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The Relationship between Oil Prices and Inflation in Oil İmporting Countries (1980-2022)

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ABSTRACT

The increase in the price of oil, which is an important input in production, decreases the level of output, causes cost inflation and generally affects the economy negatively. In oil-importing countries, it leads to an increase in costs and a decrease in competitiveness in international trade, thus negatively affecting the balance of payments. The aim of this research is to investigate the relationships between oil price and inflation by using quarterly data between 1980Q1 and 2022Q4 in oil importing countries. In addition, it is aimed to determine the contribution of the GDP and unemployment rate variables, which are widely used in explaining inflation, as well as the inflationary effects of oil prices. According to the results of the study, the effect of oil prices on inflation differs from country to country. It is observed that Italy and France are the most affected countries.

Keywords: Oil Price, Oil İmporting Countries, İnflation, Panel Cointegration
JEL Classifications: C23, G15, Q40.

1. INTRODUCTION

The increase in the consumption of energy, which is the most strategic input of the modern world economy, leads to economic productivity and industrial growth. From an empirical point of view, Hamilton (1983, 1996) states that oil prices have increased with a delay of about three quarters of a year before almost all recessions in the US economy since the Second World War, while he argues that one of the main reasons for the stagnation in the US economy is the increase in oil prices. Accordingly, oil prices create a series of effects on the economy through various transmission channels. According to Lescaroux and Mignon (2008), the increase in crude oil price causes an increase in the prices of petroleum products; From the consumer's point of view, this situation causes an increase in the energy bill (household, industry and government), and from the production point of view, it forces them to struggle with the increase in unit costs. As a result, the rise in energy prices causes a decrease in productivity, with a series of negative consequences on real wages and employment, price level and core inflation, profitability, investment and stock market capitalization.

In addition to being a final product subject to direct consumption, energy is also an important input in the production phase of many goods and services. Therefore, increases in energy prices cause inflation, which is defined as the continuous increase in the general level of goods and services prices, by increasing both input costs and direct consumer costs. Inflation, on the other hand, is demand-driven (supply does not respond at the same rate to increasing demand), cost-driven (increases in production costs reduce total supply), money supply (increases in money supply increase investment and consumption expenditures, hence demand), and inflation expectations (prices will continue to rise). There are four main reasons, namely, the increase in the prices of goods and services through future wage demands.

From a policy perspective, there are compelling reasons for the analysis of the oil price-inflation link. First, since monetary policy authorities are concerned with maintaining price stability, they are under constant pressure to understand both internal and external shocks. In addition, inflation is considered an important measure of macroeconomic stability in an economy, and foreign investors often refer to this factor when making investment decisions. For this reason, both the fiscal and monetary authorities of an economy consider price stability essential in order to attract significant investments (Olofin and Salisu, 2017). For this reason, inflation is an important factor for policy makers, and these actors are very sensitive to changes in oil prices.

In this study, following the introduction, studies in the literature on the subject were examined. As a result of the literature review, selection of variables, econometric method and model preference are made. Then, the data set of the variables used in the research, the time series characteristics of the data, and the empirical findings based on the panel data analysis used were reported. In the conclusion part of the study, it ended with the evaluation of the results based on the findings obtained from the panel data analysis.

2. LITERATURE REVIEW

There is an extensive literature on the effect of oil prices on inflation. Burbidge and Harrison (1984) studied the economy of the USA, Japan, Germany, England and Canada in their study. In the study, it has been determined that the effect of the change in oil price on inflation, the effect of the USA and Canada on the inflation rate is less than Germany, Japan and England.

Gisser and Goodwin (1986) investigated how rising oil prices affected inflation in the United States before and after the first oil shock in 1973. In the study, covering the period 1961-1986 and using quarterly time series, it was determined that while the inflationary effect of oil price increases was stronger before 1973, this effect gradually decreased after 1973. When the effect of fluctuations in oil prices on inflation is examined in the light of current studies, it is seen that this effect has an increasing marginal effect on oil price increases and a decreasing marginal effect on price decreases. In some studies, it has been determined that the shock effect is temporary in the short term, while this effect is permanent in the long term. Doroodian and Boyd (2003) determined that oil price shocks have a significant effect on inflation in the USA.

Cunado and De Gracia (2005) investigated the relationship between oil prices and inflation in six Asian countries. They found that oil prices have a significant effect on inflation in all countries and this relationship is asymmetrical. Kiptui (2009) found that rising oil prices have a significant impact on Kenya's inflation in the short and long term. Mallik and Chowdhury (2011) found that changes in oil prices significantly increased inflation uncertainty in Australia. When the literature is examined, it has also been found that oil shocks have different inflationary effects in oil exporting and importing countries. While the inflation-increasing effect of oil price increases is more destructive in oil-importing countries, it has been observed that this effect is positive in oil-exporting countries (Cologni and Manera, 2008; Bhar and Mallik, 2010; Kilian and Lewis, 2011; An et al., 2014; Salisu et al., 2017; Choi et al., 2018; Lacheheb and Sirag, 2019; Husaini et al., 2019; Su et al., 2020; Kilian and Zhou, 2022).

Mohanty and John (2015) investigated the inflation dynamics of the Indian economy in their study. As a result of the study, they found that the oil price had a dominant effect on inflation between 2009 and 2011 and reached the conclusion that this effect weakened in 2012-2013.

Sek et al. (2015) investigated the transition effect from oil prices to domestic inflation for two different country groups consisting of 20 countries in the 1980-2010 period with the help of ARDL model. The results obtained for the country groups with high and low oil dependence reveal that the transition effect is stronger in the countries in the second group. The weakness in the pass-through effect for countries with high oil dependence is explained by the fact that oil price changes primarily affect export costs in these countries, and thus the pass-through effect on domestic inflation is realized indirectly.

According to Makin et al. (2017) considers data on money supply growth and interest rates in Australia between 1970 and 2015. It is mentioned that oil prices and interest rates are related to inflation as well as money supply and money growth. The methodology used in this paper is "Lucas smoothing approach" and "structural breaks and cointegration analysis." As a result, excessive currency growth is the main determinant of the Australian economy.

Long and Liang (2018) discuss the transition effect from oil prices to consumer and producer prices in China for the 1998-2014 period within the framework of the NARDL approach. Findings obtained with the help of the Error Correction Model reveal that the pass-through effect from oil prices to domestic inflation exhibits an asymmetrical structure in the long run. Accordingly, the pass-through effect of oil price increases on domestic inflation is greater than the pass-through effect of oil price decreases on domestic inflation.

According to Khezri et al. (2019) conducts a study on inflation forecasting. They argue that key factors such as oil prices, unemployment rate, liquidity, interest rates and real GDP have an impact on inflation. The study uses quarterly data referring to 1988-2012 to estimate the effects of variables that have an impact on inflation using nonlinear dynamic models as well as the TVPDMA and TVP-DMS models. It is also shown in the article that the unemployment rate is inversely proportional to inflation according to the Philips-Curve, but this relationship is direct for other variables such as interest rates, liquidity, real GDP and oil prices. The problem with other studies was that inflation forecasts were not permanent, so this study was conducted and the main result was that dynamic models were more accurate in forecasting inflation in Iran.

Boroumand et al. (2019) analyzes the effects of "global oil price shock, euro/dollar exchange rate shock and global inflation shock" in his study. Accordingly, the study aims to determine the monetary policy rule that will increase the level of macroeconomic fluctuations and to allow inflation to be kept at a low level. The study uses Dynamic stochastic general equilibrium (DSGE) model with a Keynesian approach for the Iranian economy. Indicators used to determine their effects on macroeconomic variables such as inflation are oil prices and exchange rates. The analysis covers a time period between 1990 and 2014. In conclusion, the main findings of this study show that the best monetary rule for stability in both macro variables from the first quarter of 1990 to the quarter of 2014 is the core inflation rule.

Sekine (2020) examined the transition effect from oil prices to consumer prices for the USA in the 1974-2015 period with the help of the STAR model. The findings obtained from the study, which is handled within the framework of the Taylor Hypothesis, show that the transition effect from oil prices to domestic inflation has weakened over the years and this weakening is due to the low inflation environment.

Syzdykova et al. (2022) examined the asymmetric relationship between oil prices and inflation within the scope of BRIC countries. The authors obtained different results for the BRIC countries. When the results for Brazil and China are examined, no asymmetric causality relationship was found between oil price shocks and inflation shocks in these countries. While there is a causal relationship from negative oil price shocks to positive inflation shocks in Russia, the same situation was not observed in positive oil price shocks. For India, there is causality from positive oil shocks to positive inflation shocks. There is no causality from negative oil price shocks to inflation shocks.

Table 1: Top 15 oil importing countries

No	Country	Oil imports bln USD	share in oil imports (%)
1	China	365.5	23
2	United States	204.7	12.9
3	India	173.5	10.9
4	South Korea	106	6.7
5	Japan	101.7	6.4
6	Germany	62	3.9
7	Netherlands	58.7	3.7
8	Spain	47.7	3
9	Italy	44.9	2.8
10	United Kingdom	39.6	2.5
11	Thailand	39.1	2.5
12	France	35	2.2
13	Singapore	34	2.1
14	Taiwan	31.1	2
15	Belgium	25.1	1.6
16	Poland	16.6	1.1
17	Canada	16.5	1.1
18	Greece	15.6	1.0
19	Sweden	14.8	1.0
20	Malaysia	12.2	0.8

Source: Enerdata https://yearbook.enerdata.net/

Table 2: Cross section dependency test results

Test	*lncpi*	*lnop*	*lngdp*	*lnunr*
Breusch-Pagan LM	4230.012 (0.00)	4367.012 (0.00)	3087.037 (0.00)	369.0451 (0.00)
Bias-corrected scaled LM	179.410 (0.00)	-1.173 (0.00)	180.6030 (0.00)	0.4038 (0.00)

3. DATA SET, MODEL AND ECONOMETRIC METHOD

3.1. Data set and Model

The model of the study is shown in Equation-1. The preferred variables are the consumer price index (CPI) (*lncpi*), oil price (*lnop*), GDP (*lngdp*) and unemployment rate (*lnunr*). In Equation-1, i is the countries in the cross-section unit; t is time; β is constant term; ε represents the error term.

$$lncpi_{it} = \beta_{0it} + \beta_1 lnop_{it} + \beta_2 lngdp_{it} + \beta_3 lnunr_{it} + \varepsilon_{it} \quad (1)$$

In this model, quarterly data for the period 1980Q1:2022Q4 belonging to the 20 countries that import the most oil are used (Table 1). The countries listed in the table constitute approximately 91.2% of the world's total oil imports. All statistical data were obtained from the Bloomberg database. Data belonging to all variables were converted to logarithmic values. Stata-15.1 package program was used for analysis. In the model, besides the inflationary effects of oil prices, it is aimed to determine the contributions of the GDP and unemployment rate variables, which are widely used in explaining inflation.

3.2. Econometric Method

In this part of the study, In the analysis part, firstly, the test for the existence of cross-sectional dependence between the units forming the series was performed. Because considering the cross-sectional dependence between the series indicates that the tests to be discussed in the next stages, namely which generation panel unit root test, panel cointegration, long-term parameter estimation and panel causality analysis should be performed. Secondly, the CADF test proposed in the Pesaran (2007) study, which takes into account the cross-sectional dependence, is discussed. Next comes the error correction model-based cointegration analysis developed in the study of Westerlund (2008), whether there are long-term relationships between the variables. If there is a long-run relationship between the variables, the coefficients of the long-run parameters can be estimated. Based on this idea, it is estimated with the AMG (Augmented Mean Group Estimator) method proposed in the Eberhardt and Bond (2009) study for long-term parameter estimation during the study.

Westerlund (2008) proposed four panel cointegration tests to test the presence of cointegration in panel data. The basis of the tests is to test the existence of cointegration by deciding whether each unit has its own error correction.

Westerlund (2008) starts with the following data generation process:

$$y_{it} = \delta_i' d_t + \alpha_i \left(y_{i,t-1} - \beta_i' x_{i,t-1} \right) + \sum_{J=1}^{p_i} \alpha_{ij} \Delta y_{i,t-j}$$
$$+ \sum_{J=-q_i}^{p_i} \gamma_{iitt} \Delta x_{,-} + \varepsilon$$

Table 3: Pesaran (2007) panel unit root test results

Variables	Model	Level		1st difference	
		$\bar{t}$	Critical value (%5)	$\bar{t}$	Critical value (%5)
lncpi	Intercept	−0.975	−2.330	−2.948*	−2.330
	Intercept&Trend	−0.701	−2.830	−3.468*	−2.830
lnop	Intercept	−1.692	−2.330	−4.754*	−2.330
	Intercept&Trend	−1.895	−2.830	−4.851*	−2.830
lngdp	Intercept	−1.942	−2.330	−5.002*	−2.330
	Intercept&Trend	−2.501	−2.830	−5.224*	−2.830
lnunr	Intercept	−2.173	−2.330	−5.247*	−2.330
	Intercept&Trend	−2.541	−2.830	−4.545*	−2.830

Note: * At the 5% significance level, the H_0 hypothesis can be rejected

Here, t indicates the time dimension, N indicates the cross-section unit dimension, and d_t indicates deterministic items. The error correction process provides valid classical assumptions for cointegration tests. In the study of Westerlund (2007), Banerjee et al. (1998) wrote the error correction model as follows.

$$\Delta y_{it} = \delta_i' d_t + \alpha_i y_{i,t-1} + \lambda_i' x_{i,t-1} + \sum_{J=1}^{p_i} \alpha_{ij} \Delta y_{i,t-j} + \sum_{J=-q_i}^{p_i} \gamma_{ij} \Delta x_{i,t-j} + \varepsilon_{it}$$

Here λ_i' can be defined as $\lambda_i' = -\alpha_i \beta_i'$. In the conditional error correction, the parameter is estimated using the OLS method, and if α_i <0 means that there is an error correction, that is, y_{it} and x_{it} are cointegrated, and if $\alpha_i = 0$ means that there is no error correction, that is, there is no relationship between y_{it} and x_{it}. Therefore, the absence hypothesis for each i can be formed as $\alpha_i = 0$.

Westerlund (2008) presented four test statistics based on the least squares estimate of α_i given in equation and its t ratio. In calculating the group mean test statistics G_t and $G\alpha$, the error correction model should be estimated for each section. Group mean test statistics $G_t = \frac{1}{N}\sum_{i=1}^{N}\frac{\hat{\alpha}_i}{SE(\hat{\alpha}_i)}$ and $G_\alpha = \frac{1}{N}\sum_{i=1}^{N}\frac{T\hat{\alpha}_i}{\hat{\alpha}_i(1)}$ and Westerlund (2008) cointegration test statistics for analyzing the panel as a whole are given as $P_t = \frac{\hat{\alpha}}{SE(\hat{\alpha})}$ and $P_\alpha = T\hat{\alpha}$. The semi-parametric carnel estimator of α_i and the standard error of $\hat{\alpha}_i$ are shown by $SE(\hat{\alpha})$.

4. ANALYSIS FINDINGS

Within the scope of the analysis, firstly, whether there is a cross-section dependency will be tested and the unit root test to be applied will be determined according to the results of this test. The most important point to be considered when examining the cross-sectional dependence between the series is time and cross-section dimensions. If the time dimension is larger than the cross-section dimension ($T > N$), Breusch-Pagan (1980) LM; when the time dimension is equal to the cross section dimension ($T = N$), Pesaran Scaled LM; When the time dimension is smaller than the cross-section dimension ($T < N$), cross-sectional dependence is tested in the series with the Pesaran (2004) test. In this study, the Breusch-Pagan LM test was used because of the $T > N$ condition. Bias-Corrected Scaled LM is a test in which deviations in individual means are corrected. The cross-section size and whichever time dimension is larger is unimportant for this test.

Table 4: Westerlund (2008) cointegration analysis results

Statistics	Value	Z value	P-value	Robust P value
G_t	−2.435	−2.196	0.014	0.012**
G_a	−8.773	−0.899	0.184	0.198
P_t	−7.424	−3.099	0.001	0.023**
P_a	−8.123	−2.631	0.004	0.044**

The results of two separate tests given in Table 2 show the presence of cross-sectional dependence. Because of the existence of cross-section dependence for all variables, the stationarity of the series should be analyzed with second generation unit root tests.

As seen in Table 2, a cross-sectional dependence was found between the series. Thus, tests developed under cross-section dependence should be preferred in the study. Otherwise, the results obtained will be biased. The results of the Pesaran (2007) panel unit root test, which takes into account the cross-sectional dependence, are given in Table 3 below. In this table, CADF test results are shown for both constant term and constant term and trend cases, and the $\bar{t}$ (t-bar) statistic value and critical values at 95% confidence level are given. According to the results of this table, all the variables are stationary at the first order difference.

Westerlund (2008) uses the bootstrap method to take into account the cross-sectional dependence between the series that make up the panel. In the table below, Westerlund panel cointegration test results are given for four different statistics (Table 4).

Regarding the Westerlund (2008) cointegration test, the antecedent and lag length were determined as 1. By using the fixed model as the deterministic component, self-inference probability values with 1000 repetitions were obtained. According to the resistant P-values obtained from the G_t, P_t and P_a statistics, a long-term equilibrium relationship was found between the consumer price index, oil price, gdp and unemployment rate variables at the 5% significance level.

The long-term coefficients of the model in Table 5 were estimated by the Augmented Mean Group Estimator developed by Eberhardt and Bond (2009). The most important advantage of this method, which is expressed as the AMG estimator, is that it gives separate

Table 5: Long-run coefficients of the model (augmented mean group estimator)

Countries	*lnop*		*lngdp*		*lnur*	
	Coefficient	Test statistic	Coefficient	Test statistic	Coefficient	Test statistic
Panel	0.08168	0.072**	0.43260	0.033*	0.05793	0.380
China	−0.0113	0.704	1.1617*	0.000	0.09362*	0.000
United States	0.07644*	0.051	0.11358*	0.017	0.91015*	0.000
India	−0.01622	0.621	0.71092*	0.000	−0.60175*	0.004
Japan	−0.02174*	0.004	0.02592	0.874	−0.03744*	0.050
South Korea	0.01623	0.212	0.63338*	0.000	0.07856*	0.000
Germany	0.06308*	0.000	0.30619*	0.041	−0.05223*	0.008
Italy	0.60941*	0.000	−0.46073*	0.007	0.20634	0.226
France	0.63395 *	0.000	−1.63126	0.139	−0.20793	0.722
Spain	0.03707*	0.671	1.05133*	0.000	0.10515*	0.001
United Kingdom	0.01411*	0.051	−1.25017*	0.074	−0.26371*	0.020
Netherlands	−0.07517*	0.040	1.33004*	0.000	0.32213*	0.000
Singapore	0.05025*	0.010	0.39354*	0.000	0.09096	0.739
Thailand	0.02512*	0.009	1.14075 *	0.000	0.02144	0.675
Taiwan	−0.00716	0.751	1.05642*	0.000	0.11568*	0.000
Canada	0.01453*	0.027	0.95545*	0.000	0.03980**	0.085
Belgium	0.30874*	0.000	−1.04335*	0.000	−0.18101*	0.012
Greece	−0.09182*	0.011	1.83895*	0.000	0.34512 *	0.007
Poland	0.00622	0.227	1.02728*	0.000	0.13585*	0.000
Sweden	0.02093	0.276	0.84267*	0.000	0.08091	0.000
Malaysia	−0.03066	0.331	0.37659*	0.004	−0.04032	0.333

results for each unit, taking into account the cross-sectional dependence. The effect of oil prices on the dependent variable (lninf) differs from country to country. It is observed that Italy and France are the most affected countries. The 1% increase in oil prices in Italy and France creates an increase of 0.63% and 0.60% on consumer prices, respectively. While the effects of the changes in the GDP level on the CPI were positive in some countries, it was reversed in some countries. For example, in the United Kingdom, a 1% increase in GDP causes a 1.25% decrease in inflation. However, a 1% increase in GDP in the Netherlands causes an increase of 1.33% in CPI. Similarly, the effects of unemployment rates on inflation differ between units. While the increase in unemployment affects inflation in the same direction in some units, it affects the inflation in the opposite direction in some units.

5. CONCLUSION

As a result of the findings obtained in the study, it has been determined that the long-term effects of GDP level, unemployment rates and oil prices on CPI differ between countries. The coefficient of the oil price variable differed in Germany, USA, UK, Singapore, Thailand, Canada, Belgium, Greece, Italy and France; It was higher in developing countries such as Italy, France and Belgium. Although the coefficients of GDP levels were found to be significant in all countries except Japan and Malaysia in the panel, there are countries where they are calculated as both positive and negative.

The increase in GDP in the Netherlands and Greece creates an increase on the CPI. Coefficients of GDP were calculated as negative in Italy, France, Belgium and UK. The coefficients of unemployment rates were found to be significant in countries other than Malaysia, Singapore, Thailand, France and Italy, and were both negative and positive, similar to other variables. In India, Japan, Germany, UK and Belgium, the effect of the increase in unemployment rate on the CPI is negative; positive in other countries found to be significant. The variation of the coefficients of the variables that make up the model can be explained by factors such as the structural differences of the countries, the goods and sectors in which oil is used as an input, government interventions, and taxes or subsidies on fuel.

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