European Economic Letters
ISSN 2323-5233
Vol 14, Issue 2 (2024)
http://eelet.org.uk

The Impact of Volatile Oil Prices on the Indicators of Foreign Trade in Algeria during the Period (1990-2022)

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Received: 18/04/2024 **Accepted: 10/06/2024** **Published: 16/06/2024**

Abstract:

This study aims to highlight the impact of oil prices fluctuations on Algeria's foreign trade indicators during the period 1990-2022 and how various factors interact with oil prices development and affect the Algerian economy. Two econometric models were employed to address the research problem; the former is the ARIMA-ARCH model, a standard predictive model for analyzing volatility and oil price fluctuations during the study period, the latter is the Vector Auto regression VAR (p) model, used to analyze the impact of oil price volatility shocks on the study variables. It was found that the model reflects the complex dynamics between trade flows, openness, exchange rates, and oil volatility in Algeria. Among the key findings are: Oil price volatility initially affects increasing economic openness by boosting trade flows but later leads to somewhat discouraged exports. There are substitution effects between exports and imports. Export growth tends to lead to currency appreciation over time. Trade openness can exert downward pressure on the currency value. Finally, stability in all variables implies that shocks can have long-lasting effects. These points highlight the intricate relationships between economic factors in Algeria and underscore the importance of understanding these relationships for sound policy and economic decision-making.

Keywords: Oil Prices, Foreign Trade Indicators, Volatility, Exchange Rate.

Introduction

Oil is one of the most important economic resources in Algeria and constitutes a major source of external revenues and national income. Despite its great economic importance, oil prices were subject to significant fluctuations during the period from 1990 to 2022, as a result of changes in global markets and international political and economic factors. This study aims to explore the impact of those fluctuations in oil prices on Algeria's foreign trade indicators during the said period. We will analyze the changes in the trade openness index, exports, and imports, and focus on how these factors interact with oil price developments and how the Algerian economy in general has been affected by those changes. By understanding this impact, we will be able to identify effective strategies to enhance the Algerian economy's resistance to future oil price fluctuations and enhance its economic and financial stability.

We will use two measurement models to analyze the research topic, the first model is the ARIMA-ARCH model, which is a standard predictive model to analyze the fluctuations and volatility of oil prices during the study period, the second model is the multiple regression model var (p) , to analyze the shocks of oil price fluctuations on the study variables.

First: The standard study of oil price fluctuations during the period (1990-2022)

Oil price fluctuations are a complex economic phenomenon that significantly affects global economies, and Algeria is one of the countries most affected by these fluctuations due to its heavy dependence on oil exports as a major source of external revenues. This section of the study aims to perform a standard analysis of oil price fluctuations during the period from 1990 to 2022 using the ARIMA-ARCH model.

1- Stability Study of the Oil Price Chain

Over the period from 1990 to 2000, oil prices ranged from low levels at the beginning of the 1990s to medium levels at the end of the decade. At the beginning of the period, it was hovering around the $20 a barrel average in the first quarter of 1990, and then rose to over $32 a barrel in the last quarter of the same year. During this period, oil prices were affected by several factors, including global oil supply and demand and political events in production and consumption areas. From 2001 to 2010, oil prices rose significantly, rising from average levels at the beginning of the period (about $19 per barrel in 2001) to very high levels (nearly $105 per barrel in some periods of 2011). This period has seen significant changes in global production and demand policies, including international wars and global economic volatility, resulting in significant fluctuations in oil markets and a direct impact on their prices.

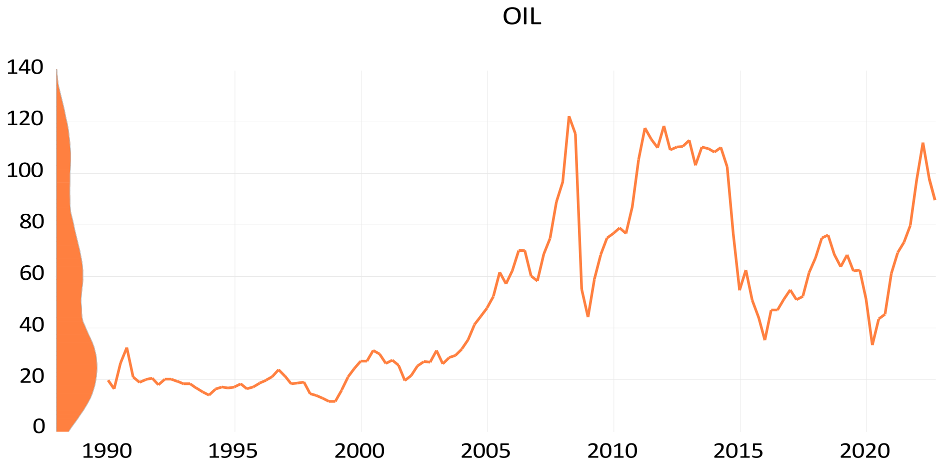


Figure (1) Evolution of oil prices during the period (1990-2022)

Through the graphical representation, it is clear as a preliminary idea that the series is unstable during the study period. To determine whether the chain is stable or not, several criteria and techniques can be used. One such technique is the Unit Root Test, which is used to determine whether we have unit roots in a time series. If there are unitary roots, the chain is unstable, while if there are no unitary roots, the chain is stable. We will apply the Augmented Dickey-Fuller (ADF) test which is one of the common tests for the root unit. If the calculated statistic value is less than the positive value in the table, we conclude that we have statistical evidence that there are no unit roots and therefore that the series is stable.

Table Augmented Dickey-Fuller (ADF) Test for Stability of Oil Price Chain

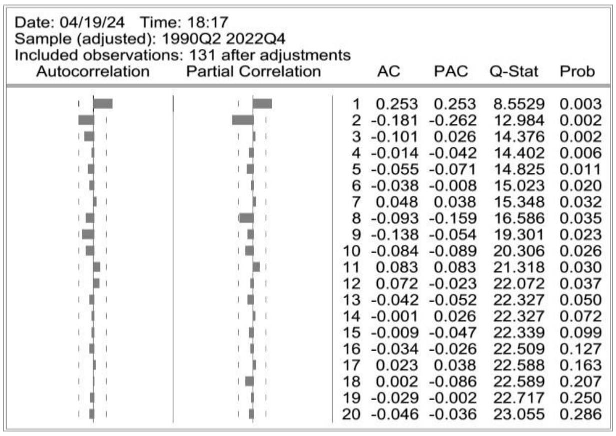
	At Level	On the first team
General & Fixed Trend	3,844	<0.0001
Thabit	5533	<0.0001
No general trend and no constant	5983	<0.0001

The results of the Augmented Dickey-Fuller (ADF) test of the stability of the oil price chain are presented in the table on three different cases. In the first case, when looking at the chain at the level without a general or constant trend, the calculated value of the p-value shows a value of 0.3844, which is higher than the usual significance level (0.05). Since the p-value exceeds this level, we do not have sufficient statistical evidence to reject the hypothesis of a unit root and, therefore, the chain can be considered unstable at the level. In the second case, when looking at the series after taking the first difference, the calculated value of p-value is less than 0.0001, and this indicates that there is sufficient statistical evidence to reject the hypothesis that there is a unit root after the first difference, and therefore, the series can be considered stable after the first difference. In the third case, when we look at the series without a general trend and without a constant, the p-value is 0.5983, which is also higher than the usual level of significance, which means that there is not enough statistical evidence to reject the hypothesis of a unit root in this case as well, and therefore, the series can be considered unstable in this case.

2- **Box & Jenkins Approach to Modeling the Oil Price Chain During the Study Period**

Box & Jenkins offers a popular analytical framework for time series modeling and forecasting, a powerful tool used to understand and predict the evolution of time data such as oil price series. This research aims to use the Box & Jenkins approach to model the oil price series during the study period (1990-2022), in order to understand the chronological pattern and future expectations of this important series.

Analyzing and detailing the steps to approach Box & Jenkins in modeling the oil price series during the specified period starts with analyzing the time series, as it is explored through charts and basic statistics such as average, standard deviation and relative changes. This is followed by analysis and correction of deviation and variation to improve the time series by applying processes such as revision and transformation to reduce deviations and undesirable changes. Next, the optimal model for the oil price chain is determined using time series analysis and testing the optimal model using tools such as ACF, PACF, and Ljung-Box testing. In the next step, the final model of the oil price chain is presented and illustrated how it is used to predict the future values of the chain. Finally, the validity of the presented model is verified through hypothesis tests and comparing the expected results with the actual data, enabling researchers in this field to analyze and predict the oil price chain using the Box & Jenkins approach in a systematic and organized manner, which helps them to understand the temporal pattern and make the right economic decisions.


Date: 04/19/24 Time: 18:17
Sample (adjusted): 1990Q2 2022Q4
Included observations: 131 after adjustments

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.253	0.253	8.5529	0.003
		2	-0.181	-0.262	12.984	0.002
		3	-0.101	0.026	14.376	0.002
		4	-0.014	-0.042	14.402	0.006
		5	-0.055	-0.071	14.825	0.011
		6	-0.038	-0.008	15.023	0.020
		7	0.048	0.038	15.348	0.032
		8	-0.093	-0.159	16.586	0.035
		9	-0.138	-0.054	19.301	0.023
		10	-0.084	-0.089	20.306	0.026
		11	0.083	0.083	21.318	0.030
		12	0.072	-0.023	22.072	0.037
		13	-0.042	-0.052	22.327	0.050
		14	-0.001	0.026	22.327	0.072
		15	-0.009	-0.047	22.339	0.099
		16	-0.034	-0.026	22.509	0.127
		17	0.023	0.038	22.588	0.163
		18	0.002	-0.086	22.589	0.207
		19	-0.029	-0.002	22.717	0.250
		20	-0.046	-0.036	23.055	0.286

Figure (02) The self and partial correlation function of the series of the first difference of oil prices.

The graph of the first divergent oil price series, D(oil) , from the second quarter of 1990 to the fourth quarter of 2022, reveals important autocorrelation patterns. Autocorrelation coefficients oscillate between positive and negative values, and their values slowly decline, indicating cyclical patterns and possible moving average or self-regression components. Q statistics and associated probabilities suggest rejection of the null hypothesis of no subjective correlation at conventional significance levels for several delay periods. These results suggest that more advanced time series modeling techniques, such as Arima models .

Independent variable:
Method: Arma Maximum Likelihood (OPG-BHHH)
Date: 04/19/24 Time: 18:25
Sample: 1990Q2 2022Q4
Included observations: 131
Convergence achieved after 48 iterations
Coefficient covariance computed using outer product of gradients

Variable	Coefficient	Std. Error	t-Statistic	PROB

(MA)	0.387984	0.064560	6.009668	0.0000
SIGMASQ	74.40666	5.419990	72819	0.0000
R-squared	0.103099	Mean dependent Var		0.526725
Adjusted R-Squared	0.096147	S.D. dependent Var		9.143189
S.E. of Regression	8.692540	Akaike info Criterion		7.179202
Sum Squared Resid	.272	Schwarz Criterion		7.223098
Log Likelihood	468	Hannan-QuinnCriter.		7.197039
Durbin-Watson stat	2.081591			
Inverted MA Roots 39				

The results of the model analysis of the oil price chain indicate that the best model to predict the chain is the Arma model (1,0), where the maximum potential technique (Maximum Likelihood) was used to determine the parameters of the model. The model was tested using the time period from Q2 1990 to Q4 2022, with a total of 131 views. The model has a coefficient MA(1) of a given value of 0.387984, with a standard error of estimation of 0.064560. The t-Statistic value of the coefficient MA(1) is shown to be about 6.009668, meaning that the coefficient is statistically significantly significant (p-value = 0.0000). This suggests that there is a significant statistical relationship between past and current values in the time series. The value of SIGMASQ (standard deviation square of error) was estimated to be about 74.40666, with a standard error of estimation of 5.419990. The t-Statistic value of SIGMASQ indicates that it is statistically significant as well (p-value = 0.0000). Statistical performance measures were calculated for the model, with R-squared indicating that the model explains about 10.31% of the variance in the data, which is a relatively weak indicator. The value of the Durbin-Watson stat is about 2.081591, which indicates that there is some chronology in the errors. Compared to the actual data, the model estimates show an average value of the dependent variable of about 0.526725, with a standard deviation of about 9.143189.

Heteroskedasticity Test: ARCH				
F-Statistic	3.604822	PROB F(2,126)		**0300%**
Obs*R-squared	6.981807	PROB Chi-Square		**0305**

Equation
Dependent Variable: resid^2
Method: Least Squares
Date: 04/19/24 Time: 18:25
Sample (adjusted): 1990Q4 2022Q4
Included observations: 129 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	PROB
C	52.95520	24.80995	2.134434	0.0347
Resid^2(-1)	0.083786	0.087165	0.961232	3383

Resid^2(-2)	0.208760	0.087394	2.388713	-0184

R-squared	0.054123	Mean dependent Var	74.54886
Adjusted R-Squared	0.039109	S.D. dependent Var	269
S.E. of Regression	264.	Akaike info Criterion	14.01314
Sum Squared Resid	8785106.	Schwarz Criterion	14.07965
Log Likelihood	900	Hannan-QuinnCriter.	14.04017
F-Statistic	3.604822	Durbin-Watson stat	1.976457
Prob(F-Statistic)	0.030033		

Arch test results indicate signs of heterogeneous regression in the standard errors of the estimated model. The arch test is a test for the presence of an anisotropic condition of the error box in the series of residues of the Arima model, where the hypothesis of anisotropy is examined. The value of the statistic F is about 3.604822, which is statistically significant at the significance level of 0.0300, indicating that there is a significant arch trace in the data. In addition, the value of the R-squared with the number of observations is about 6.981807, which is statistically significant at the significance level of 0.0305, which confirms the existence of the arch effect in the data. The test equation for the arch effect was presented, and the results showed that both the resid ^2(-1) and resid ^2(-2) coefficients are statistically significant, supporting the hypothesis that arch exists in the data. Among the proposed solutions, arch corrections can be included in the model, such as using arch or GARCH models to predict standard deviation changes and ensure the reliability of the results obtained.

3- **Modeling oil price fluctuations using ARIMA-ARCH models**

Table (01) ARIMA-ARCH Model Estimation Results

Independent variable:
Method: ML arch - Normal distribution (OPG-BHH/ Marquardt steps)
Date: 04/19/24 Time: 22:00
Sample (adjusted): 1990Q2 2022Q4
Included observations: 131 after adjustments
Convergence achieved after 67 iterations
Coefficient covariance computed using outer product of gradients
MA Backcast: 1990Q1
Presample variance: backcast (parameter = 0.7)
Log(GARCH) = C(2) + C(3) * resid (-1)/@sqrt(GARCH (-1)) + C(4)
* log (GARCH (-1))

Variable	Coefficient	Std. Error	Statistic	PROB
(MA)	0.257804	0.053432	4.824917	0.0000
Variance Equation				
C2	6.899138	0.415952	16.58640	0.0000
C 3	**-0.326415**	0.045141	231,003	0.0000

C 4	-0.689383	0.092632	-7.442152	0.0000
R-squared	0.089057	Mean dependent Var		0.526725
Adjusted R-Squared	0.089057	S.D. dependent Var		9.143189
S.E. of Regression	8.726566	Akaike info Criterion		6.981911
Sum Squared Resid	.885	Schwarz Criterion		7.069704
Log Likelihood	.453	Hannan-QuinnCriter.		7.017585
Durbin-Watson stat	1.861429			
Inverted MA Roots	.26			

The estimation results of the ARIMA-ARCH model provide valuable insights into the dynamics of the oil price chain. First, the MA(1) coefficient is estimated at 0.257804, suggesting a statistically significant lag effect of past values on current oil prices, underscoring the importance of considering past trends in predicting future prices. Moreover, the covariance equation reveals three coefficients —C(2), C(3), and C(4) — that play crucial roles in determining chain variance. Specifically, the C(2) coefficient represents the constant variation in the series and is estimated to be about 6.899138, while both the C(3) and C(4) coefficients capture the effect of time series on variance, and are also statistically significant.

Estimated Model Equation

$$\mathrm{LOG(GARCH)} = 6.899 - 0.326 \times \frac{\mathrm{RESID}(-1)}{\sqrt{\mathrm{GARCH}(-1)}} - 0.689 \times \mathrm{LOG(GARCH}(-1))$$

Although the model explains only approximately 8.91% of the variance in the data, it demonstrates good compatibility according to metrics such as the Akaike Information Standard and the Schwarz Standard. In addition, the inverted roots of the coefficient of MA(1), approximately -0.26, indicate that there are no unreasonable inverse roots for the model, confirming its stability. Overall, these findings underscore the complex interplay between past values, time-related factors, and the dynamics of variation in the formation of oil price fluctuations, thus providing valuable insights for prediction and decision-making in the oil market.

4- Extracting the series of oil price fluctuations (Conditional Standard Deviation)

Analyzing and extracting the Conditional Standard Deviation series of oil prices is critical in understanding the inherent volatility and risk associated with the oil market. Conditional standard deviation, also known as volatility, represents the degree of volatility in oil prices over time, reflecting market uncertainty and risk perceptions. This research endeavor delves into the delicate process of extracting this volatility chain, which includes sophisticated statistical techniques such as GARCH modeling. By distilling the string of conditional standard deviations, researchers and market analysts can gain insights into the underlying patterns and dynamics of oil price movements, and facilitate more accurate risk assessment, portfolio management, and decision-making in various sectors that rely heavily on oil, including energy.

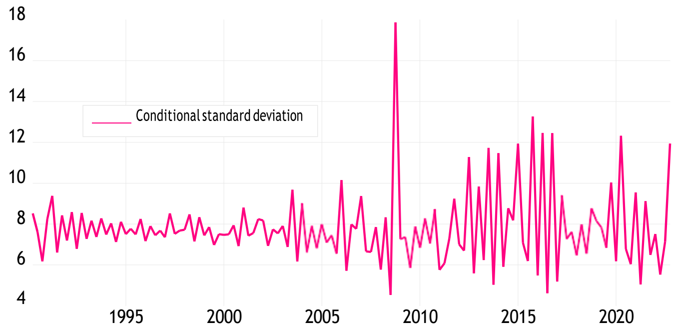


Figure (03) The conditional standard deviation series of the oil price variable resulting from the estimated model.

The conditional standard deviation (CSD) of the EGARCH model (generalized exponential conditional self-regression) is a time-varying measure of volatility or risk associated with a financial time series, such as oil prices. It represents the estimated standard deviation of the error term at each point in time, subject to the information available up to that point. CSD values fluctuate over time, capturing volatility clusters and periods of increased uncertainty, such as the spikes observed in 2008-2009 and2015-2016 in the data presented. The EGARCH model allows for asymmetric effects, as positive and negative shocks can have different effects on volatility, making it suitable for modeling potential asymmetric responses in oil prices. Higher CSD values indicate higher volatility and risk, providing important information for risk management, portfolio optimization, and derivatives pricing in the oil market. The CSD should be interpreted in conjunction with specific model specifications, parameter estimates, and any assumptions or transformations applied during the modeling process, while also using diagnostic checks and model validation techniques.

Second: The standard study of the impact of oil price fluctuations on foreign trade indicators in Algeria

The Algerian economy, which is heavily dependent on hydrocarbon exports, is vulnerable to fluctuations in global energy prices. This volatility can have significant implications for the country's trade performance and overall economic openness. In this context, understanding the potential impact of oil price fluctuations, as evidenced by the conditional standard deviation (CSD) from the EGARCH model, on key trade variables such as exports, imports and the degree of openness becomes critical for policymakers and economic analysts.

The conditional standard deviation series, derived from the EGARCH model, provides a time-varying measure of the volatility or risk associated with a financial time series, in this case, oil prices. Higher CSD values indicate periods of increased uncertainty and risk in the oil market, which could affect Algeria's trade flows and its integration into the global economy. To investigate the effects of conditional standard deviation on Algerian exports and imports and the degree of openness, this study uses a self-regression modelling (var) approach. Var models are particularly useful for analyzing dynamic correlations between multiple time series variables and capturing the effects of complex reactions found in economic systems.

By incorporating CSD as an internal variable in the var model, along with exports and imports and measuring the degree of openness, this part of the study aims to highlight the following research questions:

- Does conditional standard deviation, as an indicator of oil price volatility, affect Algeria's exports, imports and degree of openness?
- If so, what is the nature and magnitude of these influences, and how do they evolve over time?
- Are there any effects of two-way reactions or causes between the conditional standard deviation and the commercial variables studied?

1- **Study Variables**

Data source	Variable name	Variable symbol
From ARIMA-GARH Form	Conditional Standard Deviation Series	CSD

|||UNTRANSLATED_CONTENT_START|||قاعدة البنك بيانات الدولي|||UNTRANSLATED_CONTENT_END|||	Official exchange rate of the dinar against the US dollar	ER
|||UNTRANSLATED_CONTENT_START|||قاعدة البنك بيانات الدولي|||UNTRANSLATED_CONTENT_END|||	Total Exports of Goods and Services (USD)	Exho Exports
|||UNTRANSLATED_CONTENT_START|||قاعدة البنك بيانات الدولي|||UNTRANSLATED_CONTENT_END|||	Total imports of goods and services (USD)	Imports
Calculated based on World Bank database data (using GDP variable)	Trade Openness Index	Opennes

Table (02) Descriptive Statistics of Study Variables

	CSD	ER	Exho Exports	Imports	Opennes
Mean	7.838490	75.47625	3.94E+10	3.29E+10	0.735363
Median	7.513211	73.45780	3.85E+10	2.60E+10	0.671306
Maximum	17.87279	144	5.11E+10	6.88E+10	1.087919
Minimum	4.523289	7.575832	3.07E+10	1.02E+10	0.382586
Std. Dev.	1.839036	31.93590	5.74E+09	2.05E+10	0.217735
Skewness	1.898064	0.094634	0.381999	0.213300	0.163454
Kurtosis	9.626161	2.770424	2.229697	1.390959	1.445533
Jarque-Bera	.318	0.483215	6.424792	15.12505	13.77267
Probability	000000	0.785364	0.040260	0.000520	0.001022
Sum	1026.	389	5.16E+12	4.31E+12	96.33261
Sum Sq. Dev.	439	132587.2	4.29E+21	5.47E+22	6.163128
Observations	131	131	131	131	131

The table provides descriptive statistics of the study variables, as it includes important information about each variable. It is noted that the conditional standard deviation (CSD) series shows varying values with an average of about 7.84 and a standard deviation of about 1.84. As for the official exchange rate of the dinar against the US dollar (ER), the average values were about 75.48 and a standard deviation of about 31.94. For total exports of goods and services (exports) and total imports of goods and services (imports), the averages are about 3.94E+10 and 3.29E+10, respectively, with standard deviations of about 5.74E+09 and 2.05E+10, respectively. As for the trade openness index (Open NES), the average values were about 0.74 with a standard deviation of about 0.22. These statistics provide an initial understanding of the distribution and spread of data in the time series, helping to identify trends and estimate variations and changes in variables over time.

2- **Stabilization study of research variables**

Table Augmented Dickey-Fuller (ADF) test for stability of study variables.

Variables	**At Level**			**On the first team**		
	General & Fixed Trend	Thabit	No general trend and no constant	General & Fixed Trend	Thabit	No general trend and no constant
CSD	0000	0000	6003	0000	0000	0000

ER	7689 C	0.9363	0.9648	3426	1238	0.0829
Exho Exports	8583	4192	5888	1860	1542	0.0174
Imports	What's the code?	0.5855	.7002	3648	1560	0284
Opennes	4932	9284	1249	0.3908	1517	0432

3- Vector Autorgression Model Estimation

- **Determine the optimal slowness of the standard var model (p)**

Lag	LOGL	LR	FPE	AIC	SC	HQ
1	1193	NA	5.25 e-15	-18.69144	-18.12578	-18.46165
2	370	145	2.21 e-15	-19.55793	42660	-19.09833
3	208	36.67336	2.37 e-15	-19.49132	-17.79433	-18.80192
4	1350	96.35234	1.43 e-15	-20.00896	-17.74631	-19.08977
5	838,0	**102**	**7.71 e-16***	**-20.63741***	-17.80910	**-19.48842***
6	(487)	5.545813	1.11 e-15	-20.29579	-16.90181	-18.91699

* LR: sequential modified LR test statistic (each test at 5% level) FPE: Final prediction error AIC: Akaike information criterion SC: Schwarz information criterion HQ: Hannan-Quinn information criterion

Judging from the results of the statistical estimation to choose the optimal degree of slowness of the var model, we note that three statistical indicators or criteria indicate that the optimal score p=5, is the best and optimal for estimating the multiple self-regression model, and therefore we will estimate the var model (5).

Var Model Stability Study (5)

root	**Modulus**
0.999913	0.999913
-0.637619 + 0.613749i	0.885012
-0.637619 - 0.613749i	0.885012
-0.538619 + 0.686776i	0.872795
-0.538619 - 0.686776i	0.872795
-0.809362 + 0.260249i	0.850175
-0.809362 - 0.260249i	0.850175
-0.683597+0.501715i	0.847952
-0.683597 - 0.501715i	0.847952
0.527579 - 0.631672i	0.823013
0.527579 + 0.631672i	0.823013
-0.041139 - 0.759453i	0.760566
-0.041139 + 0.759453i	0.760566

0.633568 + 0.413630i	0.756636
0.633568 - 0.413630i	0.756636
0.557779 + 0.507901i	0.754374
0.557779 - 0.507901i	0.754374
0.751564 + 0.043869i	0.752843
0.751564 - 0.043869i	0.752843
0.685343 + 0.253976i	0.730889
0.685343 - 0.253976i	0.730889
0.668379	0.668379
-0.446873 - 0.487168i	0.661082
-0.446873 + 0.487168i	0.661082
0.208131	0.208131

Through the results of the estimation of the roots of the model, we note that they are all within the unit circle, that is, they are all completely less than one, which indicates and confirms that the var model (5) is stable during the study period.

Model Fit Tests (Residual Tests)

Table (03) Arch Test

Var Residual Heteroskedasticity Tests (Levels and Squares)
Date: 04/20/24 Time: 10:28
Sample: 1990Q1 2022Q4
Included observations: 126

Joint

CHI	df	**PROB**
799.	750	**0.1044**

Individual components:

معال	R-squared	F(50,75)	PROB	Chi-sq (50)	PROB
res1*res1	0.288284	0.607583	0.9689	36.32382	9263
res2*res2	0.533622	1.716278	555-0167.	67.23643	.0523
res3*res3	0.607656	2.323171	0.0005	76.56460	0092
res4*res4	0.401903	1.007955	4809	50.63978	4481
res5*res5	0.414405	1.061497	4021	52.21503	3879
res2*res1	0.356960	0.832671	7531	44.97701	0.6747

res3*res1	0.394745	0.978295	5268	49.73788	4838
res3*res2	0.621842	2.466594	0002	35207	0064
res4*res1	0.366705	0.868565	6997	46.20483	6264
res4*res2	0.454615	1.250348	1882.	57.28143	2232
res4*res3	0.455598	1.255319	1840.	57.40540	2198
res5*res1	0.214809	0.410364	9995	27.06599	9967
res5*res2	0.472156	1.341749	1229	59.49166	1683
res5*res3	0.545907	1.803289	0102	68.78430	0401
res5*res4	0.404584	1.019247	4638	50.97759	4350

The remaining var assays examine the presence of heterogeneity in the residues of the var model, both for the planes and for the square shield. The co-test statistic, which follows the chi-square distribution with 750 degrees of freedom, has a probability value of 0.1044, which is greater than the levels of statistical significance (e.g., 0.05). This suggests that the null hypothesis of no covariance in the rest of the estimated model cannot be rejected at the 5% significance level. In addition, tests of the individual components of each residue equation and the residue chain cross quotient also support the absence of heterogeneity, as most of the associated probability values are greater than 0.05.

Table (04) Sequential correlation test for the rest of the estimated model

Lag	STAT	df	PROB	Rao F-stat	df	**PROB**
1	6.463110	25	9999	0.252437	(25, 343.3)	**9999**
2	32.61134	50	9729	0.639594	(50, 400.1)	**0.9732**
3	59.50861	75%	ISO 9047	0.778878	(75, 397.0)	**0.9068**
4	2077.	100	4199	1.022287	(100, 380.3)	**4326**
5	126	125	4394	1.010359	(125, 359.3)	**4626**
6	1032	150	5285	0.974630	(150, 336.4)	**0.5662**

The LM test results check for serial correlation in the var model guard with different lengths of time. Test statistics and associated probability values fail to reject the null hypothesis that there is no serial correlation in any of the delay orders considered, from delay 1 to delay 6. Specifically, the corresponding probability values for LM statistics are consistently greater than statistical significance ranging from 0.9999 in Delay 1 to 0.5662 in Delay 6. This evidence suggests that the remnants of the var model do not show significant serial correlation until the sixth delay, providing support for the validity of the model in capturing dynamic relationships between variables.

Var Model Estimation Results (3)

	D(LIMPORT)	D(LEXPROT)	D(LOPENNES)	d	Log
D(limit (-1))	0.589419	-0.039439	-0.006174	0.016613	-0.662236
	11087	(0.04998)	(0.08422)	(0.08667)	(0.64377)
	31629	[-0.78902]	[-0.07330]	[0.19168]	.02868

D(limit (-2))	0.238864	0.020308	0.011998	-0.011013	-1.345756
	12360	(0.05573)	(0.09389)	(0.09662)	(0.71771)
	[1.93249]	[0.36443]	12,779	2022-11398	[-1.87506]
D(limit (-3))	0.061680	0.002692	0.030319	0.017750	1.049925
	12446	(0.05611)	(0.09454)	(0.09729)	(0.72269)
	[0.49558]	[0.04797]	[0.32069]	18244	[1.45280]
D(limit (-4))	-0.380530	0.073555	0.008233	-0.025621	1.242718
	(0.12430)	(0.05604)	(0.09442)	(0.09716)	(0.72174)
	[-3.06142]	[1.31258]	[0.08720]	[-0.26369]	72182
D(limit (-5))	0.146124	-0.091379	-0.023918	0.040185	-0.159061
	10703	(0.04825)	(0.08130)	(0.08366)	(0.62145)
	[1.36531]	[-1.89380]	[-0.29421]	[0.48033]	[-0.25595]
D(LEXPROT (-1))	0.069001	0.700515	0.065098	0.047508	-2.702614
	(0.20655)	(0.09312)	(0.15690)	(0.16146)	(1.19936)
	[0.33406]	[7.52254]	[0.41490]	[0.29423]	[-2.25339]
D(LEXPROT (-2))	-0.003039	0.119875	0.020809	0.001976	-0.155964
	(0.20515)	(0.09249)	(0.15584)	(0.16037)	(1.19122)
	[-0.01481]	29608	[0.13353]	[0.01232]	[-0.13093]
D(LEXPROT (-3))	-0.052121	0.030109	8.08E-05	0.007514	2.701743
	(0.20647)	(0.09308)	(0.15683)	(0.16139)	(1.19885)
	[-0.25244]	[0.32347]	- 15,000.	[0.04656]	[2.25361]
D(LEXPROT (-4))	0.063929	-0.642506	-0.543774	-0.225196	-0.136575
	(0.20786)	(0.09371)	(0.15789)	(0.16248)	(1.20692)
	[0.30757]	[-6.85634]	44400	[-1.38599]	11316
D(LEXPROT (-5))	-0.038801	0.464191	0.324786	0.143499	-1.518281
	20209	(0.09111)	15351	(0.15797)	(1.17344)
	19200	[5.09484]	[2.11573]	[0.90838]	[-1.29387]
D(LOPENNES (-1))	-0.126488	0.005117	0.596477	-0.046323	2.417906
	(0.16632)	(0.07499)	(0.12634)	(0.13002)	(0.96577)
	[-0.76049]	[0.06824]	72113	[-0.35629]	[2.50361]
D(LOPENNES (-2))	-0.025818	-0.003071	0.163642	0.012970	-0.940891

	(0.15701)	(0.07079)	(0.11927)	12274	(0.91171)
	[-0.16443]	22-04339	[1.37203]	[0.10568]	[-1.03201]
D(LOPENNES (-3))	0.021601	-0.001301	0.052034	0.000486	-1.655808
	(0.16089)	(0.07253)	(0.12221)	12577	(0.93420)
	[0.13426]	[-0.01794]	42576	[0.00386]	77244
D(LOPENNES (-4))	0.216838	0.133184	-0.411332	0.082288	-1.518002
	(0.15982)	(0.07205)	(0.12140)	(0.12493)	92,802
	[1.35674]	[1.84837]	[-3.38813]	[0.65865]	[-1.63574]
D(LOPENNES (-5))	-0.206457	-0.083341	0.228732	-0.059729	1.784862
	(0.14577)	(0.06572)	(0.11073)	(0.11395)	(0.84644)
	[-1.41629]	[-1.26811]	[2.06564]	[-0.52416]	[2.10867]
D(LER (-1))	0.070711	0.002908	-0.006131	0.639482	-1.030345
	17091	(0.07705)	12982	(0.13360)	(0.99238)
	41374	[0.03774]	[-0.04723]	[4.78659]	[-1.03825]
D(LER (-2))	-0.058376	-0.020815	0.056319	0.219432	0.281237
	(0.18873)	(0.08509)	(0.14336)	(0.14753)	(1.09588)
	[-0.30931]	[-0.24463]	[0.39284]	[1.48736]	[0.25663]
D(LER (-3))	-0.006888	-0.007053	0.016474	0.053661	0.698919
	(0.18971)	(0.08553)	(0.14410)	(0.14829)	(1.10153)
	[-0.03631]	[-0.08246]	11432	[0.36186]	[0.63450]
D(LER (-4))	-0.102024	0.147385	-0.206474	-0.343371	-0.077107
	(0.18723)	(0.08441)	14222	(0.14635)	(1.08714)
	[-0.54492]	[1.74607]	[-1.45179]	[-2.34615]	[-0.07093]
D(LER (-5))	0.085421	-0.078520	0.103586	0.137650	0.219275
	10045	04529	(0.07630)	(0.07852)	(0.58326)
	[0.85040]	[-1.73386]	[1.35759]	[1.75305]	[0.37595]
Log(CSD (-1))	0.003836	-0.000798	0.024946	0.012392	-0.652223
	(0.01684)	(0.00759)	(0.01279)	(0.01316)	(0.09779)
	[0.22777]	[-0.10512]	[1.95007]	[0.94134]	[-6.66981]
Log(CSD (-2))	0.032500	0.007453	-0.004403	-0.010743	0.111292
	(0.01657)	(0.00747)	(0.01259)	(0.01295)	(0.09621)
	[1.96146]	[0.99769]	[-0.34979]	[-0.82946]	[1.15675]

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ISSN 2323-5233
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Log(CSD (-3))	0.027309	0.008631	-0.012718	-0.013676	0.334830
	01512	(0.00682)	(0.01149)	(0.01182)	(0.08781)
	[1.80594]	[1.26604]	[-1.10719]	[-1.15694]	[3.81333]
Log(CSD (-4))	-0.028152	-0.002694	0.003266	0.009205	0.714719
	(0.01659)	(0.00748)	(0.01260)	(0.01297)	(0.09631)
	[-1.69736]	[-0.36025]	[0.25921]	[0.71001]	42124
Log(CSD (-5))	-0.033637	-0.012591	-0.012310	0.004768	0.489311
	(0.01632)	(0.00736)	(0.01240)	01276	(0.09479)
	[-2.06062]	[-1.71080]	[-0.99277]	[0.37366]	/16232
R-squared	0.540304	0.632956	0.588524	0.571905	0.510795
Adj R-squared	0.431070	0.545738	0.490748	0.470180	0.394548
Sum sq. resids	0.083050	0.016880	0.047921	0.050748	2.800101
S.E. equation	0.028675	0.012928	0.021782	0.022416	0.166505
F-Statistic	4.946275	7.257155	6.019087	5.622045	4.394055
Log Likelihood	.282	0403	317	.313	61.03120
Akaike AIC	-4.089894	-5.683180	-4.639784	-4.582463	-0.571924
Schwarz SC	-3.527139	-5.120425	-4.077030	-4.019709	-0.009169
Mean dependent Var	0.011688	0.000648	-0.006987	0.016582	2.034312
S.D. dependent Var	0.038017	0.019181	0.030524	0.030795	0.213986

Interpretation of estimation results for var model (5)

Export Equivalence

- Exports show strong stability as evidenced by the large positive coefficient on the first lag of exports (0.700). This means that current exports are strongly affected by previous export levels.
- Delayed changes in the exchange rate have a negative impact on exports, with a coefficient of -0.225 on the fourth delay. Currency appreciation makes exports less competitive and can weaken export growth over time.
- The degree of openness has a positive coefficient (0.325) at the fifth delay, suggesting that increased trade openness could boost exports after a period of time as the economy becomes more globally integrated.
- Oil price volatility (CSD) has a negative coefficient at the second delay (-2.703), suggesting that higher volatility may lead to temporarily lower exports after a few quarters as uncertainty rises.

Imports Equivalence:

- Very stable imports with a coefficient of 0.589 on the first delay. Past import levels significantly affect current imports.
- The fourth delay of imports has a negative coefficient (-0.381), and may represent an adjustment process after the rise in imports.
- Exports have a negative contemporary impact on imports, with a coefficient of -0.091 at the fifth delay. This substitution effect suggests that increased exports may discourage import demand to some extent.
- Oil fluctuations have no statistically significant direct impact on imports in the specification of this model.

Openness Equivalent:

- Stability in openness as its first delay has a coefficient of 0.596.

- Openness increases after the expansion of imports, but decreases after the expansion of exports on the basis of negative transactions.
- The volatility of oil prices has a positive impact on the opening at the first gap (2.418), indicating that high volatility leads to increased trade flows and opening initially.

Exchange Rate:

- Extremely persistent with a coefficient of 0.639 on the first delay.
- Exports have a positive impact starting from the fourth lag (0.147), indicating that export growth leads to currency appreciation over time.
- The degree of openness negatively affects the exchange rate at the fourth lag (-0.206), indicating that an increase in openness can lead to currency depreciation pressure.

Sure, let's analyze the final equation for log (CSD):

Oil Price Volatility Equation (CSD):

- Oil price fluctuations show very strong stability, as evidenced by the large negative coefficient (-0.652) in its first lag (CSD (-1)). This means that the volatility of oil prices depends heavily on its previous values, with long-lasting effects of shocks.
- Export Delay Transactions (LEXPROT) are mostly minuscule, indicating that changes in exports do not directly affect oil price volatility (CSD) in a significant way.
- Similarly, import lag (LIMPORT) has no statistically significant coefficients, which means that import volatility does not significantly affect oil price volatility.
- The degree of openness (LOPENNES) has a positive and moral coefficient (2.418) at the first delay. This suggests that the increase in the degree of openness tends to be followed by an increase in oil price volatility after the quarter.
- The exchange rate (LER) has no statistically significant coefficients in the CSD equation, indicating that changes in the exchange rate do not directly affect oil price fluctuations in this model.

Overall, the model reflects the complex dynamics between trade flows, openness, exchange rates, and oil fluctuations in Algeria. Among the main ideas: First, it is clear that oil price fluctuations initially affect increased economic openness by increasing trade flows, but later discourage exports to some extent. Second, there are substitutional effects between exports and imports. Third, export growth tends to cause the currency to appreciate over time. Fourth, trade openness can put downward pressure on a currency's value. Finally, consistency across all variables means that shocks can have long-lasting effects. These points highlight the complex relationships between economic factors in Algeria, and highlight the importance of understanding these relationships for making the right political and economic decisions.

Dynamic analysis of the reciprocal effects between study variables (response functions and analysis of variance)

1. Batch Response Functions for Study Variables

The results of shocks of other variables on the volume of imports

PERIOD	D(LIMPORT)	D(LEXPROT)	D(LOPENNES)	d	Log
1	0.028675	000000	000000	000000	000000
	[00181]	00000	00000	00000	00000
2	0.017239	0.000530	-0.001546	0.001122	0.000596
	(0.00298)	[00243]	[00266]	00270	[00262]
3	0.017543	0.000608	-0.001453	0.000449	0.004647
	(0.00342)	(0.00298)	(0.00315)	00322	[00244]
4	0.015152	-0.000719	-0.001044	-4.37E-05	0.004030
	(0.00380)	(0.00345)	(0.00360)	00367/2020	[00230]
5	0.002077	000189	-0.000316	-0.001996	-0.000657
	(0.00398)	(0.00373)	(0.00392)	(0.00392)	[00152]

6	0.004266	0.000284	-0.002247	-0.000805	0.000631
	(0.00375)	00362	(0.00386)	(0.00359)	00146
7	0.002150	0.001082	-0.001305	000395	0.001291
	(0.00373)	19-00358	(0.00380)	00348	00150
8	-0.000629	0.000791	-0.001429	13-000814	000296
	(0.00365)	(0.00350)	(0.00375)	(0.00305)	(0.00115)
9	0.001276	-0.000889	-0.003010	QSCU 000184	0.000237
	(0.00344)	(0.00327)	(0.00356)	[00230]	{00103}
10	18-000170	000145	-0.001038	0.000383	13-000827
	00256	[00244]	00272	[00202]	00087

Pulsed response function analysis reveals the dynamic effects of shocks to other variables on import volume (D(LIMPORT)) over a 10-quarter horizon. Imports show a positive and significant initial response to shocks, a response that gradually diminishes over time. In response to export shocks (D(LEXPROT)), imports show little but largely insignificant negative impact, suggesting a weak substitution effect between exports and imports. Shocks up to the degree of openness (D(LOPENNES)) have a negative but statistically insignificant impact on imports, which implies that increased openness may not directly affect import volumes significantly. Exchange rate shocks (D(LER)) have little or no statistically significant impact on imports. Notably, shocks caused by oil price volatility (log (CSD)) initially have a positive but negligible impact on imports, which becomes negative but also insignificant in later periods. Overall, impulse-response analysis suggests that import volumes primarily respond to their own shocks, while the effects of shocks on other variables, including exports, openness, exchange rates, and oil price volatility, are relatively weak and statistically insignificant during Q10.

Consequences of shocks of other variables on export volume

PERIOD	D(LIMPORT)	D(LEXPROT)	D(LOPENNES)	d	Log
1	0.005117	0.011872	000000	000000	000000
	00111	00075	00000	00000	00000
2	0.002402	0.008322	9.53E-05	4.47E-05	000124
	00146	00121	00120	00122	.00118
3	0.002353	0.007308	0.000343	-0.000287	0.001153
	[00164]	00146	00146	00149	(0.00112)
4	001721	0.006283	0.000535	-0.000601	0.001073
	[00177]	[00162]	[00164]	[00167]	00102
5	-0.002470	-0.002132	0.004811	0.001525	000256
	[00186]	[00175]	00179	[00177]	00065
6	-0.001525	-0.000121	0.002682	0.001157	0.000229
	[00181]	[00174]	[00184]	.00171	00086
7	-0.001987	-0.000619	0.003105	0.001871	0.000278
	[00183]	00176	[00185]	[00165]	00076
8	-0.002165	-0.001263	PDN-003059	0.002238	000341
	[00184]	[00178]	[00187]	[00151]	00074
9	-0.000399	0.002188	-0.001336	-0.000221	0.000226

	[00178]	[00173]	[00184]	00121	00054
10	-0.000646	0.000429	0.000344	0.000557	-0.000749
	[00134]	[00142]	[00151]	00110	(0.00053)

The Export Impulse Response Analysis (D(LEXPROT)) illustrates the following key points:

1. Exports respond positively and significantly to shocks, with continued impact over the 10-quarter horizon.

2. Shocks to imports (D(LIMPORT)) have a positive but relatively small impact on exports, an impact that diminishes over time.

3. Shocks up to the degree of openness (D(LOPENNES)) have a positive impact on exports, as the impact becomes more pronounced after the first quarters.

4. Exchange rate shocks (D(LER)) have a negative but statistically insignificant impact on exports in previous periods, which turns into a positive but still insignificant impact in subsequent quarters.

5. Shocks caused by oil price volatility (log(CSD)) have a positive but relatively small and statistically insignificant impact on exports over the 10-month horizon.

The analysis suggests that exports are primarily driven by the shocks to which they are exposed, with some positive spillovers from increased imports and economic openness. However, the impact of exchange rate shocks and oil price volatility on exports seems relatively weak and statistically insignificant in this model.

The results of shocks of other variables on the degree of trade openness

PERIOD	D(LIMPORT)	D(LEXPROT)	D(LOPENNES)	d	Log
1	-0.005790	0.002149	0.020888	000000	000000
	[00191]	[00187]	[00132]	00000	00000
2	-0.003451	0.002179	0.013863	-5.85E-05	0.003874
	[00248]	[00225]	[00222]	[00208]	00200
3	-0.003770	001649	0.012067	0.000351	-0.000923
	(0.00277)	[00258]	[00259]	[00253]	[00191]
4	-0.003095	0.002126	0.010842	0.001130	0.000987
	(0.00299)	00282	00284	CN20-00281	[00173]
5	0.000768	-0.004405	-0.001492	-0.001690	0.001389
	(0.00307)	00287/2020	(0.00299)	(0.00299)	(0.00114)
6	0.000298	-0.003788	000135	-0.000596	-0.001771
	2016/00292	CN20-00281	(0.00298)	(0.00277)	[00124]
7	0.000514	-0.004513	-0.001435	-0.001110	0.001331
	2016/00292	CN20-00280	2020-00295	00265	(0.00116)
8	0.001461	-0.005222	-0.003254	-0.001609	-0.001397
	2016/00292	CN20-00280	(0.00296)	[00237]	00111
9	0.000919	0.001280	000531	-0.000560	INV#000122

	(0.00278)	00268	(0.00289)	[00181]	00087
10	0.000966	2.52E-05	-0.001558	-0.001267	-0.000138
	00205	[00206]	[00228]	[00157]	00080

An analysis of the impulsive response to the degree of openness (D(LOPENNES)) of the Algerian economy reveals the following main ideas:

Openness shows a positive and significant response to shocks to which it is exposed, with its impact continuing over the ten-quarter horizon, indicating that shocks to openness have long-term effects on the degree of economic integration. Shocks to imports (D(LIMPORT)) have a negative but relatively small impact on the degree of openness, which implies that import volatility may not significantly affect the overall level of economic openness.

Shocks to exports (D(LEXPROT)) have a positive but statistically insignificant impact on openness in the initial periods, which turns negative and insignificant in subsequent quarters, suggesting that export shocks may not have a significant impact on the degree of openness. Exchange rate shocks (D(LER)) have a relatively small and statistically insignificant impact on openness throughout the ten-quarter horizon, suggesting that exchange rate fluctuations do not significantly affect the degree of economic openness in this model.

Interestingly, shocks to oil price volatility have a positive and significant impact on openness in the initial quarters, meaning that increased oil price volatility may lead to a temporary increase in the degree of economic openness. However, this effect becomes negative but statistically insignificant in later periods. Overall, the impulsive response analysis suggests that the degree of openness in the Algerian economy is primarily driven by the shocks to which it is exposed, with some temporary effects caused by the volatility of oil prices. The effects of shocks on imports, exports, and exchange rates appear to be relatively weak and statistically insignificant in the context of this particular model specification.

The results of shocks of other variables on the official exchange rate of the dinar

PERIOD	D(LIMPORT)	D(LEXPROT)	D(LOPENNES)	d	Log
1	-0.010110	-0.000514	0.012280	0.015786	000000
	[00189]	[00178]	[00161]	00099	00000
2	-0.005585	0.000196	0.007619	0.010114	0.001924
	[00247]	[00221]	[00232]	[00221]	00205
3	-0.005898	-5.10E-05	0.006528	0.009725	-0.001868
	(0.00277)	00256	00265	[00260]	[00191]
4	-0.004671	0.000619	0.005559	0.009469	-0.000466
	(0.00301)	(0.00283)	2016/00292	(0.00289)	[00175]
5	-0.001886	-0.001070	0.002879	0.003444	0.000902
	(0.00310)	(0.00290)	00304	(0.00303)	(0.00116)
6	-0.001136	-0.001066	0.002992	0.003389	6.51E-05
	2016/00293	(0.00283)	(0.00302)	CN20-00281	(0.00115)
7	-0.000884	-0.001462	0.001965	0.001548	1.86E-05
	2016/00292	(0.00278)	(0.00296)	00272	00120
8	0.000370	-0.001234	0.001238	0.000438	-8.38E-05
	(0.00285)	(0.00271)	00291	00245	00083

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ISSN 2323-5233
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9	0.001494	0.000292	-4.64E-05	0.000595	0.000791
	00269	[00253]	(0.00277)	[00195]	00079
10	0.000958	-0.000283	-0.000254	-0.000295	-2.21E-05
	00210	[00188]	[00214]	[00168]	00070

The analysis of the impulsive response to the exchange rate (D(LER)) of the Algerian currency reveals the following insights:

1. The exchange rate shows a positive and significant response to shocks it is exposed to, indicating that shocks to the exchange rate have ongoing effects on its future values.

2. Shocks to imports (D(LIMPORT)) have a negative but relatively small impact on the exchange rate, suggesting that import volatility may lead to a slight devaluation of the currency.

3. Shocks to exports (D(LEXPROT)) have a negligible and statistically insignificant impact on the exchange rate throughout the ten-quarter horizon.

4. Interestingly, shocks up to the degree of openness (D(LOPENNES)) have a positive and significant impact on the exchange rate in the initial periods, implying that increased economic openness may lead to currency appreciation. However, this effect becomes statistically insignificant in subsequent quarters.

5. Oil price volatility shocks (log (CSD)) have a positive but not statistically significant impact on the exchange rate, except for a minor negative impact in Q3.

Overall, impulsive response analysis suggests that the exchange rate of the Algerian currency is primarily driven by shocks to which it is exposed, with some temporary upward pressure arising from increased economic openness. The effects of shocks on imports, exports, and oil price fluctuations appear to be relatively weak and statistically insignificant in the context of this model specification specifically.

Consequences of shocks of other variables on oil price fluctuations

PERIOD	D(LIMPORT)	D(LEXPROT)	D(LOPENNES)	d	Log
1	-0.008659	0.004867	0.059267	0.001533	0.155275
	(0.01482)	(0.01481)	(0.01433)	(0.01383)	(0.00978)
2	-0.030755	-0.029535	-0.000802	-0.017265	-0.101274
	(0.01877)	(0.01688)	(0.01792)	(0.01812)	(0.01647)
3	-0.038187	-0.001988	0.017353	0.004445	0.090658
	(0.02050)	01672	(0.01846)	01936	(0.01983)
4	0.022126	0.007678	-0.003918	000585	-0.028796
	02105	(0.01660)	(0.01888)	(0.01998)	(0.02114)
5	-0.003706	-0.012439	0.007042	-8.68E-05	0.092369
	(0.02263)	(0.01817)	(0.02037)	(0.02124)	(0.02160)
6	-0.015306	-0.016411	0.002919	-0.008721	-0.031033
	(0.02091)	(0.01610)	01900).	(0.01739)	(0.02277)
7	0.010465	-0.005870	-0.004926	0.001952	0.050286
	(0.01627)	(0.01249)	(0.01496)	01432	(0.02269)

8	-0.010459	-0.015896	0.023456	0.000760	0.018035
	(0.01438)	(0.01180)	(0.01405)	01100	(0.02154)
9	0.006540	-7.59E-05	0.002630	-0.001421	0.030787
	01152	(0.01063)	(0.01266)	(0.01116)	02111
10	-0.008907	-0.013044	0.011890	-0.000932	0.027978
	(0.01095)	(0.01033)	01147	SFI-00993	(0.02013)

An analysis of the impulse response to oil price fluctuations, the Conditional Standard Deviation (log (CSD)), reveals the following key insights:

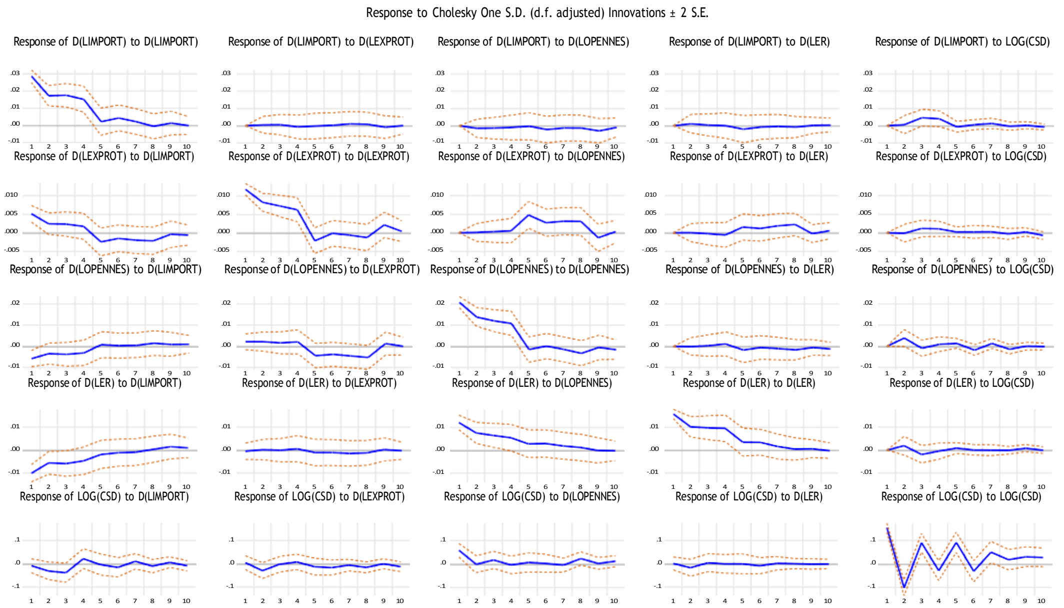
1. Oil price volatility shocks have a positive and significant impact on log (CSD) itself, indicating that volatility shocks tend to persist and have long-lasting effects on future volatility levels.

2. Shocks to imports (D(LIMPORT)) have a negative impact on oil price volatility in initial periods, suggesting that import volatility may temporarily moderate volatility. However, this effect becomes positive but statistically insignificant in subsequent quarters.

3. Shocks to exports (D(LEXPROT)) adversely affect oil price volatility, particularly in the first few quarters, which implies that export shocks may initially reduce volatility in the oil market. However, this effect diminishes and becomes statistically insignificant over time.

4. Interestingly, shocks to the degree of openness (D(LOPENNES)) have a positive and significant impact on oil price volatility in the initial period, suggesting that increased economic openness may initially contribute to increased volatility in the oil market. This effect becomes statistically insignificant in later periods.

5. Exchange rate shocks (D(LER)) have a relatively small and statistically insignificant impact on oil price volatility throughout the 10-month horizon. The analysis suggests that oil price fluctuations are primarily due to the shocks that accompany them, with some temporary effects from import and export shocks and openness in the initial periods. However, these effects tend to fade over time, and exchange rate shocks do not appear to significantly affect oil price fluctuations in the specification of this model.



European Economic Letters
ISSN 2323-5233
Vol 14, Issue 2 (2024)
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2. Results of variance segmentation analysis of estimated model variables

D-variance analysis (LIMPORT):

- This table shows the percentage contribution of each variable to the variance of the prediction error of variable D(LIMPORT) across different prediction horizons.

- In the first period, D(LIMPORT) alone accounts for 100% of the variance of the prediction error, indicating its dominance in the initial prediction horizon.

- As we move into later periods, other variables such as D(LEXPROT), D(LOPENNES), D(LER), and log (CSD) begin to gradually contribute to the variability of the prediction error, reflecting their increasing influence over time.

- For example, by the 10th period, D(LIMPORT) is still important but its contribution drops to 95.62%, while the other variables combined contribute more, indicating a shift in system dynamics over time.

D variance analysis (LEXPROT):

- This table shows the percentage contribution of each variable to the variance of the prediction error of variable D(LEXPROT) over the different prediction horizons.

- Initially, D(LEXPROT) dominated the variance of the prediction error, showing about 84.33% in the first period.

- However, as we progress in later periods, the contribution of other variables such as D(LIMPORT), D(LOPENNES), D(LER), and log(CSD) increases, indicating a more balanced effect of different factors on the error variance projections.

Analysis of variance for D(LOPENNES):

- This table shows the percentage contribution of each variable to the variance of the prediction error of variable D(LOPENNES) across different prediction horizons.

- Initially, D(LOPENNES) accounts for the majority of the variance of the prediction error, showing about 91.96% in the first period.

- Going forward, the contribution of other variables gradually increases, indicating the influence of a variable of different factors on the variance of the expected error of D(LOPENNES).

D variance analysis (LER):

- This table shows the percentage contribution of each variable to the variance of the prediction error of variable D(LER) across different prediction horizons.

- Initially, D(LER) contributed significantly to the variation of the prediction error, amounting to about 49.60% in the first period.

- However, as we progress in later periods, the contribution of other variables increases, indicating a more balanced effect of different factors on the expected error variance of D(LER).

Record Variance Analysis (CSD):

- This table shows the percentage contribution of each variable to the variance of the log (CSD) prediction error across different prediction horizons.

- In the initial period, log (CSD) is mainly affected by itself, which explains about 86.97% of the variance of the prediction error.

European Economic Letters
ISSN 2323-5233
Vol 14, Issue 2 (2024)
http://eelet.org.uk

- As we move forward, other variables begin to contribute gradually, indicating the variable effect of different factors on the variability of log (CSD) prediction error over time.

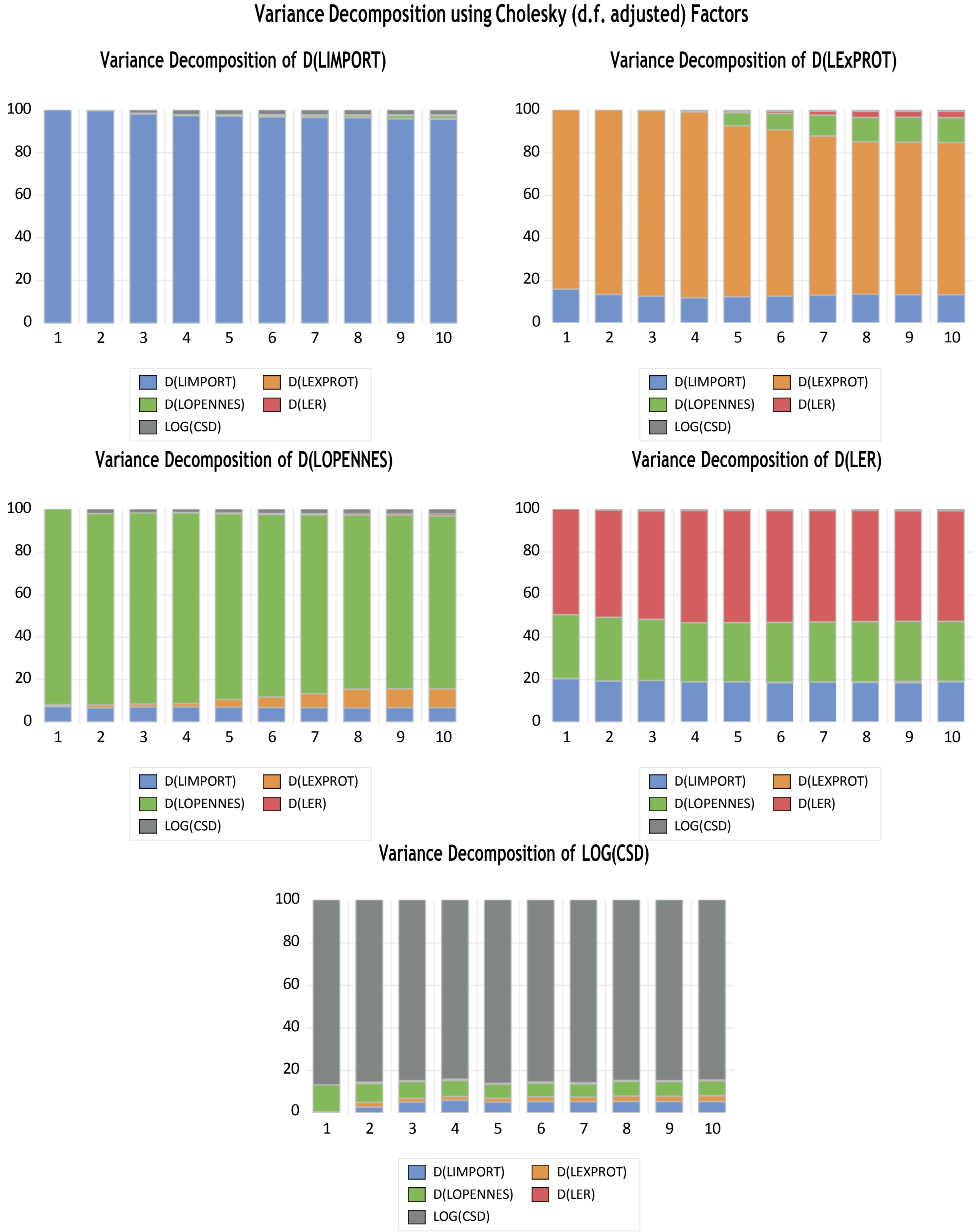

Figure (04) Variance Component Analysis Table for Estimated Model Variables

3. Grnager causation test analysis

Granger's pairwise causality tests are a valuable tool for detecting causal dynamics between different variables within the model. A thorough analysis of the output reveals several key insights. First, regarding the relationship between LEXPOROT and LIMPORT, the test results indicate that neither of the two variables Granger causes the other, as evidenced by the probability values exceeding the 5% significance level. Similar conclusions were drawn for the interactions between LOPPENNES and LIMPORT, LER and LIMPORT, and CSD and LIMPORT, where no significant evidence of a causal relationship for Granger was found in either direction. However, it should be noted that the relationship between LIMPORT and CSD shows marginal significance, with LIMPORT marginally causing Granger in CSD at the 10% level. Turning to the interactions between LEXPOROT and LOPENNES, the results indicate that there is no causal relationship of Granger between the two variables in either direction.

Hypothesis	OBS	F-Statistic	PROB
DELXPORT does not Granger Cause CSD	129	0.92234	4003
CSD does not Granger Cause DELXPORT		1.37151	2575
DLER does not Granger Cause CSD	129	0.55761	5740
CSD does not Granger Cause DLER		0.74589	4764
DLIMPORT does not Granger Cause CSD	129	14019	3231
CSD does not Granger Cause DLIMPORT		1.03606	3579
DLOPENNES does not Granger Cause CSD	129	1.47336	2331
CSD does not Granger Cause DLOPENNES		2.28776	1058
DLER does not Granger Cause	129	0.43317	.6494

<table>
<tr><td>DELXPORT</td><td></td><td></td><td></td></tr>
<tr><td>DELXPORT does not Granger Cause DLER</td><td></td><td>0.16763</td><td>0.8459</td></tr>
<tr><td>DLIMPORT does not Granger Cause DELXPORT</td><td>129</td><td>|||UNTRANSLATED_CONTENT_START||| 0.53175|||UNTRANSLATED_CONTENT_END|||</td><td>5889</td></tr>
<tr><td>DELXPORT does not Granger Cause DLIMPORT</td><td></td><td>0.01561</td><td>0.9845</td></tr>
<tr><td>DLOPENNES does not Granger Cause DELXPORT</td><td>129</td><td>1.11423</td><td>3314</td></tr>
<tr><td>DELXPORT does not Granger Cause DLOPENNES</td><td></td><td>No. 58058</td><td>0.5611</td></tr>
<tr><td>DLIMPORT does not Granger Cause DLER</td><td>129</td><td>04376</td><td>0.9572</td></tr>
<tr><td>DLER does not Granger Cause DLIMPORT</td><td></td><td>0.65138</td><td>5231</td></tr>
<tr><td>DLOPENNES does not Granger Cause DLER</td><td>129</td><td>0.34939</td><td>7058</td></tr>
<tr><td>DLER does not Granger Cause DLOPENNES</td><td></td><td>0.05576</td><td>0.9458</td></tr>
<tr><td>DLOPENNES does not Granger Cause DLIMPORT</td><td>129</td><td>0.08648</td><td>T \ 9172</td></tr>
<tr><td>DLIMPORT does not Granger Cause DLOPENNES</td><td></td><td>3.5E-05</td><td>1.0000</td></tr>
</table>

Conversely, while LEXPOROT does not cause LER in Granger, there is an important directional causal relationship from LER to LEXPOROT. Furthermore, the tests revealed no significant evidence of a Granger causal relationship between LOPENNES and LER, although marginally LOPENNES causes Granger CSD at the 10% significance level. Finally, the LER or CSD Granger does not cause the other to occur, as both directions fail to provide significant evidence of causation. Overall, these findings highlight temporal precedence and potential causal relationships between variables, enriching our understanding of dynamic interactions within the model.

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