



forecasting pharmaceutical imports (increase or decrease) in Algerian between 1990 and 2024 (in-sample and out-of-sample)

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Abstract:

The pharmaceutical industry plays a crucial role in the broader industrial sector and the national economy, principally because of its direct impact on health security. Consequently, many governments give priority to achieving self-sufficiency in pharmaceutical production through import-substitution strategies and subsequently seek to expand exports to improve the trade balance.

This study forecasts Algeria's pharmaceutical imports for the period 1990–2024 using the Box–Jenkins ARIMA time-series approach. Data were drawn from several national and international sources and analysed with the EViews statistical software.

The methodological framework comprised data preprocessing, model identification, estimation, diagnostic checking, and forecasting. The results point to a significant decline in Algeria's pharmaceutical imports over the study period. They also indicate tangible progress towards self-sufficiency in several product categories, reflecting a strategic shift towards strengthening domestic production. The close correspondence between the actual data and the fitted values attests to the robustness and predictive accuracy of the adopted model.

These findings have important policy implications for further developing domestic pharmaceutical capacity and reducing external dependence.

Key Words: pharmaceutical imports; ARIMA; forecasting; Algeria.

JEL classification: F14, I18, C53

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Introduction:

For decades, Algeria has relied heavily on oil revenues as the primary source of national income and taxation, while contributions from other productive sectors have remained relatively limited. This reliance has led to persistent structural imbalances in the national economy. In response, the Algerian government has implemented various development strategies aimed at restructuring economic activity to establish a diversified, resilient, and integrated production base. These strategies emphasize import substitution by focusing on sectors in which Algeria possesses a comparative advantage and the technical capacity to produce domestically. The overarching goal is to reduce the country's import bill and



improve macroeconomic indicators, such as the trade balance, the balance of payments, and the public budget, while also laying the groundwork for genuine economic diversification. One sector identified as a strategic pillar in this transition is the pharmaceutical industry. (Ihmin-Shafir, 2021)

Globally, the pharmaceutical sector is recognized as a high-value, innovation-driven industry, with developed countries investing heavily in its advancement. The sector's profitability stems from its reliance on specialized technical expertise, advanced infrastructure, and high-technology equipment. In Algeria, the focus has been on building local capacity to manufacture essential medicines, particularly those used in the treatment of chronic diseases such as diabetes, hypertension, and cancer. Notably, domestic production of insulin alone has reached €300 million—an amount that was previously covered entirely through imports. Furthermore, the annual return on turnover in the pharmaceutical sector has reached up to 25 % for certain leading national firms, underscoring the sector's potential. (Mehdi.K, 2025)

To assess the extent to which these policy goals have materialized, a number of studies have examined themes such as pharmaceutical import trends, import substitution strategies, and the transition toward local production and self-sufficiency (Kaplan, 2005);

Building upon this literature, the present study aims to contribute by forecasting the trajectory of Algeria's pharmaceutical imports, providing an empirical basis to evaluate the effectiveness of national strategies aimed at reducing external dependency in this critical sector.

Accordingly, this paper seeks to address the following central research question:

To what extent can Algeria achieve self-sufficiency in the pharmaceutical sector by forecasting trends in pharmaceutical imports from 1990 to 2024 using time series analysis?

In light of Algeria's strategic shift toward economic diversification and local pharmaceutical production, and in response to the central research question regarding the forecast of pharmaceutical imports, the study proposes the following hypotheses:

- Algeria has achieved partial self-sufficiency in the production of specific essential medicines, particularly those used in the treatment of chronic diseases.
- The forecasting model (Box-Jenkins/ARIMA), applied to historical data, demonstrates a strong predictive capacity, with a high degree of convergence between the actual and fitted pharmaceutical import data.

I. General Literature on the Pharmaceutical Industry:

The pharmaceutical industry is considered one of the most important sectors in various medication-producing countries around the world. Its importance is growing due to intense competition, as it is regarded as a cornerstone of the economy in these countries because of its economic returns, and it has become an important tributary of economic activity in a number of developed countries. It also plays a major role in health-sector activities, combating diseases and epidemics, and protecting against

them. One of its most important characteristics is its reliance on research, which is why it is protected by the Trade-Related Aspects of Intellectual Property Rights (TRIPS) Agreement. (Cockburn, 2001, pp. 1033–1057)

The production process is long, lasting more than 20 years, from the beginning of research to the drug being put on the market. The cost of research is estimated at 14% of the turnover, which is a high percentage when compared to other industries. (DIDIER & M, 2007) It also represents 3% of the volume of global trade.

figure.1. Global Pharmaceutical Market Geography 2021



Source: Leem-les entreprises du médicament, Bilan économique, édition 2022, p 48 .

The global pharmaceutical market has witnessed significant growth in recent years, tripling in size from 2001 to 2022. The total global pharmaceutical market was estimated at \$1.48 trillion in 2022, (Mikulic, 2024) a 280% increase. This growth is attributed to several factors, most notably population growth, the spread of chronic diseases such as diabetes, heart disease, and cancer, and epidemics such as the recent COVID-19 pandemic, which has increased demand for vaccines and healthcare supplies globally. (Steven Yu, 2023) The United States has emerged as a leading pharmaceutical market, followed by emerging markets, which include low- and middle-income countries such as Brazil, India, Russia, China, Colombia, and Egypt. Among the best-selling pharmaceutical products globally in 2021, the COVID-19 vaccine Comirnaty was the best-performing pharmaceutical product, generating revenues of \$37 billion. (Luciana-Correia-Borges, 2022, pp. 3101-3113) Humira (mostly used to treat rheumatoid and psoriatic arthritis) was the second-best-selling drug in 2021, with total revenues of nearly \$21 billion. (Annalee-Armstrong, 2025)

The global pharmaceutical market is highly competitive, with a few global companies monopolizing market share due to the large expenditures on research and development in this sector. The market is characterized by strong differentiation.



Global pharmaceutical market sales reached \$1.482 billion in 2022 (approximately €1.353 billion), thus regaining their pre-COVID-19 dynamism, with a growth rate of 2.2% compared to 2021. According to IQVIA estimates, the global pharmaceutical market should eventually exceed pre-pandemic projections and reach \$1.9 trillion by 2020-2027 (approximately €1.735 billion). (IQVIA-Institute, Jan 18, 2023) However, this growth masks strong disparities across geographies. In 2022, ten markets accounted for 72.1% of global pharmaceutical market sales. The United States maintains its dominant position with a 42.6% market share of global sales. China, the second largest global market, represents 7.6% of the market share, ahead of Japan (4.5%). In Europe, Germany remains in the lead with 4% of global sales, followed by France (2.8%), Italy (2.4%), the United Kingdom (2.3%), and Spain (1.9%).

Finally, the presence of Brazil, with a 1.9% global market share, demonstrates the growth potential of some emerging countries. In fact, IQVIA forecasts strong growth by 2027 in markets primarily comprised of emerging countries. Market growth is driven by two pillars: volume growth, (IQVIA-Institute, Jan 18, 2023) driven by an increase in the number of packages sold, and value growth, which corresponds to the evolution of the average price of the drugs sold. This average price is rising, particularly due to the arrival of innovative drugs, and declining due to increased competition in older markets. Western markets, which include Western Europe and North America, are characterized by long-standing population access to established healthcare systems and to pharmaceuticals. Since the population has largely access to health and medication coverage, these markets are no longer able to grow in size. (BMI-to-fitch-solutions-company, Thu 31 Dec, 2020).

II. Current State of Algeria's Pharmaceutical Sector

1. Local Production and Market Coverage: As of mid-2025, national pharmaceutical production meets 76.8 % of domestic demand, compared to approximately 70 % in 2023. (Saada.Hana, 2025)

In 2024, local output was projected to exceed USD 4 billion, with actual production reaching USD 3.56 billion in 2023 and USD 3.14 billion in 2022 (Hana.Saada, 2024)

Over the past decade, market coverage by local production rose from ~40 % in 2011 to over 70 % by 2021 and nearly 77 % by 2025.

2. Import Reduction: Import expenditures have dropped significantly: from USD 2 billion in 2019 to USD 1.2 billion in 2021, and further from EUR 1.422 billion in 2022 to EUR 1 billion projected for 2024;

The pharmacological deficit continues to contract in line with increased domestic capacity. (APS, 2022)

3. Industrial Base & Strategic Developments: There are over 200 pharmaceutical production units (public and private) active nationwide, Notable public-private partnerships include ventures with multinationals like Sanofi, Pfizer, and Novo Nordisk, and private entities such as Biopharm, Biocare, Merinal. Key infrastructure investments include insulin production (Biocare), anti-cancer drug facilities,



biosimilar and biotech production (e.g., Frater Raze), and a vaccine plant producing CoronaVac. (BMI, a Fitch Solutions company, 2022)

4. Regulation & Innovation: A standalone Ministry of Pharmaceutical Industry and a National Drug Agency, combined with supportive legislative frameworks, digital traceability systems and improved clinical trial regulation, have streamlined registration and monitoring. (HERMS CONSULTANCY DMCC, 2023)

The issuance of long-term, five-year licensing and regulatory reforms for pricing and exports are being rolled out.

5. Exports & Regional Strategy: Pharmaceutical exports rose to USD 12.6 million in 2023 and are expected to reach USD 17 million in 2024.

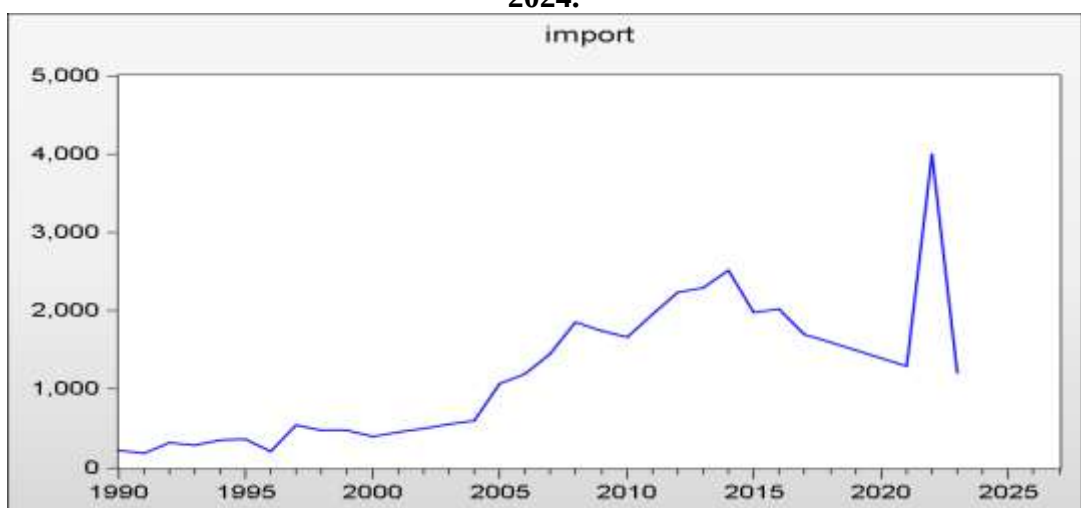
Nine Algerian labs—including Saidal—now export to African and Middle Eastern markets. Algeria aims to upscale exports from ~30 products to over 150, targeting Africa, Arab states, and Europe by 2025. (Saada.Hana, 2025)

III. The econometric study of forecasting growth of the Algerian pharmaceutical imports between 1990 and 2024:

1. Evolution of Algerian pharmaceutical imports between 1990 and 2024:

We find that growth was normal from 1990 to 2020, then experienced a significant decline, followed by a significant increase, and then a sharp decline. This period, from 2021 to 2024, was marked by the spread of the COVID-19 pandemic from 2021 to the end of 2022. During this period, Algeria adopted a strategy of local production and import substitution by reducing its import bill and relying on its own domestic production. This was actually achieved in 2024, when imports of some medications, such as those for diabetes and cancer, fell by 50%, while exports rose to \$80 million. (BMI, Tue 18 Oct, 2022)

Figure.02:evolution of Algerian pharmaceutical imports between 1990 and 2024.



Source: Statistical Program Outputs EVIEWS



2. Modelling the relationship related to forecasting Algeria's pharmaceutical imports during the period 1990-2024 using autoregressive moving average growth (ARIMA):

The ARIMA model, a time series forecasting method, was proposed by Box and Jenkins in the 1970s. The model consists of AR, I, and MA. Here, "AR" represents the autoregressive model, "I" represents the integral, which refers to the order of one integer, and "MA" represents the moving average model.). (Box-G.E.P-Jenkins-G.M&Reinsel, 2008) In general, to first measure the stationarity of the time series, we can rely on the ADF and Philip Perron unit root tests. For non-stationary series, it must be transformed into a stationary series at the first difference. This is called the first-order integral, i.e., the first difference (one integer) **ARIMA (p, D, q)** (Perron.P, 1988, pp. 335–346)

We write the model as follows:

$$\Delta^D Y_t = c + \phi_1 \Delta^D Y_{t-1} + \dots + \phi_p \Delta^D Y_{t-p} + \varepsilon_t + \theta_1 \varepsilon_{t-1} + \dots + \theta_q \varepsilon_{t-q}$$

where $\Delta^D Y_t$ denotes a divergent series of degree D (the difference), and ε_t is an uncorrelated process with zero mean, in delay factor notation $L_i Y_t = Y_{t-i}$, We can write the ARIMA (p, D, q) model as follows, assuming the delay factor $L_i Y_t = Y_{t-i}$:

$$\phi * (L) y_t = \phi(L)(1 - L)^D y_t = c + \theta(L) \varepsilon_t$$

Here, $\phi(L)$ is an unstable polynomial with an AR factor with D having an exact unit root. Anyone can factor this polynomial into $\phi(L)(1 - L)^D$ where: $\phi(L) = (1 - \phi_1 - \dots - \phi_p L^p)$ is a stable polynomial with AR lag factor p. Similarly, $\theta(L) = (1 - \theta_1 - \dots - \theta_q L^q)$ is an invertible polynomial with MA lag factor q degrees. When two of the three terms in ARIMA(p, D, q) are zeros, The model can be referred to, based on the non-zero parameter, by dropping "AR," "I," or "MA" from the abbreviation describing the model. For example, ARIMA (1,0,0) is AR=1, ARIMA (0,1,0) is I=1, and ARIMA (0,0,1) is MA=1.

2. 1. Stationarity Test:

Based on the **ADF** and **PHILLIP PERRON** tests, this is based on two hypotheses: the null hypothesis, which states that the series has a unit root, and therefore is non-stationary; and the alternative hypothesis, which states that there is no unit root, and therefore the series is stationary. Upon conducting the test, we found that the series was non-stationary at the level. After re-running the test, we found that the series was stationary at the first difference.(Alhassan.A., 2020, p. 41)

Table No (01): Results of stationary tests for LEXPOR:

Null Hypothesis: D(IMPORT) has a unit root				
Exogenous: Constant				
Augmented Dickey-Fuller test statistic			t-Statistic	Prob.*
Test critical values:			-10.33637	0.0000
	1% level		-3.653730	
	5% level		-2.957110	
	10% level		-2.617434	
*MacKinnon (1996) one-sided p-values.				



Augmented Dickey-Fuller Test Equation				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(IMPORT(-1))	-1.963645	0.189974	-10.33637	0.0000
C	145.3584	98.51810	1.475449	0.1505
R-squared	0.780767	Mean dependent var		-86.39219
Adjusted R-squared	0.773459	S.D. dependent var		1140.169
S.E. of regression	542.6784	Akaike info criterion		15.49137
Sum squared resid	8834996.	Schwarz criterion		15.58298
Log likelihood	-245.8620	Hannan-Quinn criter.		15.52174
F-statistic	106.8406	Durbin-Watson stat		1.973194
Prob(F-statistic)	0.000000			

Source: EVIEWS Statistical Program Outputs

2. 2. Autocorrelation and Partial Autocorrelation Test:

According to this test, the p-value, which represents the AR value, for autocorrelation, takes a value of: 1, according to the figure shown in Table (2), and according to the significance, i.e., the p-value, and the q-value, which represents the MA value, takes two values according to the figure, which are: 1, 2. This choice is not precise, but rather relative. Since the stability was at the first difference, the D-value, which represents the (I) value, is: 1. From here, we extract five models, (Hyndman-R.J& Athanasopoulos.G, 2018) which are: ARIMA (0. 1. 1); ARIMA (1. 1. 0); ARIMA (1. 1. 1); ARIMA (0. 1. 2); ARIMA (1. 1. 2).

Table No (02): Results of the autocorrelation and partial autocorrelation tests.

Autocorrelation	Partial Correlation	MN	AC	PAC	Q-Stat	Prob
		1	-0.479	-0.479	8.2687	0.004
		2	0.023	-0.268	8.2878	0.016
		3	0.011	-0.144	8.2927	0.040
		4	0.001	-0.075	8.2928	0.081
		5	-0.032	-0.083	8.3341	0.139
		6	0.072	0.025	8.5574	0.200
		7	-0.104	-0.078	9.0412	0.250
		8	0.128	0.067	9.8035	0.279
		9	-0.042	0.066	9.8889	0.360
		10	0.016	0.076	9.9025	0.449
		11	-0.001	0.068	9.9025	0.539
		12	-0.085	-0.080	10.303	0.589
		13	-0.015	-0.145	10.316	0.668
		14	0.079	-0.061	10.696	0.710
		15	-0.027	-0.017	10.742	0.771
		16	-0.031	-0.066	10.805	0.821

Source: Statistical Program Outputs EVIEWS

2. 3. Choosing the optimal model for forecasting (prediction):

$p = 1$ or $p = 2$. Since the judgment is highly subjective, i.e., it remains with the researcher, to create a more accurate model, the range of p and q values is appropriately relaxed, and multiple ARMA (p , q) models are constructed. The



ranking is performed with 0, 1, and 2 in the pre-estimation of the autoregressive moving average on the processed sample data. **Table 3** lists the results of the **ARMA (p, q)** test for various parameters. The corrected **R-squared**, **AIC value**, **SC value**, and **S.E.** regressions are important criteria for model selection. (Fang.Z.Dowe.D.L-Peiris.S&Rosadi.D, 2021)

The **AIC** and **SC** criteria are primarily used for classification and selection of the optimal model. In general, the higher the coefficient of determination, the lower the AIC and SC value, and the regression coefficient or variance. The chosen **ARMA (p, q)** model, i.e., the one with the highest significance, then the corrected coefficient of determination, and the lowest **AIC** and **SC** values, and the regression coefficient (variance), is the best, most efficient, and most effective model for forecasting. (Bardet.-M&Kare-K&Kengne, 2021)

The selection of the best-fitting ARMA(p, q) model holds practical implications for policymakers. A model that accurately captures the autoregressive and moving average components of pharmaceutical import data can support more precise forecasting, enabling better inventory management, import planning, and industrial policy formulation. Given the strategic importance of the pharmaceutical sector—both from a public health and economic sovereignty standpoint—the development of a statistically robust and economically interpretable model enhances the government's capacity to anticipate fluctuations in external dependence and align its import strategies accordingly.

a. Identifying Proposed Models: It should be emphasized that although an appropriate ARMA model is typically selected using the AIC value and SC value, the minimum AIC value and SC value are not sufficient conditions for an optimal ARMA model. The method used in this work is to first construct a model with the minimum AIC value and SC value, and then perform a parameter significance test and a random residual test on the estimation result. If the test passes, the model can be considered optimal. If it fails, the second-smallest AIC value and SC value are selected, and the relevant statistical test is performed. This continues until the appropriate model is selected: Arima (p. 1. q); Arima (0. 1. 1); Arima (0. 1. 2); Arima (1. 1. 0); Arima (1. 1.1); Arima (1. 1. 2)

The choice of models is precise, but at the expense of the researcher. Hence, we chose five models by including 0 as a choice for: p, q.

b. Estimation using the least squares method:

We estimated the eight models that we chose based on the autocorrelation function and the partial autocorrelation function, where the values of (p. q) were where p=0. 1 and also q=0. 1. 2. After conducting the tests based on the least squares method, we relied on four indicators, which are the adjusted R-squared, the Akaike info criterion and the Schwarz criterion, and the S.E. of regression, where we found the results as follows: Two models were accepted and three models were rejected based on the lack of significance because the p-value was greater than 0.05.



Table No. (03): Results of selecting models using the least squares method and based on the previously mentioned indicators

(p, q)	Adjusted R-squared	AIC	SC	S.E. of regression
(0, 1) *	0.3539	15.65	15.79	575.69
(0, 2)	0.0069	16.13	16.26	737.15
(1, 0) *	0.4197	15.56	15.70	545.59
(1, 1)	0.4003	15.6201	15.8015	554.6657
(1, 2)	0.4009	15.6288	15.8102	554.3934

*: Indicates the presence of significance in the model.

Source: Statistical Program Outputs EVIEWS

After selecting the two models based on significance, we select the ARIMA (1,1,0) model based on the four criteria. It relies primarily on significance, as the variables c, ar (1), and ma(1) are significant, meaning their p-values are less than 0.05. It also has the highest corrected coefficient of determination (CoD) of 0.4197, the lowest standard deviation, and the lowest AIC and SC values. From this, we create and test the model. This level of significance implies that past values and shocks have a meaningful and quantifiable influence on current import levels, which aligns with the economic intuition that trade flows are often influenced by both historical patterns and short-term fluctuations.

2. 4. Test the selected model using the ordinary least squares (OLS) method:

The results estimated using the ARIMA model using the ordinary least squares (OLS) method are as follows

Table No(4):Test the selected model using the ordinary least squares (OLS) method

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	71.25224	89.35579	0.797399	0.4315
(1) AR	-0.857401	0.150964	-5.679507	0.0000
SIGMASQ	270609.9	46183.75	5.859418	0.0000
R-squared	0.456041	Mean dependent var		29.59576
Adjusted R-squared	0.419777	S.D. dependent var		716.2603
S.E. of regression	545.5922	Akaike info criterion		15.56839
Sum squared resid	8930127.	Schwarz criterion		15.70443
Log likelihood	-253.8784	Hannan-Quinn criter.		15.61416
F-statistic	12.57562	Durbin-Watson stat		2.132211
Prob(F-statistic)	0.000108			
Inverted AR Roots	-.86			

Source: Statistical Program Outputs EVIEWS.

The final model for the IMPORT time series is ARIMA (1,1,0). We write the mathematical formulation of the selected model as follows. Note that the data in parentheses below the equation are the t-test statistics for the corresponding estimate.

$$\Delta \text{Import} = 71.25224 - 0.857401 \text{ import}_{t-1}$$

t(0.797399) t(-5.679507)



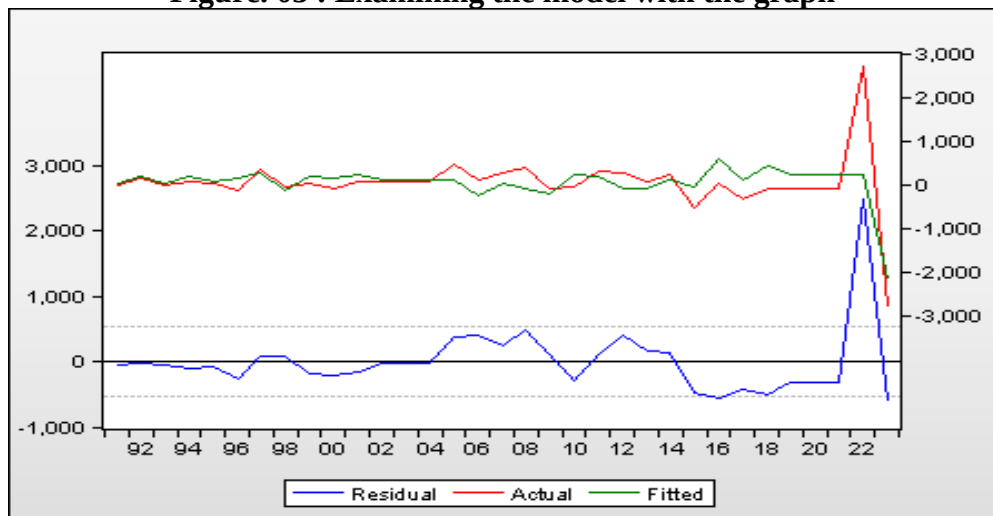
This model also appears to be good, based on the corrected coefficient of determination of 0.456041, meaning it has moderate explanatory power and is significant for the p-value of the AR (1) variable. We also find that the estimated value of the error variance for the selected model is;

That current levels of pharmaceutical imports are strongly influenced by their past values reflects a high degree of persistence in import behavior. This is consistent with trade dynamics in essential goods, such as medicines, where procurement decisions and stock adjustments often follow historical demand patterns and institutional purchasing cycles. The significance of the SIGMASQ term further supports the model's reliability, indicating that the variance of the error term is appropriately modeled and does not undermine the accuracy of predictions.

It can be seen from the t-statistic for the model's coefficients and its p-value that the parameter estimates for the explanatory variables of the AR (1) and SIGMASQ models are significant at the 0.05 significance level. From this, we examine the model using the actual values, the fitted expected values, and the residual values, also known as errors, which are the difference between the actual and expected values, according to the conditions related to ARIMA models, (Smigel.L, 2023).

IV. Examining the model with the graph: (actual, fitted, residual) and we found the following figure:

Figure. 03 : Examining the model with the graph



Source: Statistical Program Outputs EVIEWS

We found a high convergence between the actual and fitted curves, i.e., between the actual values and the expected values, which explains the high efficiency of the selected model. It is a predictive model, and the differences are minimal over the study period.

1. White noise test:

To determine the efficiency of the selected model, we look at the residual curve, which shows that the differences are minimal. From this, we determine that the

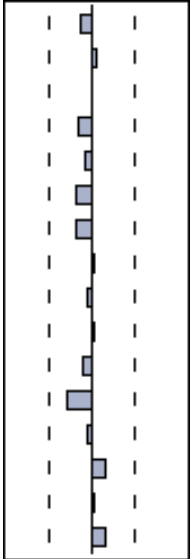
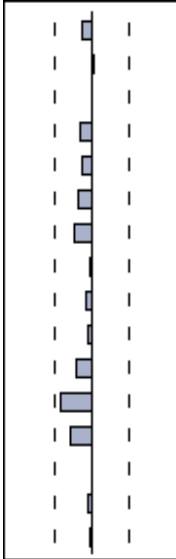


selected model is suitable and good for **FORECASTING**. After fitting the **ARIMA (1,1,0)** model to make predictions using the approved indicators, the residual values curve (the difference between the actual values and the expected values) shows that the model is good and demonstrates the model's validity for in-sample and out-of-sample predictions. (Luo.L., 2024, pp. 227–232)

2. Testing the stability of the selected model (which is the best):

Next, we test the series stability of the selected model:

Table No. (05): Testing the stability of the selected model (which is the best)

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.088	-0.088	0.2765	
		2	0.026	0.019	0.3022	0.582
		3	0.001	0.005	0.3022	0.860
		4	-0.103	-0.104	0.7263	0.867
		5	-0.065	-0.085	0.9012	0.924
		6	-0.118	-0.130	1.4970	0.913
		7	-0.129	-0.156	2.2320	0.897
		8	0.023	-0.017	2.2575	0.944
		9	-0.045	-0.064	2.3538	0.968
		10	0.014	-0.039	2.3630	0.984
		11	-0.076	-0.141	2.6692	0.988
		12	-0.194	-0.290	4.7350	0.943
		13	-0.034	-0.194	4.8034	0.964
		14	0.105	0.006	5.4742	0.963
		15	0.023	-0.039	5.5087	0.977

Source: according to the output of statistical program.

It is clear from the figure that the series is stationary, as all points lie within the confidence bounds of both the autocorrelation and partial-autocorrelation functions. Therefore, we can say that the model is sound and predictable. From an economic perspective, stationarity is a crucial precondition for building reliable and interpretable forecasting models, particularly in time-series econometrics. A stationary series ensures that past behaviours and patterns can be meaningfully used to predict future outcomes without distortion from trends or structural breaks.

In this context, the stationarity of the series implies that the underlying process governing Algeria's pharmaceutical imports is predictable and exhibits no explosive tendencies. Consequently, the selected model can be considered both statistically valid and economically sound for short- and medium-term forecasting. This enhances its practical utility for policymakers and stakeholders, who rely on consistent data behaviour to make informed decisions regarding import planning, budget allocation, and industrial strategy.



V. Forecasting Algeria's pharmaceutical imports:

1. Forecasting Algeria's pharmaceutical imports from within the sample

According to the table's results, we see that the residual values are small, meaning that the difference between the actual and fitted values is close across all years. We find that the actual values for 2023 are estimated at \$2,800 million, while the fitted values are approximately \$2,182.64 million. The residual values, meaning the difference, amounted to \$617.36 million. This difference appears not to be very large. While we find the differences stable in some years, they are very weak in other years. We observe a very large difference in 2022, as shown in the figure attached to the table (the point outside the range). (Howell.E, 2023)

Table No. (06): Results of the within-sample forecasting test: Actual values, fitted values, and residual values

Year	Actual	Fitted	Residual	ResidualPlot
1991	-35.4500	19.4641	-54.9141	
1992	136.560	162.739	-26.1789	
1993	-34.9500	15.2573	-50.2073	
1994	65.1700	162.310	-97.1402	
1995	9.31100	76.4672	-67.1562	
1996	-153.982	124.361	-278.343	
1997	335.451	264.368	71.0826	
1998	-64.5500	-155.272	90.7222	
1999	0.10000	187.689	-187.589	
2000	-81.0000	132.258	-213.258	
2001	50.0000	201.794	-151.794	
2002	50.0000	89.4739	-39.4739	
2003	50.0000	89.4739	-39.4739	
2004	50.0000	89.4739	-39.4739	
2005	470.000	89.4739	380.526	
2006	120.000	-270.635	390.635	
2007	260.000	29.4558	230.544	
2008	400.000	-90.5804	490.580	
2009	-110.000	-210.617	100.617	
2010	-70.0000	226.658	-296.658	
2011	290.000	192.362	97.6379	
2012	280.000	-116.302	396.302	
2013	50.0000	-107.728	157.728	
2014	230.000	89.4739	140.526	
2015	-540.000	-64.8583	-475.142	
2016	40.0000	595.341	-555.341	
2017	-320.000	98.0479	-418.048	
2018	-100.000	406.712	-506.712	
2019	-100.000	218.084	-318.084	
2020	-100.000	218.084	-318.084	
2021	-100.000	218.084	-318.084	
2022	2700.00	218.084	2481.92	
2023	-2800.00	-2182.64	-617.360	

Source: based on the progrm. EVIEWS.

2. Out-of-sample forecasting tests for Algerian pharmaceutical imports in 2025, 2026, and 2027:

After conducting out-of-sample forecasting tests, the volume of imports of medicines and pharmaceutical products into Algeria in 2025, 2026, and 2027 was determined as follows, in order: 2,717,168, 2,788,420, and 2,859,673. This can be explained by the fact that import growth was very low and stable, i.e., it was not very high.



This indicates that Algeria has achieved its strategy of import substitution and self-sufficiency, despite the increase in demand for medicines, on the one hand, and the growth in domestic production of medicines and pharmaceutical products, thanks to the pharmaceutical sector's contribution to the overall demand matrix for medicines.

We find that the difference (the margin of error) between the forecasted import volume and the actual import volume released is very small (this data for actual imports was taken from the ISS African Futures website). As for the forecasted imports, they are very close to the economic reality, as the government has turned to local industry to produce approximately 50% of medicines and reduce imports by 22%. Pharmaceutical imports reached \$4 billion in 2022 and declined significantly in 2023, reaching \$1.2 billion (themaghrebtimes.com, 2024).

Table No. (07): Results of out-of-sample forecasting tests.

YEAR	2025	2026	2027
Forecast importation (million dollar)	2717.168	2788.420	2859.673
Release importation (million dollar)	3120.00	2433.60	1898.21
Relative error	0.12	-0.1458	-0.5065

Source: outputs EViews and ISS African Futures website. (futures-ISS.AFRICA, 2025)

Furthermore, the government's pivot toward domestic production—reportedly meeting approximately 50 % of national pharmaceutical demand—has played a critical role in reducing Algeria's dependence on foreign imports. This is corroborated by the significant decline in pharmaceutical-import expenditures, which dropped from USD 4 billion in 2022 to USD 1.2 billion in 2023, a reduction of nearly 70 %. The policy measures that enabled this shift include investment incentives, improved regulatory frameworks, local manufacturing support, and public-private partnerships.

Overall, the forecasted stability in import volumes, combined with actual observed trends, reflects the success of Algeria's pharmaceutical-industrial policy. It confirms that import-substitution efforts are not only reducing external dependence but also ensuring the availability of essential medicines through increased national production capacity. Going forward, this trajectory supports broader economic objectives such as health sovereignty, foreign-exchange savings, and the development of a competitive pharmaceutical sector capable of meeting domestic demand and exploring export potential.

**Conclusion:**

This study employed the Box–Jenkins methodology to forecast and analyze Algeria’s pharmaceutical import trends, yielding compelling insights. Our model demonstrated strong statistical performance—evident from low residual values and reliable in-sample and out-of-sample fits—validating its appropriateness for this time-series data. Importantly, our findings confirm a marked decline in Algeria’s pharmaceutical imports, dropping from approximately USD 4 billion in 2022 to USD 1.2 billion in 2023—a trend the model accurately captured .

These results align with the initial hypothesis and indicate substantial progress toward Algeria’s goals of pharmaceutical self-sufficiency and import substitution. Specifically, local production now satisfies nearly 50 % of the domestic demand in key therapeutic categories such as diabetes treatments. Additionally, Algeria has begun exporting medicines to around 15 African countries, with export revenues rising from USD 12.6 million in 2023 to an estimated USD 17 million in 2024. (themaghrebtimes.com, 2024)

Altogether, these outcomes reflect Algeria’s successful strategy of strengthening domestic pharmaceutical production, reducing import dependency, and entering export markets. The Box–Jenkins model proved effective in forecasting these structural changes, offering policymakers and industry leaders a robust analytical tool for strategic planning.

Looking ahead, integrating explanatory variables—such as domestic manufacturing output, regulatory frameworks, and pharmaceutical pricing—via ARIMAX or transfer-function models could provide deeper insights. Periodic model recalibration will also be essential to accommodate structural shifts. Ultimately, this research underscores Algeria’s advancing pharmaceutical sovereignty and presents a solid framework for future studies in comparable contexts.(Saada.H, 2024)

Forecast and Policy Recommendations: Based on the estimated ARIMA model, Algeria’s pharmaceutical imports are projected to continue rising at a moderate pace over the coming years. However, slight seasonal fluctuations may occur due to external factors such as public health policies or exchange rate volatility.

Policy Implications and Recommendation: Policymakers in Algeria should closely monitor the evolution of pharmaceutical demand and anticipate future trends to ensure the timely and efficient procurement of imported medicines.

- It is recommended to strengthen the domestic pharmaceutical industry in order to reduce dependency on external sources, particularly in light of ongoing global economic fluctuations.
- **Enhance Regulatory Frameworks:**
Streamline and modernize regulatory procedures for drug registration, quality control, and import licensing to reduce bureaucratic delays and improve access to essential medicines.
- **Promote Public-Private Partnerships (PPPs):**
Encourage collaboration between the public sector and private pharmaceutical companies to stimulate innovation, local production, and technology transfer.



○ **Invest in Pharmaceutical R&D:**

Allocate greater resources to research and development initiatives in pharmacology and biopharmaceuticals, with a focus on locally prevalent diseases and the production of generic medicines.

○ **Establish Strategic Reserves:**

Create national reserves of critical pharmaceutical products to safeguard against potential supply chain disruptions, pandemics, or geopolitical shocks

○ **Support Workforce Development:**

Invest in training programs for pharmacists, chemists, and regulatory professionals to build a skilled workforce capable of supporting a sustainable pharmaceutical sector.

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Appendices:

The two models selected using the least squares method, for example:

1 - The first model: (1.1.0)

Dependent Variable: D(IMPORT)

Method: ARMA Maximum Likelihood (OPG - BHHH)

Date: 04/07/25 Time: 18:35

Sample: 1991 2023

Included observations: 33

Convergence achieved after 11 iterations

Coefficient covariance computed using outer product of gradients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	71.25224	89.35579	0.797399	0.4315
AR(1)	-0.857401	0.150964	-5.679507	0.0000
SIGMASQ	270609.9	46183.75	5.859418	0.0000
R-squared	0.456041	Mean dependent var		29.59576
Adjusted R-squared	0.419777	S.D. dependent var		716.2603
S.E. of regression	545.5922	Akaike info criterion		15.56839
Sum squared resid	8930127.	Schwarz criterion		15.70443
Log likelihood	-253.8784	Hannan-Quinn criter.		15.61416
F-statistic	12.57562	Durbin-Watson stat		2.132211
Prob(F-statistic)	0.000108			
Inverted AR Roots	-.86			



2 - The first model: (0.1.1)

Dependent Variable: D(IMPORT)

Method: ARMA Maximum Likelihood (OPG - BHHH)

Date: 04/07/25 Time: 18:36

Sample: 1991 2023

Included observations: 33

Convergence achieved after 52 iterations

Coefficient covariance computed using outer product of gradients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	59.93126	30.80752	1.945346	0.0612
MA(1)	-0.732514	0.164458	-4.454102	0.0001
SIGMASQ	301295.0	87789.80	3.432005	0.0018
R-squared	0.394361	Mean dependent var		29.59576
Adjusted R-squared	0.353985	S.D. dependent var		716.2603
S.E. of regression	575.6948	Akaike info criterion		15.65885
Sum squared resid	9942736.	Schwarz criterion		15.79489
Log likelihood	-255.3710	Hannan-Quinn criter.		15.70462
F-statistic	9.767209	Durbin-Watson stat		2.118184
Prob(F-statistic)	0.000541			
Inverted MA Roots	.73			