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The Impact of Global Energy Price Volatility on Oil Derivative and Local Price in Jordan: Using DCC-GARCH Model

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ABSTRACT

The central aim of this study is to evaluate the repercussions of global energy price fluctuations on the pricing of local oil derivatives in Jordan, and their subsequent impact on domestic price levels. This research seeks to propose risk mitigation strategies to address the challenges posed by energy price volatility, offering valuable insights for Jordanian policymakers. Given the dearth of understanding among policymakers and industry stakeholders regarding the economic ramifications of global energy prices on local markets, this study posits a statistically significant relationship, at a 5% significance level, between global energy prices, local oil derivative prices, and the prices of commodities and services. To investigate these dynamics, the study employs a Dynamic Conditional Correlation-Generalized Autoregressive Conditional Heteroskedasticity (DCC-GARCH) model, utilizing monthly data spanning from January 2008 to March 2022, encompassing global energy prices, local energy prices, and the consumer price index. The study's findings reveal that fluctuations in global oil prices, specifically the Brent benchmark, have a discernible impact on local oil derivative prices in Jordan. However, the reverse causal relationship is not supported, indicating a unidirectional link from oil prices to oil derivatives. The estimated DCC-GARCH model further quantifies this connection, demonstrating that a 1% increase in Brent oil prices corresponds to a 0.21% increase in local oil derivative prices within Jordan. Moreover, a 1% uptick in local oil derivative prices corresponds to a 0.23% increase in the consumer price index. Based on these research outcomes, it is strongly recommended that measures be explored to effectively manage the volatility of oil derivative prices in Jordan. The implementation of such measures holds the potential to bolster local price stability and foster a more resilient economic environment.

Keywords: Oil, Price Fluctuations, Energy, Jordan, Oil Derivatives
JEL Classifications: E31, E52, K32

1. INTRODUCTION

Energy plays a pivotal and crucial role in all economic and social development plans in Jordan. It is considered one of the key determinants of economic growth in the country. Particularly, oil stands as one of the most important energy sources, holding the top position in the global energy balance. Its significance lies in its substantial production expenses and the amount of energy it generates, making it a strategic commodity at the international level. Energy poses a significant challenge for Jordan due to its reliance on large imports and lacking local energy sources. Jordan requires relatively substantial amounts of energy, and the energy-related issues, particularly in electricity generation, have burdened the state with significant financial pressures, leading to a rise in public debt. Consequently, the government decided to liberalize oil derivative prices, resulting in a fundamental impact on the prices of essential goods.

Before 2004, local oil derivative prices (gasoline, diesel, kerosene, and gas) in Jordan remained fixed and did not reflect global prices. Since 2004, in response to the interruption of oil grants, especially from Iraq, the government began liberalizing oil derivative prices. Full liberalization occurred in 2008, and from the beginning of 2011 until the end of 2012, the prices were fixed. However, since then, the government has resumed monthly pricing for oil derivatives. The fluctuation of global energy prices and its impact on local oil derivative prices and domestic prices in Jordan is a critical issue that requires attention. Policymakers and producers in Jordan lack a clear understanding of the economic implications of global energy prices and their influence on local prices. By analyzing the relationship between global energy prices, local energy prices (particularly oil derivatives), and commodity and service prices, this research intends to close this knowledge gap and offer insightful information to policymakers.

The main focus of the problem statement is Jordan's need to improve local pricing stability and reduce the dangers brought on by energy price variations. Studies conducted locally that evaluate how changes in oil prices affect local prices currently lack modern standard models. This study seeks to close this gap by analysing the statistical significance of the correlation between the prices of commodities and services in Jordan and the prices of energy at the international, national, and local levels.

This study has two goals in mind. First, it wants to know how well changes in commodity prices, such those for oil, can be used to forecast inflation in the main consumer price index. It also aims to provide methods for reducing the risks brought on by variations in energy prices and promoting a more stable business climate in Jordan. By fulfilling these goals, this study intends to offer beneficial insights to Jordanian producers and policymakers, empowering them to decide wisely and create efficient economic strategies. This study intends to fill a substantial research vacuum by educating policymakers and producers on the economic effects of global energy prices and how they affect local costs. Moreover, the absence of recently adopted standards.

2. LITERATURE REVIEW

Depending on whether a nation imports or produces its own oil, the effects of changes in global oil prices on domestic pricing vary. Generally, in oil-producing countries, prices are often subsidized and do not reflect global changes, leading to a limited impact on local prices compared to oil-importing countries (Mokni, 2020). In oil-importing countries, when the prices of oil derivatives are liberalized in the local market, they change according to global oil market fluctuations, both upward and downward (e.g., gasoline, diesel, gas, heavy fuel). These price changes affect the conditions of the overall supply of goods and, consequently, prices based on the elasticity of demand for these products. Consequently, the cost fluctuations influence final prices. Moreover, there are indirect effects of oil prices on essential global commodities such as iron, copper, mining industries, and construction cement, which are significantly influenced by oil price fluctuations.

Numerous previous studies have addressed the measurement of global energy price expectations and their impact on local prices. In their study on Jordan, (Hijazine and Al-Assaf, 2022) revealed a short-term positive impact of oil prices on headline inflation, emphasizing a unidirectional Granger causality. However, the transitory nature of oil prices became evident in the long run, with no substantial positive effect on both headline and core inflation. (Almajali and Almubidin, 2022) in their exploration of Jordanian monetary policy, found limited but significant impacts on inflation and the output gap, with a pronounced effect on foreign reserves covering crucial imports. (Anderl and Caporale, 2023) extended this discourse by introducing the concept of asymmetric impact, emphasizing economic policy uncertainty (EPU) and oil price uncertainty (OPU). Their Nonlinear ARDL model revealed larger effects of EPU and OPU shocks when accounting for asymmetries. Furthermore, (Husaini and Lean, 2021) in their examination of Indonesia, Malaysia, and Thailand, identified an asymmetrical impact of oil price and exchange rate fluctuations on disaggregated price inflation, suggesting refinements in energy incentive programs. Meanwhile, (Sabayo et al., 2023) study on Tanzania highlighted the negative impact of oil price volatility on economic growth, coupled with a positive effect on inflation in the long run, reinforcing the importance of managing oil price volatility for economic stability. (Pradeep, 2022) investigating diesel price reforms in India, found a reduction in short and long-run asymmetric oil transmission post-reform, emphasizing a preference for passing oil price hikes. Additionally, (Osei, 2022) study in Brazil, utilizing a nonlinear model, uncovered nonlinear and asymmetric effects of oil prices on inflation, underlining the need to consider asymmetries in the inflation-oil price nexus. (Turan and Özer, 2022) extended this exploration to Central and Eastern European (CEE) countries, revealing significant short and long-run effects of oil price changes on inflation, emphasizing the role of asymmetries in explaining inflation dynamics. (Amroun and Smaali, 2022) research on Algeria noted the absence of a causal relationship between oil prices and inflation but highlighted the substantial impact of oil price fluctuations on inflation. Meanwhile, (Kpagih, 2022) study on Nigeria explored the relationship between energy prices and inflation, finding no long-run impact and varied short-run impacts. (Jiranyakul, 2021) examination of Asian and Pacific economies emphasized a stable positive long-run relationship between crude oil prices and inflation during periods of low and less fluctuating oil prices. Collectively, these studies contribute nuanced insights for policymakers, urging them to adopt region-specific and dynamic strategies. For instance, in the study by (Cutler and Chan, 2000), it was found that changes in commodity prices, including oil prices, aid in predicting inflation in the main consumer price index. Increases in commodity prices were associated with a higher inflation rate due to a high degree of openness, a relatively large share in the consumer price index, and the density of basic commodities in the manufacturing sector. In another study by (Khairuddin, 2008) the aim was to determine the effects of crude oil import price fluctuations and how these effects are transmitted to both price levels and the Jordanian trade deficit. This study measured the impact of oil prices separately from other import prices by using the method of analyzing small squares of logarithms of the variables in the model. The results indicated that the inflation rate in the kingdom was linked to changes in global oil prices in previous years, and the Jordanian trade balance was found to be flexible to oil price fluctuations. Similarly, (Cologni and Manera, 2008) revealed that oil prices significantly influence inflation, which, in turn, affects the real economy by raising interest rates. They employed a structurally integrated VAR model for the Group of

Seven countries. Furthermore, (Zhong et al., 2019) found that the indirect effects of oil price fluctuations on inflation in China were limited compared to the indirect effects in the United States. The dynamic relationship between international oil prices and inflation in China was weaker than the relationship between global oil prices and inflation in the United States. (Wu and Ni, 2011) estimated the relationships between oil prices, inflation, and interest rates. Their results, using time series analysis, showed a strong correlation between inflation and oil prices. However, none of the previous studies accounted for the indirect effects of oil prices, as oil prices do not directly affect inflation; there are intermediary prices represented by oil derivatives. This is what the current study aims to prove by measuring the impact of oil prices on derivatives, which, in turn, affect local inflation. Additionally, (Abduljawad et al., 2013) found a unidirectional causal relationship between the real-world oil price to the real GDP using causality analysis. (Malhotra and Krishna, 2015) demonstrated a positive and close-to-one relationship between the wholesale price index and global crude oil prices, with DCC-GARCH results showing a significant impact of global crude oil prices on inflation. (Naurin and Qayyum, 2016), using the EGARCH bivariate model, also found a positive relationship between oil prices and the consumer price index. Another study by (Abida and Abdul, 2016) using the EGARCH bivariate model discovered a positive relationship between oil prices and the consumer price index as well. (Malik, 2016) highlighted the significant role of energy prices in the inflation rates in Pakistan. (Zakaria, 2017), using the VAR-GARCH model, identified inconsistency in the local price response to external shocks and found that uncertainty in oil prices had a positive and significant impact on local prices. (Guechari, 2017) indicated that the economic impact of oil shocks on the Algerian economy was very limited, and most macroeconomic variables responded variably to oil price fluctuations. (Choi et al., 2018) demonstrated that a 10% increase in oil prices raised local inflation by 0.4%, and this effect disappeared after 2 years, being similar between advanced and developing economies. (Abubaker and Ali, 2018) concluded that there was a direct impact of crude oil price volatility on the inflation rate in the Omani economy. (Jamal, 2019) found a short- and long-term relationship between oil prices and inflation. In a study by Rehman et al. (2020), nonlinear effects of oil prices on inflation were found in both the United States and the United Kingdom. Moreover, a study by (Keček, 2023) aimed to estimate the impact of global energy price increases on the stability of the Croatian economy using the input-output model. The results indicated that the Croatian economy was highly sensitive to energy price shocks in various economic sectors and the overall economy.

Previous studies focused on exploring the relationship between oil prices and economic variables without investigating indirect relationships. As oil prices do not directly impact final commodity prices, but rather first affect oil derivative prices (such as gasoline, diesel, kerosene, etc.), these studies diverged from the approach taken in the current study, which seeks to measure this relationship. Moreover, from a statistical perspective, this study employs the DCC-GARCH model, which has not been commonly used in Jordan's economic research.

3. DATA AND METHODOLOGY

3.1. Data

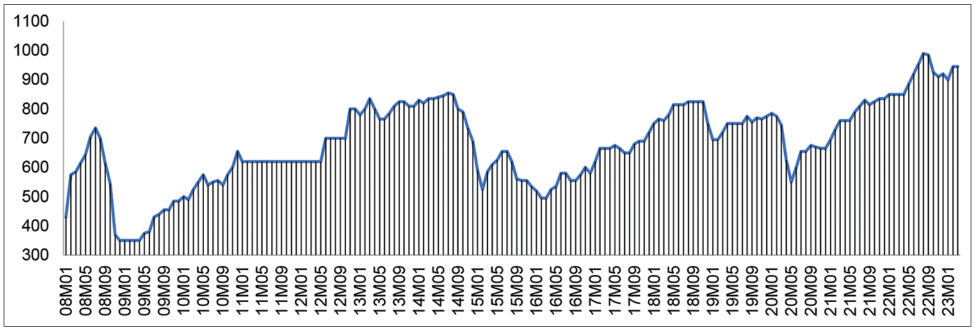
The energy sector in Jordan faces numerous challenges, including heavy reliance on international markets through imports, high costs of oil and petroleum derivatives imports, and the need to improve the specifications of petroleum derivatives to align with global standards for environmental protection and public safety. To address these challenges, there is a need to diversify the forms and sources of imported energy (oil and petroleum derivatives, electricity, natural gas) and expand the use of renewable energy sources. Additionally, improving energy efficiency in various sectors (industries, transportation) is essential (Al-Bataineh and Al-Louzi, 2008).

In Jordan, petroleum derivatives are priced according to a pricing mechanism based on the international price of the derivative itself. The pricing equation issued by the Ministry of Energy and Mineral Resources determines the selling price of petroleum derivatives in Jordan based on the average prices of petroleum derivatives in the global markets for the 30 days preceding the announcement date, according to Platts' bulletin. The pricing includes all costs of transporting the product from the global market to the consumer, including special taxes and stamp fees. The prices of petroleum derivatives also include additional costs determined from the world markets to Aqaba city, including the cost of marine transportation from Singapore to Yanbu, in addition to the cost of maritime shipping from Yanbu to Aqaba, including marine insurance and additional costs due to marine transportation and documentary credits. Regarding additional costs within Jordan, which involve transportation from Aqaba to the refinery and distribution to the stations, they include fees from the Ports Corporation, delay fines, and storage and handling costs at the refinery facilities. The additional costs also encompass transportation fees from the petroleum refinery in Zarqa to the fuel stations, in addition to the distribution costs, fuel station commissions, and inventory valuation change costs. Moreover, the additional costs include taxes and fees (special taxes in addition to stamp fees) (Ministry of Energy and Mineral Resources, 2023).

The prices of petroleum derivatives in Jordan have witnessed several fluctuations resulting from changes in the pricing mechanism. Jordan moved from subsidized prices until 2008, then suspended the subsidies from 2011 to 2012, and finally shifted to complete liberalization with monthly pricing. Additionally, these prices were affected by changes in global oil prices. Below, we provide an overview of the prices of petroleum derivatives in Jordan:

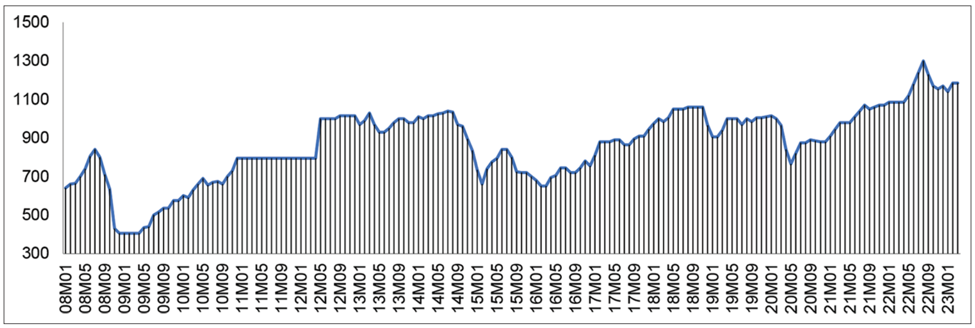
Gasoline Unleaded 90 Considered one of the most used petroleum derivatives in Jordan due to most cars in the country using this type of fuel. As shown in Figure 1, the prices of Gasoline Unleaded 90 decreased in 2008, then increased from 2010 to 2014. Subsequently, it decreased, deviating from the general trend, reaching 495 fl/L in March 2016. Afterward, prices started to increase again until 2018, and they rose again during the period from May 2020 to March 2022, reaching their highest level of 1300 fl/L in August 2022.

Figure 1: Gasoline unleaded 90 prices in Jordan (fl/L)



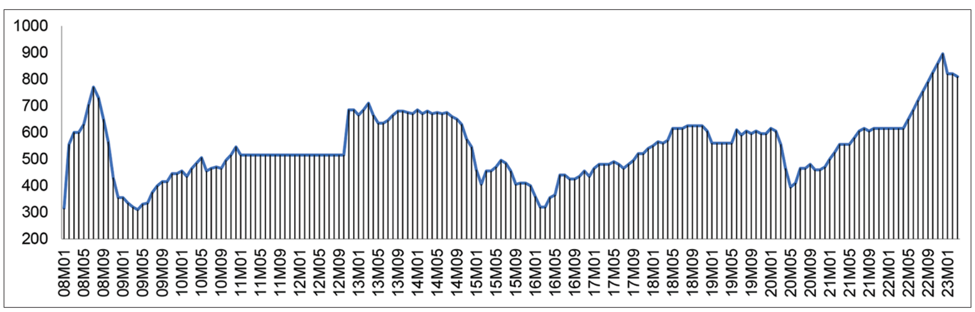
Source: Ministry of Energy and Mineral Wealth, Annual Reports, 2008-2023

Figure 2: Gasoline unleaded 95 prices in Jordan (fl/L)



Source: Ministry of Energy and Mineral Wealth, Annual Reports, 2008-2023

Figure 3: Diesel prices in Jordan (fl/L)



Source: Ministry of Energy and Mineral Wealth, Annual Reports, 2008-2023

Gasoline Unleaded 95 This type of gasoline is consumed less compared to Gasoline Unleaded 90 due to its higher prices. Only a few cars in Jordan use this type of fuel. As depicted in Figure 2, the prices of Gasoline Unleaded 95 decreased from 2008 to 2010, then increased until 2014. Later, they deviated from the general trend, reaching 650 fl/L in March 2016. Prices then increased again until 2018, and they reached their highest-level of 1300 fl in August 2022.

The prices of diesel and kerosene (Figures 3 and 4) are considered subsidized compared to gasoline prices. They also witnessed fluctuations during the study period.

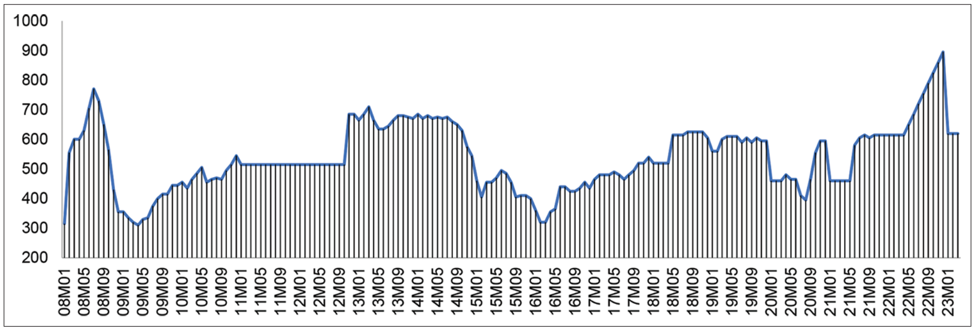
Overall, the pricing of petroleum derivatives in Jordan has been influenced by both international market prices and the changes in the pricing mechanism adopted by the government over time (Ministry of Energy and Mineral Resources, 2018).

Expressing oil derivatives prices in Jordan is complex, considering the impact of each price. To simplify this complexity, an index was constructed to represent the movements of all oil derivatives prices. This involved dividing all prices (Gasoline Unleaded 90, Gasoline Unleaded 95, kerosene, and diesel) by the base year 2012, which was considered a stable year for global oil prices and had average prices during the study period. The average prices were then calculated as shown in Annex (A) using the following equation:

$$DR_{INDEX} = \sum_{i}^{n} \frac{DR_{it}}{DR_{i}2012} \times 100 \quad (1)$$

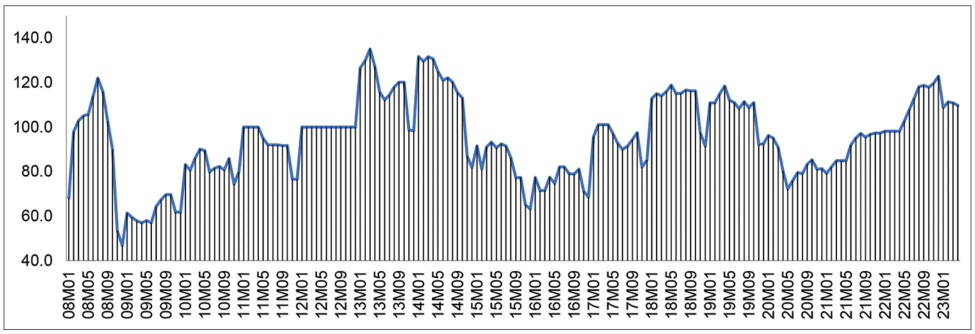
When DR: The prices of oil derivatives (Gasoline Unleaded 90, Gasoline Unleaded 95, kerosene, and diesel) in year t compared to the prices of oil derivatives in the base year, the Figure 5 illustrates the movements of the Oil Derivatives Price Index in Jordan from 2008 to 2023, showing fluctuations during the study period.

Figure 4: Kerosene prices in Jordan (fl/L)



Source: Ministry of Energy and Mineral Wealth, Annual Reports, 2008-2023

Figure 5: Oil derivatives price index in Jordan (basis point)



Source: Compiled by the researcher based on oil derivatives prices announced by the Ministry of Energy and Mineral Resources

3.2. Methodology

In this study, the initial step in econometric analysis involves assessing the stationarity of the time series data. This assessment is crucial as it underpins the modeling of the data generation process (Lütkepohl and Krätzig 2004). The Augmented Dickey-Fuller test (Dickey and Fuller 1981) (Said and Dickey, 1984) posits the null hypothesis that the data is non-stationary or integrated of order d (d > 0), denoted as I (1) (Noman and Zillur Rahman 2010), (Kwiatkowski et al., 1992).

The methodology used to Assessing the Influence of Global Energy Price Fluctuations on Oil Derivative and Domestic Prices in Jordan, using a GARCH-DCC (Generalized Autoregressive Conditional Heteroskedasticity – Dynamic Conditional Correlation) model. Once this correlation is determined, it is analyzed how it evolves in each of the identified Oil Derivative and Domestic Prices in Jordan. We consider that this approach is suitable because, in the view of this study, the oil derivatives price index in Jordan is associated with the occurrence of excessive co-movements in oil price, and Jordanian CPI is also associated with the oil derivatives price index, i.e. to episodes of increased correlation between oil derivatives price index with the oil price, which can therefore reflect on Jordanian CPI. The Dynamic Conditional Correlation GARCH model, abbreviated as DCC-GARCH, was introduced by Engle (2002) and Tse and Tsui (2002). What sets this model apart from others, such as the constant conditional correlation model proposed by Bollerslev (1990), is its ability to capture the changing nature of the conditional correlation matrix over time.

One significant advantage of employing the DCC-GARCH model lies in its capacity to identify shifts in conditional correlations over time (Schwert and Seguin, 2002). This capability enables the examination of the dynamic behavior of the Jordanian consumer price index (CPI) in response to changes in the Jordanian oil derivatives price index and the global oil price. Furthermore, the dynamic conditional correlation measure proves suitable for scrutinizing potential alterations in the oil derivatives price index and the Jordanian CPI due to fluctuations in global oil price volatility.

For each variable, specify a univariate GARCH model. Let's consider i_index and oil_price, where the GARCH(1,1) model for each variable can be represented as follows:

$$\ln(dr\_index_t) = \sigma_{i,t} * \varepsilon_i, t \qquad 2$$

$$\hat{\sigma}^2_{i,t} = \omega_i + \alpha_i * \ln(dr\_index^2_{t-1}) + \beta_i \ \sigma^2_{i,t-1} \qquad 3$$

$$\ln(oil\_price_t) = \sigma_{o,t} * \varepsilon_o, t \qquad 4$$

$$\hat{\sigma}^2_{o,t} = \omega_o + \alpha_o * \ln(oil\_price^2_{t-1}) + \beta_o \ \sigma^2_{o,t-1} \qquad 5$$

$$\ln(cpi_t) = \sigma_{d,t} * \varepsilon_{od}, t \qquad 6$$

$$\hat{\sigma}^2_{d,t} = \omega_d + \alpha_d * \ln(cpi^2_{t-1}) + \beta_d \ \sigma^2_{d,t-1} \qquad 7$$

Where ln: Natural logarithm, *dr_index*: Oil derivatives price index in Jordan, and *oil_price*: Brent oil prices, *cpi*: Consumer price index, *t*: Time, $\varepsilon_{i,t}$ and $\varepsilon_{o,t}$ are the standardized residuals, and $\hat{\sigma}^2_{i,t}$, $\hat{\sigma}^2_{d,t}$ and $\hat{\sigma}^2_{o,t}$ are the conditional variances for *dr _index*, *cpi* and *oil_price*.

To estimate the conditional correlation between *dr_index*, *cpi* and *oil_price* using the dynamic conditional correlation model. A simplified representation might be:

Table 1: Stationary test (unit root test [ADF])

	At level		
Type of test	**P_OIL**	**DR_INDEX**	**CPI**
With constant			
t-Statistic	−2.4704	−2.3070	−0.5652
Prob.	0.1245	0.1709	0.8739
Result	no	no	no
With constant and trend			
t-Statistic	−2.5217	−2.3117	−2.0854
Prob.	0.3174	0.4251	0.5501
Result	no	no	no
Without constant and trend			
t-Statistic	−1.0012	0.2163	3.5284
Prob.	0.2835	0.7480	0.9999
Result	no	no	no
At first difference			
	d (P_OIL)	d (DR_INDEX)	d (CPI)
With constant			
t-Statistic	−9.2513	−11.6995	−12.4426
Prob.	0.0000	0.0000	0.0000
Result	***	***	***
With constant and trend			
t-Statistic	−9.2312	−11.6629	−12.3644
Prob.	0.0000	0.0000	0.0000
Result	***	***	***
Without constant and trend			
t-Statistic	−9.2723	−11.7395	−6.5217
Prob.	0.0000	0.0000	0.0000
Result	***	***	***

a: (*) Significant at the 10%; (**) Significant at the 5%; (***) Significant at the 1% and (no) Not Significant, b: Lag Length based on SIC, c: Probability based on MacKinnon (1996) one-sided *P* values

Table 2: Selection of the suitable DCC-Garch model

Model	SIC	AIC
DCC-ARCH (1)	−1.31	−1.44
DCC-ARCH (2)	−1.28	−1.42
DCC-ARCH (3)	−1.26	−1.43
DCC-ARCH (4)	−1.22	−1.41
DCC-GARCH (1 ,1)	−1.54	−1.69
DCC-GARCH (1 ,2)	−1.57	−1.73
DCC-GARCH (2 ,1)	−1.57	−1.73
DCC-GARCH (2 ,2)	−1.69	−1.87

SIC: Schwarz Information Criterion, AIC: Akaike Information Criterion

$$\rho_{io,t} = \rho_{bar,io} + \alpha_{io} * \varepsilon_{i,t-1} * \varepsilon_{o,t-1} + \beta_{io} * \rho_{io,t-1} \quad 8$$

$$\rho_{id,t} = \rho_{bar,do} + \alpha_{do} * \varepsilon_{i,t-1} * \varepsilon_{d,t-1} + \beta_{io} * \rho_{id,t-1} \quad 9$$

Here, $\rho_{io,t}$ represents the conditional correlation between *dr_index* and *oil_price*, $\rho_{bar,io}$ is the long-term average correlation, α_{io} and β_{io} are parameters, and $\varepsilon_{i,t-1}$ and $\varepsilon_{o,t-1}$ are the lagged standardized residuals. $\rho_{id,t}$ the conditional correlation between *dr_index* and *cpi*. With combine the univariate GARCH models and the correlation dynamics to create a DCC-GARCH model. The conditional covariance between (*dr_index* and *oil_price*), (*cpi* and *dr_index*) at time *t* can be expressed as:

$$Cov(\ln(i\_index_t), \ln(oil\_price_t)) = \sigma_{i,t} * \sigma_{o,t} * \rho_{io,t} \quad 10$$

$$Cov(\ln(cpi_t), \ln(i\_index_t)) = \sigma_{d,t} * \sigma_{i,t} * \rho_{di,t} \quad 11$$

4. DATA ANALYSIS

In this part of the study, the impact of global oil prices, represented by Brent oil prices, on the index of local derivative prices in Jordan was measured. Subsequently, the impact of derivative prices on the consumer price index was measured through the estimation of the DDC-GARCH model. Data were also filtered from seasonal effects, as monthly data may contain seasonal effects that hinder the identification of the real impact on both local and global prices assessing the stationarity of the time series data. The appropriate dimensions of the GARCH model were determined based on the Akaike information criterion (AIC) and the Schwarz information criterion (SIC), along with the significance of the estimated parameters.

4.1. Stationary Test

The ADF test results Table 1 shows that the series are likely not stationary at level where stationary after taking the first difference of the series.

4.2. Impact of Oil Prices on Derivative Prices in Jordan

To select the best dimensions of the DCC-GARCH model, which will be used to measure fluctuations in oil prices on derivative prices in Jordan, the Akaike Information Criterion (AIC) and the

Table 3: Results of impact of oil prices on derivative prices in Jordan

Variable	Parameter	Standard error	Z test	Probability
@SQRT (GARCH)	−5.29	0.33	−15.93	0.0000
LOG (P_BRENT)	0.21	0.06	3.48	0.0005
C	4.201	0.27	15.49	0.0000
Variance equation				
C (4)	−0.75	0.37	−2	0.0411
C (5)	−0.17	0.04	−3.98	0.0001
C (6)	−0.27	0.04	−5.9	0.0000
C (7)	−0.43	0.03	−12.4	0.0000
C (8)	0.73	0.06	11.1	0.0000
C (9)	0.06	0.08	0.8	0.408
R-squared	0.77		Value (theta (1) = 0.568)	
Adjusted R-squared	0.76		Value (theta (2) = 0.104)	
Durbin-Watson stat	1.67		* Stability condition: theta (1) + theta (2) < 1 is met.	

Schwarz Information Criterion (SIC) were relied upon (Table 2). The appropriate model is the one with the lowest values for the criteria, and significant estimated parameters. Table 3 shows the estimated models and the values of the two criteria, indicating that DCC-GARCH (2,2) model is the best as it has the lowest values for AIC and SIC.

The results of estimating the DCC-GARCH (2,2) model, as shown in Table 3, indicate that the relationship between global oil prices (Brent) and derivative prices in Jordan is positive. This finding is consistent with theoretical literature and previous studies regarding the direction of the relationship. The magnitude of the impact indicates that a 1% increase in Brent oil prices leads to a 0.21% increase in derivative prices in Jordan. However, this impact is considered weak due to specific taxes imposed on derivative prices, ranging from approximately 42 to 52%. Moreover, there are several other fixed costs in the mechanism of pricing derivative products in Jordan, such as storage and transportation costs, loss allowances, and import expenses.

The significance of model indicates that they are statistically significant at a probability level of 0.000. The model's explanatory power is 77%, additionally, the Durbin-Watson statistic (DW) suggests no autocorrelation problem. Furthermore, the stability test of the model's results indicates that the values of theta (1) and theta (2) in the model are <1, suggesting stability. The ARCH test is used to test the randomness of time series errors, meaning to test whether the errors follow a normal distribution. This is accomplished by modelling the DCC-GARCH model's squared errors in an autoregressive model and then testing for the presence of autocorrelation. The test statistics are compared with critical values for the chi-square test at a 5% significance level to decide on the test. We reject the hypothesis that there is no ARCH effect if the estimated value exceeds the critical value or the likelihood is <5%, and vice versa. Table 4 reveals that the ARCH test probability values are larger than 5%, indicating that the null hypothesis is not rejected. This implies that the errors are random and dispersed independently, confirming the model's appropriateness.

Table 4: Results of ARCH test

F-statistic	1.096511	Prob. F (1,141)	0.2968
Obs*R-squared	1.103482	Prob. Chi-Square (1)	0.2935

Table 5: Selection of the Suitable GARCH Model for the Impact of Oil Prices on Oil Derivative Prices

Model	SIC	AIC
ARCH (1)	−3.93	−4.09
ARCH (2)	−4.09	−4.28
ARCH (3)	−3.82	−4.03
ARCH (4)	−3.08	−3.31
GARCH (1 ,1)	−4.77	−4.93
GARCH (1 ,2)	−4.44	−4.59
GARCH (2 ,1)	−4.14	−4.03
GARCH (2 ,2)	−4.16	−4.04

4.3. Impact of Oil Derivative Prices in Jordan on the Consumer Price Index

We used two criteria to determine the appropriate dimensions for the DCC-GARCH model to quantify the influence of oil derivative prices in Jordan on the consumer price index (CPI): The Akaike Information Criterion (AIC) and the Schwarz Information Criterion (SIC). The calculated models and associated criterion values are shown in Table 5. The findings show that the DCC-GARCH (1,1) model is the best fit, since it has the lowest AIC and SIC values.

The results of estimating the DCC-GARCH(1,1) model, as shown in Table 6, indicate that there is a positive relationship between oil derivative prices in Jordan and the consumer price index (CPI). These findings align with theoretical literature and previous studies regarding the direction of the relationship. As for the magnitude of the impact, the estimates suggest that a 1% increase in oil derivative prices leads to a 0.23% increase in the consumer price index (CPI).

Moreover, the statistical significance of the oil derivative prices parameter in Jordan indicates that it is statistically significant, with a probability value of 0.000. The explanatory power of the model reached 67%, the Durbin-Watson (DW) statistic indicates the absence of autocorrelation issues. Furthermore, the stability test of the model's results reveals that the values of theta (1) and theta (2) in the model are <1. Table 7 shows that the probability values for the ARCH tests are > 5%. This indicates the non-rejection of the hypothesis of no ARCH effect, suggesting that the residuals are random and independently distributed. This confirms the adequacy of the model and its suitability.

Table 6: Estimating Oil Derivative Prices in Jordan on the CPI

	Parameter	Standard error	Z test	Probability
@SQRT (GARCH)	−2.56	0.46	−5.53	0.0000
LOG (DR_INDEX)	0.23	0.02	10.86	0.0000
C	3.81	0.09	41.27	0.0000
Variance equation				
C (4)	−5.19	0.64	−8.08	0.0000
C (5)	0.41	0.08	4.68	0.0000
C (6)	0.85	0.15	5.59	0.0000
C (7)	0.27	0.08	3.43	0.0006
C (8)	−0.82	0.14	−5.73	0.0000
C (9)	0.32	0.1	3.17	0.0015
R-squared	0.67	Value (theta (1) = 0.48)		
Adjusted R-squared	0.667	Value (theta (2) = 0.51)		
Durbin-Watson stat	1.89	* Stability condition: theta (1) + theta (2) < 1 is met.		

CPI: Consumer price index

Table 7: Results of the ARCH test

Heteroskedasticity Test: ARCH			
F-statistic	0.103809	Prob. F(1,141)	0.7478
Obs*R-squared	0.105204	Prob. Chi-Square(1)	0.7457

5. CONCLUSION AND RECOMMENDATIONS

The study's findings reveal that fluctuations in global oil prices, specifically the Brent benchmark, have a discernible impact on local oil derivative prices in Jordan. However, the reverse causal relationship is not supported, indicating a unidirectional link from oil prices to oil derivatives. The estimated DCC-GARCH model further quantifies this connection, demonstrating that a 1% increase in Brent oil prices corresponds to a 0.21% increase in local oil derivative prices within Jordan. Moreover, a 1% uptick in local oil derivative prices corresponds to a 0.23% increase in the consumer price index.

Based on the study's findings, the following recommendations are proposed:

1. Reevaluate the mechanism of pricing oil derivatives in Jordan and explore methods to mitigate the impact of global fluctuations on local prices. This could involve reducing the taxes imposed on oil derivatives to increase their price flexibility towards global trends. Additionally, investigate the efficiency of importation, storage, and distribution processes, as they directly affect the final cost of oil derivatives. Furthermore, consider allowing other private companies, aside from petroleum refineries, to import oil derivatives and engage in refining activities, fostering more competition that can positively influence pricing effectiveness in Jordan.
2. Monthly pricing adjustments may contribute to fluctuations in the consumer price index (CPI) due to global volatilities. Therefore, researching mechanisms to minimize the volatility of oil derivative prices would enhance local price stability, especially considering its significant impact, which amounts to 0.23%.

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ANNEX

Annex A: Oil Derivatives Price Index in Jordan (basis point)

	Price of				Sub index of				DR_INDEX (Basis point)
	Gasoline Unleaded 90 FILS/ LITER	Gasoline Unleaded 95 FILS/ LITER	GASOLINE FILS/LITER	DIESEL FILS/ LITER	Gasoline Unleaded 90 (Basis point)	Gasoline Unleaded 95 (Basis point)	GASOLINE (Basis point)	DIESEL (Basis point)	
08M01	430	640	315	315	69.4	80.5	61.2	61.2	68.0
08M02	575	660	555	555	92.7	83.0	107.8	107.8	97.8
08M03	585	665	600	600	94.4	83.6	116.5	116.5	102.8
08M04	615	700	600	600	99.2	88.1	116.5	116.5	105.1
08M05	645	740	630	630	104.0	74.0	122.3	122.3	105.7
08M06	705	805	705	705	100.7	80.5	136.9	136.9	113.8
08M07	735	840	770	770	105.0	84.0	149.5	149.5	122.0
08M08	700	800	730	730	100.0	80.0	141.7	141.7	115.9
08M09	615	710	650	650	87.9	70.0	126.2	126.2	102.6
08M10	545	635	565	565	77.9	62.6	109.7	109.7	90.0
08M11	370	430	430	430	46.3	42.4	62.8	62.8	53.5
08M12	350	405	355	355	43.8	39.9	51.8	51.8	46.8
09M01	350	405	355	355	56.5	50.9	68.9	68.9	61.3
09M02	350	405	335	335	56.5	50.9	65.0	65.0	59.4
09M03	350	405	320	320	56.5	50.9	62.1	62.1	57.9
09M04	350	405	310	310	56.5	50.9	60.2	60.2	56.9
09M05	375	435	330	330	60.5	43.5	64.1	64.1	58.0
09M06	380	440	335	335	54.3	44.0	65.0	65.0	57.1
09M07	430	500	375	375	61.4	50.0	72.8	72.8	64.3
09M08	440	515	400	400	62.9	51.5	77.7	77.7	67.4
09M09	455	535	415	415	65.0	52.7	80.6	80.6	69.7
09M10	455	535	415	415	65.0	52.7	80.6	80.6	69.7
09M11	485	575	445	445	60.6	56.7	65.0	65.0	61.8
09M12	485	575	445	445	60.6	56.7	65.0	65.0	61.8
10M01	500	600	455	455	80.6	75.5	88.3	88.3	83.2
10M02	490	590	435	435	79.0	74.2	84.5	84.5	80.5
10M03	525	630	465	465	84.7	79.2	90.3	90.3	86.1
10M04	550	660	485	485	88.7	83.0	94.2	94.2	90.0
10M05	575	690	505	505	92.7	69.0	98.1	98.1	89.5
10M06	540	655	455	455	77.1	65.5	88.3	88.3	79.8
10M07	550	670	465	465	78.6	67.0	90.3	90.3	81.5
10M08	555	675	470	470	79.3	67.5	91.3	91.3	82.3
10M09	540	660	465	465	77.1	65.0	90.3	90.3	80.7
10M10	575	700	495	495	82.1	69.0	96.1	96.1	85.8
10M11	600	730	515	515	75.0	71.9	75.2	75.2	74.3
10M12	655	795	545	545	81.9	78.3	79.6	79.6	79.8
11M01	620	795	515	515	100.0	100.0	100.0	100.0	100.0
11M02	620	795	515	515	100.0	100.0	100.0	100.0	100.0
11M03	620	795	515	515	100.0	100.0	100.0	100.0	100.0
11M04	620	795	515	515	100.0	100.0	100.0	100.0	100.0
11M05	620	795	515	515	100.0	79.5	100.0	100.0	94.9
11M06	620	795	515	515	88.6	79.5	100.0	100.0	92.0
11M07	620	795	515	515	88.6	79.5	100.0	100.0	92.0
11M08	620	795	515	515	88.6	79.5	100.0	100.0	92.0
11M09	620	795	515	515	88.6	78.3	100.0	100.0	91.7
11M10	620	795	515	515	88.6	78.3	100.0	100.0	91.7
11M11	620	795	515	515	77.5	78.3	75.2	75.2	76.5
11M12	620	795	515	515	77.5	78.3	75.2	75.2	76.5
12M01	620	795	515	515	100.0	100.0	100.0	100.0	100.0
12M02	620	795	515	515	100.0	100.0	100.0	100.0	100.0
12M03	620	795	515	515	100.0	100.0	100.0	100.0	100.0
12M04	620	795	515	515	100.0	100.0	100.0	100.0	100.0
12M05	620	1000	515	515	100.0	100.0	100.0	100.0	100.0
12M06	700	1000	515	515	100.0	100.0	100.0	100.0	100.0
12M07	700	1000	515	515	100.0	100.0	100.0	100.0	100.0
12M08	700	1000	515	515	100.0	100.0	100.0	100.0	100.0
12M09	700	1015	515	515	100.0	100.0	100.0	100.0	100.0

(Contd...)

Annex A: ***(Continued)***

	Price of				Sub index of				DR_INDEX (Basis point)
	Gasoline Unleaded 90 FILS/ LITER	Gasoline Unleaded 95 FILS/ LITER	GASOLINE FILS/LITER	DIESEL FILS/ LITER	Gasoline Unleaded 90 (Basis point)	Gasoline Unleaded 95 (Basis point)	GASOLINE (Basis point)	DIESEL (Basis point)	
12M10	700	1015	515	515	100.0	100.0	100.0	100.0	100.0
12M11	800	1015	685	685	100.0	100.0	100.0	100.0	100.0
12M12	800	1015	685	685	100.0	100.0	100.0	100.0	100.0
13M01	780	970	665	665	125.8	122.0	129.1	129.1	126.5
13M02	800	990	685	685	129.0	124.5	133.0	133.0	129.9
13M03	835	1030	710	710	134.7	129.6	137.9	137.9	135.0
13M04	800	970	665	665	129.0	122.0	129.1	129.1	127.3
13M05	765	930	635	635	123.4	93.0	123.3	123.3	115.7
13M06	765	930	635	635	109.3	93.0	123.3	123.3	112.2
13M07	785	950	645	645	112.1	95.0	125.2	125.2	114.4
13M08	810	980	665	665	115.7	98.0	129.1	129.1	118.0
13M09	825	1000	680	680	117.9	98.5	132.0	132.0	120.1
13M10	825	1000	680	680	117.9	98.5	132.0	132.0	120.1
13M11	810	980	675	675	101.3	96.6	98.5	98.5	98.7
13M12	810	980	670	670	101.3	96.6	97.8	97.8	98.4
14M01	830	1010	685	685	133.9	127.0	133.0	133.0	131.7
14M02	820	1000	670	670	132.3	125.8	130.1	130.1	129.6
14M03	835	1015	680	680	134.7	127.7	132.0	132.0	131.6
14M04	835	1015	670	670	134.7	127.7	130.1	130.1	130.6
14M05	840	1025	675	675	135.5	102.5	131.1	131.1	125.0
14M06	845	1030	670	670	120.7	103.0	130.1	130.1	121.0
14M07	855	1040	675	675	122.1	104.0	131.1	131.1	122.1
14M08	850	1035	660	660	121.4	103.5	128.2	128.2	120.3
14M09	800	970	650	650	114.3	95.6	126.2	126.2	115.6
14M10	790	960	630	630	112.9	94.6	122.3	122.3	113.0
14M11	735	895	575	575	91.9	88.2	83.9	83.9	87.0
14M12	690	835	545	545	86.3	82.3	79.6	79.6	81.9
15M01	590	735	460	460	95.2	92.5	89.3	89.3	91.6
15M02	525	660	405	405	84.7	83.0	78.6	78.6	81.2
15M03	585	740	455	455	94.4	93.1	88.3	88.3	91.0
15M04	610	775	455	455	98.4	97.5	88.3	88.3	93.1
15M05	625	795	470	470	100.8	79.5	91.3	91.3	90.7
15M06	655	840	495	495	93.6	84.0	96.1	96.1	92.5
15M07	655	840	485	485	93.6	84.0	94.2	94.2	91.5
15M08	620	800	455	455	88.6	80.0	88.3	88.3	86.3
15M09	560	725	405	405	80.0	71.4	78.6	78.6	77.2
15M10	555	720	410	410	79.3	70.9	79.6	79.6	77.4
15M11	555	720	410	410	69.4	70.9	59.9	59.9	65.0
15M12	535	700	400	400	66.9	69.0	58.4	58.4	63.2
16M01	520	680	360	360	83.9	85.5	69.9	69.9	77.3
16M02	495	650	320	320	79.8	81.8	62.1	62.1	71.5
16M03	495	650	320	320	79.8	81.8	62.1	62.1	71.5
16M04	525	695	355	355	84.7	87.4	68.9	68.9	77.5
16M05	535	705	365	365	86.3	70.5	70.9	70.9	74.6
16M06	580	745	440	440	82.9	74.5	85.4	85.4	82.1
16M07	580	745	440	440	82.9	74.5	85.4	85.4	82.1
16M08	555	720	425	425	79.3	72.0	82.5	82.5	79.1
16M09	555	720	425	425	79.3	70.9	82.5	82.5	78.8
16M10	575	745	435	435	82.1	73.4	84.5	84.5	81.1
16M11	600	780	455	455	75.0	76.8	66.4	66.4	71.2
16M12	580	755	435	435	72.5	74.4	63.5	63.5	68.5
17M01	620	810	465	465	100.0	101.9	90.3	90.3	95.6
17M02	665	880	480	480	107.3	110.7	93.2	93.2	101.1
17M03	665	880	480	480	107.3	110.7	93.2	93.2	101.1
17M04	665	880	480	480	107.3	110.7	93.2	93.2	101.1
17M05	675	890	490	490	108.9	89.0	95.1	95.1	97.0
17M06	665	890	480	480	95.0	89.0	93.2	93.2	92.6
17M07	650	865	465	465	92.9	86.5	90.3	90.3	90.0
17M08	650	865	480	480	92.9	86.5	93.2	93.2	91.4
17M09	680	895	495	495	97.1	88.2	96.1	96.1	94.4

(Contd...)

Annex A: ***(Continued)***

	Price of				Sub index of				DR_INDEX (Basis point)
	Gasoline Unleaded 90 FILS/ LITER	Gasoline Unleaded 95 FILS/ LITER	GASOLINE FILS/LITER	DIESEL FILS/ LITER	Gasoline Unleaded 90 (Basis point)	Gasoline Unleaded 95 (Basis point)	GASOLINE (Basis point)	DIESEL (Basis point)	
17M10	690	910	520	520	98.6	89.7	101.0	101.0	97.5
17M11	690	910	520	520	86.3	89.7	75.9	75.9	81.9
17M12	720	945	540	540	90.0	93.1	78.8	78.8	85.2
18M01	750	975	520	550	121.0	122.6	101.0	106.8	112.8
18M02	765	1000	520	565	123.4	125.8	101.0	109.7	115.0
18M03	760	985	520	560	122.6	123.9	101.0	108.7	114.0
18M04	780	1005	520	570	125.8	126.4	101.0	110.7	116.0
18M05	815	1050	615	615	131.5	105.0	119.4	119.4	118.8
18M06	815	1050	615	615	116.4	105.0	119.4	119.4	115.1
18M07	815	1050	615	615	116.4	105.0	119.4	119.4	115.1
18M08	825	1060	625	625	117.9	106.0	121.4	121.4	116.6
18M09	825	1060	625	625	117.9	104.4	121.4	121.4	116.3
18M10	825	1060	625	625	117.9	104.4	121.4	121.4	116.3
18M11	825	1060	625	625	103.1	104.4	91.2	91.2	97.5
18M12	750	965	605	605	93.8	95.1	88.3	88.3	91.4
19M01	695	905	560	560	112.1	113.8	108.7	108.7	110.9
19M02	695	905	560	560	112.1	113.8	108.7	108.7	110.9
19M03	720	940	600	560	116.1	118.2	116.5	108.7	114.9
19M04	750	1000	610	560	121.0	125.8	118.4	108.7	118.5
19M05	750	1000	610	560	121.0	100.0	118.4	108.7	112.0
19M06	750	1000	610	610	107.1	100.0	118.4	118.4	111.0
19M07	750	970	590	590	107.1	97.0	114.6	114.6	108.3
19M08	775	1000	605	605	110.7	100.0	117.5	117.5	111.4
19M09	755	985	590	595	107.9	97.0	114.6	115.5	108.7
19M10	770	1005	605	605	110.0	99.0	117.5	117.5	111.0
19M11	765	1005	595	595	95.6	99.0	86.9	86.9	92.1
19M12	775	1010	595	595	96.9	99.5	86.9	86.9	92.5
20M01	785	1015	460	615	98.1	100.0	67.2	119.4	96.2
20M02	775	1000	460	605	96.9	98.5	67.2	117.5	95.0
20M03	745	965	460	555	93.1	95.1	67.2	107.8	90.8
20M04	625	840	480	465	78.1	82.8	70.1	90.3	80.3
20M05	550	765	465	395	68.8	75.4	67.9	76.7	72.2
20M06	600	820	465	410	75.0	80.8	67.9	79.6	75.8
20M07	655	875	410	465	81.9	86.2	59.9	90.3	79.6
20M08	655	875	395	465	81.9	86.2	57.7	90.3	79.0
20M09	675	890	465	480	84.4	87.7	67.9	93.2	83.3
20M10	670	885	555	460	83.8	87.2	81.0	89.3	85.3
20M11	665	880	595	460	83.1	86.7	86.9	67.2	81.0
20M12	665	880	595	470	83.1	86.7	86.9	68.6	81.3
21M01	695	910	460	500	86.9	89.7	67.2	73.0	79.2
21M02	730	945	460	525	91.3	93.1	67.2	76.6	82.0
21M03	760	980	460	555	95.0	96.6	67.2	81.0	84.9
21M04	760	980	460	555	95.0	96.6	67.2	81.0	84.9
21M05	760	980	460	555	95.0	96.6	67.2	81.0	84.9
21M06	790	1010	580	580	98.8	99.5	84.7	84.7	91.9
21M07	810	1040	605	605	101.3	102.5	88.3	88.3	95.1
21M08	830	1070	615	615	103.8	105.4	89.8	89.8	97.2
21M09	815	1050	605	605	101.9	103.4	88.3	88.3	95.5
21M10	825	1060	615	615	103.1	104.4	89.8	89.8	96.8
21M11	835	1070	615	615	104.4	105.4	89.8	89.8	97.3
21M12	835	1070	615	615	104.4	105.4	89.8	89.8	97.3
22M01	850	1085	615	615	106.3	106.9	89.8	89.8	98.2
22M02	850	1085	615	615	106.3	106.9	89.8	89.8	98.2
22M03	850	1085	615	615	106.3	106.9	89.8	89.8	98.2
22M04	850	1085	615	615	106.3	106.9	89.8	89.8	98.2
22M05	885	1120	650	650	110.6	110.3	94.9	94.9	102.7
22M06	920	1180	685	685	115.0	116.3	100.0	100.0	107.8
22M07	955	1240	720	720	119.4	122.2	105.1	105.1	112.9
22M08	990	1300	755	755	123.8	128.1	110.2	110.2	118.1
22M09	985	1230	790	790	123.1	121.2	115.3	115.3	118.7

(Contd...)

Annex A: ***(Continued)***

	Price of				Sub index of				DR_INDEX (Basis point)
	Gasoline Unleaded 90 FILS/ LITER	Gasoline Unleaded 95 FILS/ LITER	GASOLINE FILS/LITER	DIESEL FILS/ LITER	Gasoline Unleaded 90 (Basis point)	Gasoline Unleaded 95 (Basis point)	GASOLINE (Basis point)	DIESEL (Basis point)	
22M10	925	1170	825	825	115.6	115.3	120.4	120.4	117.9
22M11	910	1155	860	860	113.8	113.8	125.5	125.5	119.7
22M12	920	1170	895	895	115.0	115.3	130.7	130.7	122.9
23M01	900	1140	620	820	112.5	112.3	90.5	119.7	108.8
23M02	945	1185	620	820	118.1	116.7	90.5	119.7	111.3
23M03	945	1185	620	810	118.1	116.7	90.5	118.2	110.9
23M04	940	1180	620	785	117.5	116.3	90.5	114.6	109.7