The Relationship between Crude Oil Prices and the Gross Domestic Product, Inflation, and Unemployment: Evidence from Jordan

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Abstract

The primary goal of this study is to assess the effect of oil prices on Jordan's gross domestic product, inflation, and unemployment. The GDP represents a summation of gross value added via all resident producers in the economy and any product taxes not involved in the evaluation of output, divided by mid-year population. While the concept of unemployment denotes to the portion of the labor force that is without work but available for and looking for employment, as well as to inflation as stately by the consumer price index by using quarterly time series data from 2000 to 2021. The study employs an autoregressive distributed lag (ARDL) equations system or a multivariate ARDL model to analyze the relationship. The findings indicate that in panel A, the ARDL(0,0) results suggest the absence of both short-term and long-term effects of oil prices on GDP, inflation, and unemployment. Conversely, panel B demonstrates that there are no immediate or prolonged impact of oil prices on unemployment (UNE) based on the ARDL(1,0) analysis. However, in panel C, the ARDL-ECM (1,0) highlights the existence of short-term and long-term impacts on inflation by oil prices. Decision makers in the Jordanian economy could employ the outcomes of this study to formulate the suitable policies that assist in dealing with the quantities of the oil imports from different countries which will directly affect in minimizing unemployment rates among Jordanians.

Keywords: Crude Oil Price, Inflation, Unemployment, Autoregressive Distributed Lag Model.

العلاقة بين أسعار النفط الخام و الناتج المحلي الإجمالي و التضخم و البطالة: دلائل من الأردن

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ملخص

الهدف الأساسي لهذه الدراسة هو تقييم تأثير أسعار النفط على الناتج المحلي الإجمالي والتضخم والبطالة في الأردن، اذ يمثل الناتج المحلي الإجمالي مجموع اجمالي القيمة المضافة من خلال جميع المنتجين المقيمين في الاقتصاد وأي ضرائب على المنتجات غير المشاركة، في تقييم الإنتاج مقسوماً على عدد السكان في منتصف العام، في حين يشير مفهوم البطالة الى جزء من القوى العاملة التي ليس لديها عمل ولكنها متاحة للعمل وتبحث عنه، كما تشير الى التضخم من خلال مؤشر أسعار المستهلك باستخدام بيانات السلاسل الزمنية ربع السنوية في الفترة الزمنية (٢٠٠٠–٢٠٢١)، تستخدم الدراسة نموذج الانحدار الذاتي لفترات الابطاء الموزع أو نموذج الانحدار الذاتي متعدد المتغيرات لتحليل العلاقة، وبالرجوع الى جدول (A) وحسب نموذج (٠.٠) (ARDL) فان هناك غياب لتأثير أسعار النفط على الناتج المحلي الإجمالي والتضخم والبطالة، بالمقابل فانه وبالرجوع الى جدول (B) وحسب نموذج (١.٠) (ARDL) فانه لا يوجد تأثير فوري أو على المدى الطويل لأسعار النفط على البطالة، وأخيراً وبالرجوع الى جدول (C) (١.٠) (ARDL–ECM) فان هناك تأثير لأسعار النفط في المدى الطويل والقصير على التضخم، هذا ويمكن لصناع القرار في الاقتصاد الأردني توظيف نتائج هذه الدراسة لرسم السياسات المناسبة التي تساعد على التعامل مع كميات الواردات النفطية من مختلف الدول والتي بدورها ستؤثر بشكل مباشر في تقليل نسب البطالة بين الأردنيين.

الكلمات المفتاحية: أسعار النفط الخام، التضخم، نموذج الانحدار الذاتي الموزع للإبطاء

1. Introduction

Crude oil is recognized as a trade commodity with significant strategic importance in any national economy. Its utilization directly and indirectly impacts all sectors of an economy. Consequently, fluctuations in crude oil prices can influence the macroeconomic conditions of any country. Elevated crude oil prices can lead to an increase in rates, subsequently affecting inflation, unemployment, and gross domestic product. This escalation in oil prices triggers a rise in the costs

of petroleum products, energy expenses for consumers, industries, and the government, as well as production costs. Consequently, this hike contributes to an increase in overall production costs and a subsequent decline in production levels. Unemployment, a persistent economic challenge, affects all countries, regardless of their level of development. The prevalence of unemployment varies across countries, dependent on the prevalent economic, social, and environmental circumstances. The emergence of unemployment is linked to a decline in overall economic performance and the occurrence of fluctuations within economic cycles, often leading to a reduction in gross domestic product. Fields (2011) has argued that developed countries typically exhibit lower unemployment rates compared to developing economies.

The impact of fluctuations in oil prices varies for countries depending on whether they are exporters or importers of oil. Oil-dependent countries heavily rely on oil revenues, leading to increased funds available for financing development projects when oil prices rise. However, the relationship between oil prices and economic growth differs across various business cycles and oil price levels, as indicated by Kilian and Vigfusson (2011) and Das et al. (2018).

The variability in oil prices can have a significant influence on price increases, particularly considering that oil serves as a vital energy source in the manufacturing sector (Shrestha et al., 2019; Pal and Mitra, 2018). Additionally, studies have delved into the disparity of oil pass-through effects on disaggregated inflation across different sectors (Babuga and Naseem, 2021; Balcilar et al., 2018; Iwayemi and Fowowe, 2011).

The key focus of this research is to analyze the impact of oil price volatility on crucial macroeconomic variables such as inflation, unemployment, and GDP, utilizing a quarterly time series extended from2000-2021 dataset on oil prices specific to the case of Jordan. Notably, this study is one of the rare investigations that simultaneously explore the association among oil prices and designated macroeconomic variables, using advanced time series practices. Lastly, this study also marks the first comprehensive assessment of the post-devaluation era, aiming to evaluate the effect of oil price variations on the Jordan's economy.

2. Literature Review

The oil sector serves as a crucial lifeline for stimulating global production factors, thereby exerting a significant influence on inflation rates worldwide, consequently leading to economic and social ramifications that affect the populace of all countries. In essence, fluctuations in oil prices can expressively influence all activities in an economy (Nazarian and Amiri, 2014; Adam, 2016). In the meantime, Cologni and Manera (2008) have also identified the presence of the influence in inflation by the oil prices.

Numerous studies, such as those undertaken by Berument et al. (2010), Akinlo and Apanisile (2015), Hassan and Abdullah (2015), and Musa (2017), have demonstrated a positive correlation that combine oil prices and economic growth. Conversely, a host of other analyses from different countries, conducted by Hamilton (1983), Guo and Klieses (2005), Jiménez-Rodríguez and Sánchez (2005), Malik (2008), Bhusal (2010), Berk and Aydogan (2012), Farhani (2012), Ahmad (2013), Nazir and Qayyum (2014), and Eyden et al. (2019), have proposed a negative association among oil and economic growth.

Mukhtarov et al. (2020) uncovered a positive influence of oil prices on economic growth, exports, and inflation in the case of Azerbaijan. In contrast, there was found to be a negative impact of oil rates on the exchange rate. Chen et al. (2015) established a positive relationship between oil rates and the Chinese Consumer Price Index. Abounoori et al. (2014) established that oil rates impact inflation positively in short term and long term in Iran. Conversely, Katircioglu et al. (2015) revealed the negatively affects among inflation and oil rates in OECD countries.

Brown and Yucel (2002) posited that higher oil prices lead to increased output costs, subsequently leading to reduced production rates and slower growth rates. This dynamic may result in lower real wage rates, factory closures, and an increase in the unemployment rate. The same study indicated that when oil rates experience downward stickiness, reduced expenditure levels contribute to a decline in GDP growth in countries reliant on oil imports. Chuku et al. (2010) demonstrated that there is no direct relationship between economic growth and crude oil rates, emphasizing the dependence of each on a country's macroeconomic strategy, established frameworks, and sectoral organization.

Hamilton (1983) and Filis & Chatziantoniou (2013) argued that there exists an inverse relationship between crude oil prices and GDP growth in developed countries. Cunado and De-Gracia (2005) discovered a lasting impact of oil rates on inflation in the short run, as well as asymmetric effects of oil rates on the production index. Furthermore, Masih et al. (2011) asserted the existence of an association between oil rates and economic activities. Meanwhile, a study conducted by Oladosu et al. (2018) confirmed the impact of oil rates on GDP.Bouzaid (2012) argued that, there is a ten percent increase in the oil price implies to a decrease in GDP with 3.4% in the case of Tunisian economy.Mahmood and Zamil (2019) argued that, volatilities in oil prices have a substantial impact on Saudi Arabia GDP by the impact on the budget deficit. Similar results are concluded for for Bahrain by Abou Elseoud and Kreishan (2020).(Majali, 2008) explores the probability of controller over the inflation rate in the short-term and long -term interest rates quarterly in the banking sector of Jordan in the period 1994 to 2007using Unrestricted Model and Autoregressive Integrated model. The outcomes show that there is a strong impact of interest rates in the banking sector on the inflation rate, and that the liquidity growth rate for the GDP growth rate effects the inflation rate.Alkhazaleh (2024) assess how volatilities in crude oil rates influence inflation in Jordan. The outcomes designate the occurrence of both short-term and long-term effects of oil prices on inflation.

3. Data and Methodology

3.1. Data

The data utilized comprise information on crude oil prices (in USD per barrel), inflation (in %), unemployment, and Gross Domestic Product in JD. The dataset pertaining to crude oil prices, inflation, and GDP consists of quarterly observations spanning the period from 2000 to 2021. These data points have been sourced from the Bank of St. Louis, United States.

3.2. Methodology

In order to assess the influence of crude oil rateson inflation, the unemployment rate, and Jordan's gross domestic product, we apply the ARDL technique suggested

by Heij et al. (2004) and Pesaran and Shin (1999). This decision is rooted in the presence of three dependent variables, namely inflation, the unemployment rate, and the gross domestic product, along with one independent variable, which is the crude oil rate. To effectively examine this relationship, we utilize a multivariate ARDL model comprising three equations, as outlined below:

$$I_t = a_1 + \sum_{i=1}^{p_1} \mu_{1i} I_{t-i} + \sum_{i=0}^{q_1} \psi_{1i} O_{t-i} + \tau_{it} \quad (1)$$

$$U_t = a_2 + \sum_{i=1}^{p_2} \mu_{2i} U_{t-i} + \sum_{i=0}^{q_2} \psi_{2i} O_{t-i} + \tau_{2t} \quad (2)$$

$$G_t = a_3 + \sum_{i=1}^{p_3} \mu_{3i} G_{t-i} + \sum_{i=0}^{q_3} \psi_{3i} O_{t-i} + \tau_{3t} \quad (3)$$

In this context, the symbol O denotes crude oil prices, I denotes inflation, U denotes the unemployment rate, and G denotes the gross domestic product. Moreover, for the purpose of the equations τ_{it}, (i=1, 2, 3) represent the errors, while a, μ, ψ denote the parameters of the regression equation.

$$D(I_t) = \psi_{10} D(O_t) + \lambda_1 \mathrm{Res}1_{(t-1)} + \sum_{i=1}^{p_1-1} \mu_{1i} D(I_{t-i}) + \sum_{i=1}^{q_1-1} \psi_{1i} D(O_{t-i}) + \tau_{1t} \quad (4)$$

$$D(U_t) = \psi_{20} D(O_t) + \lambda_2 \mathrm{Res}2_{(t-1)} + \sum_{i=1}^{p_2-1} \mu_{2i} D(U_{t-i}) + \sum_{i=1}^{q_2-1} \psi_{2i} D(O_{t-i}) + \tau_{2t} \quad (5)$$

$$D(G_t) = \psi_{30} D(O_t) + \lambda_3 \mathrm{Res}3_{(t-1)} + \sum_{i=1}^{p_3-1} \mu_{3i} D(G_{t-i}) + \sum_{i=1}^{q_3-1} \psi_{3i} D(O_{t-i}) + \tau_{3t} \quad (6)$$

Here, D(O) signifies the former alteration form of the variable Oil. Equations (4), (5), and (6) are referred to as error correction models. The parameters (i=1,2,3) in these equations are misplaced in the subsequent analysis. If there is no cointegration in the variables, this would lead to the ARDL equation in the first difference. The residual variable is the error correction variable denoted by Res in equations (7), (8), and (9).

$$Res1_{(t-1)} = I_{t-1} - \frac{a_1}{1-\sum_{i=1}^{p_1}\mu_{1i}} - \frac{\sum_{i=1}^{q_1-1}\psi_{1i}}{1-\sum_{i=1}^{p_1}\mu_{1i}} O_{t-1} \quad (7)$$

$$Res2_{(t-1)} = U_{t-1} - \frac{a_2}{1-\sum_{i=1}^{p_2}\mu_{2i}} - \frac{\sum_{i=1}^{q_2-1}\psi_{2i}}{1-\sum_{i=1}^{p_2}\mu_{2i}} O_{t-1} \quad (8)$$

$$Res3_{(t-1)} = G_{t-1} - \frac{a_3}{1-\sum_{i=1}^{p_3}\mu_{3i}} - \frac{\sum_{i=1}^{q_3-1}\psi_{3i}}{1-\sum_{i=1}^{p_3}\mu_{3i}} O_{t-1} \quad (9)$$

4. Findings and Discussion

4.1. Findings

Initially, our analysis involves conducting stationary tests. One of the primary tests used is the Augmented Dickey-Fuller (ADF) test, originally developed by Dickey and Fuller (1979). Alternatively, the Philip Perron (PP) test, developed by Phillips and Perron (1988), can be employed for comparison. In both tests, the null hypothesis states that the time series is non-stationary, while the alternative hypothesis suggests stationarity.

The stationary tests constituted the first phase of our analysis. The outcomes of the ADF test and the PP test are condensed in Table 1. Specifically, the variables GDP and I demonstrate stationarity at the level, whereas the variables U and OIL exhibit stationarity at the first difference or an integrated order of I(1).

Table 1: Stationary test results

Variable	ADF test statistic		Phillips-perron test statistic	
	Constant	Constant and trend	Constant	Constant and trend
GDP	-3.372	-2.0192	-4.8119	-2.136
I	-3.311	-3.5717	-6.7292	-6.440
U	-0.068	-2.0524	-0.1205	-2.602
D(U)	-5.289	-5.2746	-9.3669	-9.352
OP	-2.863	-2.6977	-2.5635	-2.506
D(OP)	-6.5863	-6.6014	-7.4221	-7.442

The next step involves the utilization of the cointegration test, specifically if one or both of the variables in the initial three models are stationary at the first difference. The Engle-Granger cointegration test was adopted for this purpose. Initially, this test entails estimating the regression between inflation and oil, resulting in residual one, followed by the regression between unemployment and oil, resulting in residual two. Finally, a regression is conducted between gross domestic product and oil, leading to residual three. Subsequently, the stationarity of the three residuals is examined using the ADF test. Should the results indicate stationarity at the level, it suggests that the two time series are cointegrated.

Finally, the parameters are esimated of models (4), (5), and (6) by employing the multivariate ordinary least square technique, under the assumption that errors are interdependent or that autocorrelation exists (IHS, 2017). The validity of this assumption is assessed through the use of the Portmanteau multivariate test, proposed by Lütkepohl (2004). When a long-run impact is identified, the stability of the long-run coefficients is tested based on the ARDL model, using the CUSUM test, as introduced by Brown et al. (1975).

On the other hand, the cointegration test is conducted to ascertain the relationship between oil prices and inflation, gross domestic product, and unemployment, presented in Table 2. The p-values of the tau-statistic suggest that oil prices and inflation are cointegrated, whereas there is no cointegration observed between oil prices and both GDP and unemployment. Therefore, it can be concluded that oil prices and inflation exhibit a long-run relationship, while no such relationship exists between oil prices and either GDP or unemployment.

Moreover, based on the results of the multivariate autocorrelation test using the Portmanteau test, it is apparent that error term εt demonstrates autocorrelation, validating the use of the multivariate OLS method. The outcomes of the multivariate autocorrelation are presented in Table 3.

The evaluation of time lags reveals that the estimated ARDL models indicate a one-way association from oil prices to inflation. Precisely, there is no short-run and long-run effects of oil prices on both GDP and unemployment, as indicated by the ARDL(0,0) results in panel A. Similarly, the results indicate no short-run and long-run effects of oil prices on unemployment, with ARDL(1,0) in panel B.

Conversely, there exists a short-run and long-run impact of oil prices on inflation according to the ARDL-ECM (1,0), as shown in panel C. Furthermore, the CUSUM tests affirm the stability of the ARDL model coefficients for the long-run relationship between oil prices and inflation, illustrated in figure 1.

Table 2: Engle granger co-integration test

Dependent Variables	Independent variables	Residual variables	ADF Test (P-value)
GDP	OIPR	Residual 1	0.2411
Inflation	OIPR	Residual 2	0.0000
Unemployment	OIPR	Residual 3	0.8876

Table 3: autocorrelation test

Lag	Q-statistic	P-value
Lag 1	24.6201	0.0053
Lag 2	31.0521	0.0376
Lag 3	45.2531	0.0212
Lag 4	54.7658	0.2103

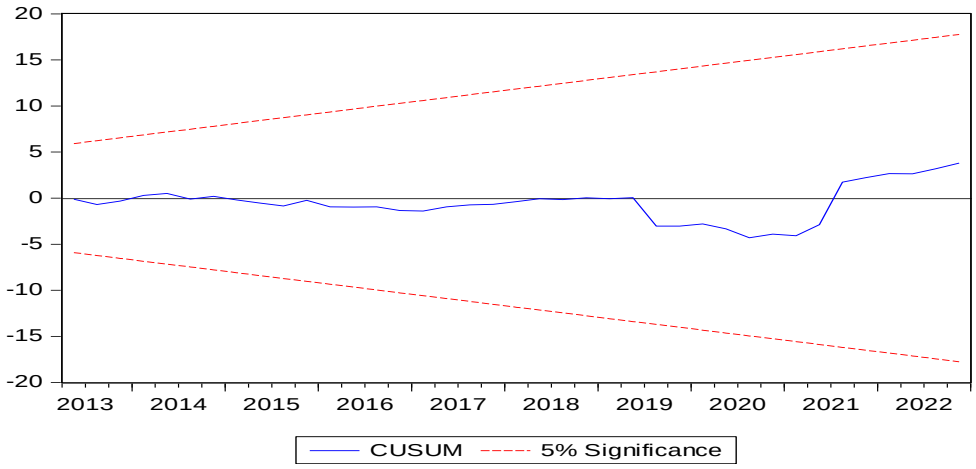

Figure 1: CUSUM test regarding the stability of ARDL between oil prices and inflation

4.2. Discussion

Autoregressive distributed lag (ARDL) models are employed to analyze dynamic associations with time series data in a single-equation context. The recent value of the dependent variable is certified to depend on its own past realizations – the autoregressive part – as well as recent and values of the past of additional explanatory variables – the distributed lag part. The variables can be stationary, nonstationary, or a mixture of the two kinds. In its equilibrium correction (EC) representation, the ARDL model can be employed to isolated the long-term and short-term belongings, and to check for co-integration or, more commonly, for the presence of a long-term association between the variables of interest.

The findings indicate no short-term and long-term influences of oil rates on both GDP and unemployment, as illustrated by the ARDL(0,0) results in panel A. This conclusion is similarly applicable to the unemployment variable, where ARDL(1,0) in panel B demonstrates the absence of both short-term and long-term influences of oil rates on unemployment. Conversely, there exists a clear short-run and long-run impact of oil prices on inflation. This finding aligns with the conclusions drawn by Cologni and Manera (2008), who also identified the influence of oil prices on inflation. These findings are corroborated by the works of Reicher (2010) and Eryigi (2012). Notably, various studies have explored the relationship between oil prices and inflation. For instance, Ahmed and Wadud (2011) found a negative relationship between oil prices and inflation. Similarly, Iwayemi and Fowowe (2011) and Roeger (2005) observed no significant association between oil prices and inflation. In contrast, Adam et al. (2016) reported a positive dynamic impact of global crude oil prices on inflation, with multiplier effects of 0.33%. Furthermore, Cunado and De-Gracia (2005) identified a lasting effect of oil prices on inflation in the short run, accompanied by asymmetric effects of oil prices on the production index. It is worth noting that Jordan, unlike other countries, is unique in many aspects in terms of its influence by economic, political and social factors alike.

This is due to its important geographical location in the Middle East region and the repercussions of the ongoing conflicts in the region, such as the Arab-Israeli conflict, as it has the longest land borders with Israel, and the number of

refugees, which casts a shadow on the Jordanian economy as a result of the displacement of a very large number of refugees from neighboring countries due to the wars raging in the region, especially the war. The brutal civil war in Syria and the instability of the neighboring country, Iraq, and the accompanying instability in the neighboring country, Lebanon, and the exceptional circumstances in the West Bank in Palestine (Barari, 2014).

In addition, the demographic composition of the population, which has changed significantly since approximately the past thirty years until the present time, has contributed greatly to the pressures on all macroeconomic factors and thus the steady increase in rates of inflation, unemployment, and other economic factors. Let us also not forget the instability in the neighboring country, Egypt, and the difficult economic conditions it is suffering from, especially those related to the collapse of its currency exchange rate as a result of its flotation. In addition to the consequences of the Russian-Ukrainian war and the entry of international parties into this conflict. As Jordan is considered one of the largest countries importing grains from these countries, the prices of various foodstuffs related to its imports from these countries are affected (Barari, 2014).

Table 4:Estimation results of multivariate ARDL using multivariate OLS.

Independent variables	Dependent and constant variables	Coefficient	probability
Panel A: ARDL(0,0)			
D(GDP)	D(O)	-0.03986	0.6098
	Breusch-Godfrey Serial Correlation LM Test	0.5364	
Panel B:ARDL(1,0) Model			
D(U)	D(U(-1))	-0.4176	0.0023
	D(O)	-1.2744	0.4175
	Breusch-Godfrey Serial Correlation LM Test	0.8569	
Panel C: ARDL-ECM (1,0) Model Short-run effect			
D(I)	D(I(-1))	0.2097	0.0067

Independent variables	Dependent and constant variables	Coefficient	probability
	D(O)	0.1489	0.0032
	Breusch-Godfrey Serial Correlation LM Test	0.6508	
Long-run effect			
I	C	0.2456	0.0013
	O	0.1395	0.0001
	Breusch-Godfrey Serial Correlation LM Test	0.5210	

5. Conclusion

The objective of this study is to investigate the impact of oil prices on inflation, gross domestic product, and unemployment. Utilizing quarterly time series data for Inflation, unemployment, and GDP in Jordan spanning the period from 2000 to 2021, the study employed an autoregressive distributed lag (ARDL) equations system or a multivariate ARDL model to conduct the analysis. The parameters of the multivariate model were computed using the multivariate ordinary least squares (OLS) method.

The outcomes of the analysis indicate that there are no short-run and long-run effects of oil prices on both GDP and unemployment, as observed in the ARDL(0,0) model. Similarly, the study finds no short-run and long-run effects of oil prices on unemployment with ARDL(1,0). However, there is clear evidence of short-run and long-run effects of oil prices on inflation according to the ARDL-ECM (1,0) model. Furthermore, the stability of the ARDL model coefficients in the long-run association among oil prices and inflation is supported by the results of the CUSUM tests.

Researchers can employ this study to build more options related to Jordanian economy. They can add more macroeconomic variables or make a separate relationship between crude oil prices and each one of them as well. However, the policy makers and regulators can measure the relationships according to the new events happened in the whole region. The limitations of this study are classified as

the availability of the data up to date, in addition to find a trustable governmental source of the data in any time needed in Jordan.

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