
cfxrate	-2.203006	1.523989	-1.45	0.154			
cintrate	0.0370195	0.189046	0.20	0.845			
_cons	-0.4082855	0.1892718	-2.16	0.035			

Table 4: Results of Regression with Newey-West st. errors: US case

cinf	Coefficient	Newey-West St. error	t-statistic	p-value	Prob>F	Number of obs	F (5, 54)
coilprice	0.0305868	0.0082515	3.71	0.000	0.0000	63	9.21
cunem	0.0707398	0.0238709	2.96	0.005			
gdpgrowth	-0.0143916	0.1147891	-0.13	0.901			
cexp	-1.22e-11	1.36e-11	-0.90	0.373			
cimp	3.21e-11	6.30e-12	5.10	0.000			
cm2	2.17e-12	1.17e-12	1.85	0.070			
cfxrate	-2.203006	1.716108	-1.28	0.205			
cintrate	0.0370195	0.1521661	0.24	0.809			
_cons	-0.4082855	0.1886043	-2.16	0.035			

Table 5: Results of Prais-Winsten Estimation: US case

cinf	Coefficient	St. error	t-statistic	p-value	R-squared	Number of obs	F (8, 54)
coilprice	0.0271935	0.0111373	2.44	0.018	0.6234	63	11.18
cunem	0.0794013	0.0676064	1.17	0.245			
gdpgrowth	-0.0283737	0.1560328	-0.18	0.856			
cexp	-1.48e-11	1.75e-11	-0.85	0.401			
cimp	3.48e-11	9.93e-12	3.50	0.001			
cm2	2.01e-12	1.19e-12	1.69	0.097			
cfxrate	-2.202506	1.418033	-1.55	0.126			
cintrate	0.0294884	0.1767827	0.17	0.868			
_cons	-0.3873865	0.1784026	-2.17	0.034			

Table 6: Results of OLS Estimation: Russia case

cinf	Coefficient	St. error	t-statistic	p-value	R-squared	Number of obs	F (8, 54)
coilprice	-0.0781731	0.1617685	-0.48	0.631	0.1626	63	1.31
cunem	1.647191	2.258399	0.73	0.469			
gdpgrowth	-1.770595	1.062749	-1.67	0.101			
cexp	3.55e-11	2.54e-10	0.14	0.890			
cimp	8.14e-11	1.26e-10	0.65	0.520			
cm2	3.10e-12	2.31e-12	1.34	0.187			
cfxrate	-0.1892923	0.6689456	-0.28	0.778			
cintrate	-0.9165388	0.4238599	-2.16	0.035			
_cons	-1.011855	1.74418	-0.58	0.564			

Using the following model results have been derived for Russia:

$$cinf=\beta_0+\beta_1 coilprice+\beta_2 cunem+\beta_3 gdpgrowth+\beta_4 cexp+\beta_5 cimp+\beta_6 cm^2+\beta_7 cfxrate+\beta_8 cintrate$$

From Table 7, unlike the US case, there is no statistically significant effect of the change in the price of oil on the change in the inflation rate. However, the main discrepancy between the two is their opposite signs. The estimated negative sign is not what we would expectand is contrary to economic theories. However, the change in short-term interest rates has a statistically significant effect on change in inflation rate. Though it is worth to mention this relationship, it is not of much relevance to our topic of interest. One explanation for the lack of statistical significance may be the presence of serial correlation in the errors. To test this hypothesis, we again estimate the OLS regression, but now using Newey-West standard errors instead. The output did not yield the positive results, as even after using Newey-West standard errors, t-statistics did not increase much and are statistically insignificant at any conventional significance levels. Though t-statistics did not change much, there are still moderate differences between the two different types of standard errors, which clearly indicates the presence of serial correlation and underlines the need for FGLS estimation.

Table 8 shows that the use of Prais-Winsten method to correct for the serial correlation yielded more promising results. Particularly, t-statistics for the variables coil price, cunem and cintrate have increased considerably but are still not significant. We would not expect the estimation to become significant, since it would go contrary to theories. This might suggest that part of the cause of statistical insignificance of coilprice found in OLS regression was indeed serial correlation. This also illustrates that there are some other factors resulting in insignificance of coil price.

5. CONCLUSION

Recent oil price shocks have affected numerous of oil producing countries and had a considerable negative effect on inflation rate to the extent that some countries experienced levels of inflation peculiar to 1970s. One of the countries struck by the oil price shock is Kazakhstan and is what induced us to implement this project at the first place. Due to the fact that there is no enough information regarding the macroeconomic variables for Kazakhstan, Russia seemed to be the country close in its dependence to crude oil and the level of production to Kazakhstan. For the purpose of finding out the effect of oil price on inflation rate and how

Table 7: Results of Regression with Newey-West st. errors: Russia case

cinf	Coefficient	Newey-West St. error	t-statistic	p-value	Prob>F	Number of obs	F (5, 54)
coilprice	-0.0781731	0.1316474	-0.59	0.555	0.8303	63	0.42
cunem	1.647191	1.870506	0.88	0.382			
gdpgrowth	-1.770595	1.471545	-1.20	0.234			
cexp	3.55e-11	7.69e-11	0.46	0.646			
cimp	8.14e-11	6.01e-11	1.35	0.181			
cm2	3.10e-12	3.11e-12	1.00	0.324			
cfxrate	-0.1892923	0.5722244	-0.33	0.742			
cintrate	-0.9165388	0.9446454	-0.97	0.336			
_cons	-1.011855	1.45804	-0.69	0.491			

Table 8: Results of Prais-Winsten Estimation: Russia case

cinf	Coefficient	St. error	t-statistic	p-value	R-squared	Number of obs	F (8, 54)
coilprice	-0.132122	0.0962825	-1.37	0.176	0.3179	63	3.15
cunem	-2.214041	1.372863	-1.61	0.113			
gdpgrowth	-0.543656	0.9210376	-0.59	0.557			
cexp	2.40e-11	1.64e-10	0.15	0.884			
cimp	4.15e-11	6.97e-11	0.59	0.554			
cm2	-1.95e-12	2.47e-12	-0.79	0.434			
cfxrate	0.5155891	0.4715438	1.09	0.279			
cintrate	-1.495043	0.3049255	-4.90	0.000			
_cons	-0.6652663	2.950798	-0.23	0.822			

this effect changes over countries depending on their different macroeconomic indicators, we have compared the data for the US and Russia.

The estimation results yielded outcomes unexpected prior to the study. The expected positive effect of oil price on inflation rate was observed only for the US, while the estimated effect for Russia was negative, though it was statistically insignificant. This insignificance is due to the fact that numerous economic factors, direct and indirect ones result in a positive relationship between oil price and inflation. One possible cause for the estimated negative sign may be incorrect functional form of the variables. However, this possibility would have resulted in unexpected signs for both of the countries, not only one, as we have used the same model for estimation. Even though, we have not derived statistically significant expected results for Russia, we still produced statistically significant outcome for the US which is substantiated with other literature available in this area.

REFERENCES

Blanchard, O., Galí, J. (2007), The macroeconomic effects of oil price shocks: Why are the 2000s so Different from the 1970s? SSRN Electronic Journal, 8, 435-441.

Castro, C., Jerez, M., Barge-Gil, A. (2016), The deflationary effect of oil prices in the euro area. Energy Economics, 56, 389-397.

Cunado, J., Perez de Gracia, F. (2005), Oil prices, economic activity and inflation: Evidence for some Asian countries. The Quarterly Review of Economics and Finance, 45(1), 65-83.

Guegan, D., Lanouar, C. (2005), Can the Sup Lr test discriminate between different switching regression models: Application to the US GNP and the UK/US Exchange Rate. SSRN Electronic Journal, 14. DOI: 10.2139/ssrn.897954.

Karadzic, V. (2014), A regression model of inflation in montenegro. Montenegrin Journal of Economics, 2(10), 103-110.

Neely, C. (2015), How much do oil prices affect inflation? Economic Synopses, 2015, 10.

Saxena, S., Shanker, I. (2016), Dynamics of external debt and capital flight in India. Scholedge International Journal of Management Development, 3(2), 49-60.

Sek, S., Teo, X., Wong, Y. (2015), A comparative study on the effects of oil price changes on inflation. Procedia Economics And Finance, 26, 630-636.

Simionescu, M. (2015), The Identification of Inflation Rate Determinants In The USA Using The Stochastic Search Variable Selection. CES Working Papers, 8(1). Available from: https://www.ideas.repec.org/a/jes/wpaper/y2016v8i1p171-181.html.

U.S. Energy Information Administration (EIA). (2017), Available from: https://www.eia.gov.