OIL PRICE SHOCKS PASS-THROUGH INTO INFLATION IN ALGERIA: ASSESSING THE RELATIVE IMPORTANCE OF THE TRANSMISSION CHANNELS USING STRUCTURAL VAR-X

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ABSTRACT

The present research paper seeks to investigate the channels through which oil price shocks pass-through into inflation in Algeria between 2002 and 2021 by focusing on the relative importance of each channel. The methodology we adopt here attempts to disentangle the possible effects of these channels on inflation after experiencing an oil price shock. Our results indicate the relative importance of three channels depending on the time horizon basis. In the short-run, the channels can be ranked as follows: (1) Public spending channel (2) Exchange rate channel and (3) the Money supply channel. In the long-run, we found the following ranking: (1) Money supply channel (2) Exchange rate channel and (3) Public spending channel. Taking into consideration the most relevant shocks the Algerian economy has gone through between 2002 and 2021, we emphasized the role and the importance of the public spending channel.

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JEL CLASSIFICATION : F4, E3, P4

تمرير صدمات أسعار النفط إلى التضخم في الجزائر: تقييم الأهمية النسبية لقنوات النقل باستخدام VAR-X الهيكلي

ملخص

تسعى الورقة البحثية الحالية إلى التحقيق في القنوات التي تمر من خلالها صدمات أسعار النفط إلى التضخم في الجزائر بين عامي 2002 و2021 من خلال التركيز على الأهمية النسبية لكل قناة. إن المنهجية التي نتبناها هنا تحاول فصل التأثيرات المحتملة لهذه القنوات على التضخم بعد التعرض لصدمة أسعار النفط. تشير نتائجنا الأولية إلى الأهمية النسبية لثلاث قنوات اعتماداً على الأفق الزمني. على المدى القصير، يمكن تصنيف القنوات على النحو التالي: (1) قناة الإنفاق العام، (2) قناة سعر الصرف و(3) قناة العرض النقدي. على المدى الطويل، وجدنا الترتيب التالي: (1) قناة العرض النقدي، (2) قناة سعر الصرف و(3) قناة الإنفاق العام. مع الأخذ في الاعتبار الصدمات الأكثر صلة التي مر بها الاقتصاد الجزائري بين 2002 و2021، أكدنا على دور وأهمية قناة الإنفاق العام.

كلمات مفتاحية: التضخم ، النفط ، قنوات النقل ، SVAR-X

LE PASS-THROUGH DES CHOCS DES PRIX DU PÉTROLE VERS L'INFLATION EN ALGÉRIE : ÉVALUATION DE L'IMPORTANCE RELATIVE DES CANAUX DE TRANSMISSION À L'AIDE D'UNE APPROCHE VAR-X STRUCTURELLE

RÉSUMÉ

Le présent article cherche à étudier les canaux par lesquels les chocs pétroliers se répercutent sur l'inflation domestique en Algérie entre 2002 et 2021 en se concentrant sur l'importance relative de chaque canal. La méthodologie que nous adoptons ici tente de démêler les effets possibles de ces canaux sur l'inflation après avoir subi un choc pétrolier. Nos résultats indiquent l'importance relative de trois canaux en fonction de l'horizon temporel. À court terme, les canaux peuvent être classés comme suit : (1) canal des dépenses publiques (2) canal du taux de change et (3) canal de la masse monétaire. A long terme, nous avons trouvé le classement suivant : (1) canal de la masse monétaire (2) canal du taux de change et (3) canal des dépenses publiques. Prenant en considération les chocs les plus pertinents que l'économie algérienne a traversés entre 2002 et 2021, nous avons souligné le rôle et l'importance du canal de la dépense publique.

MOTS CLÉS : Inflation, Pétrole, Canaux de transmission, VAR-X structurelle.

INTRODUCTION

The 2018 IMF report about Algeria highlights that average inflation declined from 6.4% in 2016 to 5.6% due to slowing inflation for manufactured goods and services and stood at 3.4% year-on-year in April 2018. In 2022, the IMF through its report, states that besides the oil shock of 2014, Covid-19 accentuated the ongoing economic vulnerabilities and that the higher inflation recorded in 2022 that was 7.7% and before that 6.5% (2021) are essentially the result of higher

international food prices affecting then the households' purchasing power, as explained in MENA economic update of the word bank in last April 2023.

The oil markets witnessed many shocks, in some, prices have fallen by about 70%of its value since June 2014, and even before that, five shocks, where prices dropped by 30% or more. In 1986, the first significant drop in oil prices occurred as a result of OPEC policy change. Other declines were the result of the decrease in global demand for oil due to the economic recession experienced by the United States (1990, 1991 and 2001), the Asian crisis (1997-1998) and the financial crisis (2008-2009) and finally the pandemic in 2020 in which the world witnessed a fall in global demand affecting then oil markets. These have caused great damage to oil-dependent economies, including Russia, Venezuela and Algeria, after prices remained for years above $100 per barrel. This decline cannot be attributed only to supply and demand factors. Some authors[1] gave some interpretations of the current oil market situation. In addition to the factors of supply and demand, the change in the objectives of OPEC member countries[2], the geopolitical changes in the Middle East, the rise in the dollar exchange rate against other currencies[3], and the speculation in the oil market contributed to the deterioration of prices. We can add to these factors the entry of non-conventional oil production (shale) into the market, which reduced the dominance of the OPEC countries and the recession caused by the pandemic.

We are interested in this work in investigating the channels through which oil price fluctuations pass-through into inflation by focusing on the relative importance of each channel. What is common in the literature that three channels through which oil price fluctuations pass-

[1] Baffes John et al,. "The Great Plunge in Oil Prices: Causes, Consequences, and Policy Responses." Policy Research Notes. Washington: World Bank Group, (2015), p.11.

[2] OPEC maintained the same level of production despite a surplus of about 2 million barrels per day in world supply, reversing the trend that has been put in place to reduce production in case of low prices.

[3] The exchange rate of the dollar rose by 10% compared to other currencies between January 2014 and January 2015.

through into inflation have been identified: First, high oil prices affect directly the cost of production which will lead to high inflation in what we call the cost channel. The mechanisms of this channel are different in oil-exporting countries than in oil-importing countries. In Algeria, where energy prices are subsidized, the cost of production increases not because of the rise in energy prices but because of the increase in the prices of intermediate and final imported goods due to oil prices increase. Second, high oil prices make local currency to appreciate which will automatically weaken the competitiveness of the non-oil sector. As an effort to save the non-hydrocarbon sector, the monetary authorities depreciate the local currency and as a consequence will push inflation to rise. The third channel is called the fiscal channel. In a rentier economy, like Algeria, fiscal spending is the most important tool in the hand of the authorities to boost economic growth and is considered as a tool through which oil revenues are redistributed to the other sectors. The importance of fiscal spending explains the pro-cyclicity character of the Algerian economy (Menna and Mehibel, 2017) and its role in triggering inflation.

We intend through this paper to explore the effects of oil price shocks on domestic inflation in Algeria. Higher oil prices pass-through into inflation through the three channels we discussed above. The interaction between these channels results in higher inflation. The methodology we adopt here attempts to disentangle the possible effects of these channels on inflation after experiencing an oil price shock. To reach our objective, we use a structural VAR-X framework to implement « *Unrestricted* » and « *Restricted* » impulse-response functions. The approach we are inspiring from is in the spirit of the methodology proposed by Sims and Zha (1995), Bernanke, et al (1997) and Waggoner and Zha (1998). From our identification strategy in structural VAR-X, we get the « *Unrestricted* » impulse-responses of the variables. Then, following an oil price shock on the system, we put the channel variable at a special order and at a second stage we start muffling this channel and get the impulse-response functions of domestic inflation and the other variables. This procedure is repeated

by putting another channel variable in the same position as the previous one.

This paper is organized as follows. In section one, we discuss the problematic of oil, rent and economic crisis. In section two, we focus on the origin of the Algerian economic crisis. We consider that the actual crisis has an origin, not only from the structure of the Algerian economy but has also historical roots. In the third section, we use a structural VAR-X model to highlight the three channels namely: monetary channel, public spending channel and the exchange rate channel. Finally, we conclude with our main results.

1- OIL, RENT AND ECONOMIC CRISIS

The concept of rents is widely traded in academia but it lacks theoretical foundations (Talahite, 2010). The rent-state theory is an important contribution to the Middle East studies in political science, which is based on concepts derived from the political economy. However, economic sciences have not built a unified theory of this concept. Economists in their study of this phenomenon use theoretical tools other than those related to rent, except for the theory of rent seeking, which is not directly related to natural resources.

Andersson (1987) considered that the states marked by legitimacy are usually authoritarian states, due to the external nature of oil revenues. On the basis of this idea, the authoritarian nature of these economies can be explained, given the enormous financial potential in their possession, which enables them to finance repressive institutions and cannot respond to the requirements of good governance. The effects of external resources, especially those related to oil and gas exports, can be summarized in three effects (World Bank, 2003): the impact of taxes, if the government has significant financial resources that can reduce the tax burden; The impact of expenditures, and the emergence of a class of rent beneficiaries that weaken institutions and reduce pressure to carry out reforms. The third effect is the impact of group formation so that the government can prevent the emergence of social independent groups of the State.

However, the use of the term rent in political science was limited to describing it as an external income (some considered foreign aid, and remittances from abroad as rents), and as a gift from nature, relying on economic sciences to strengthen its position towards it. However, it does not attach great importance to the political and legal conditions for its establishment.

The relationship between population size in the oil economy and the amount of crude oil production is particularly important. Therefore, there is a need to distinguish between those economies with large population sizes and those of small size. The dividing line between these countries can be determined on the basis of the number of barrels of crude oil per capita per day (Oil Barrels per capita / per day).

The first to link the concept of rent in the State under the name of the rentier State is Hossein Mahdavi, in his research entitled "Pattern and Problems of Economic Development in the Renting States - The Case of Iran" published in 1970. The State is dependent on a sustainable income from abroad. This is the case in developing oil countries, where the local economy has little to do with oil production or manufacturing.

In 1995, Sachs and Warner (1995) found a statistically significant negative relationship between the share of raw material exports in GDP or total exports and the rate of economic growth, known as the curse of resources. Since the publication of this important paper, researchers have been studying the phenomenon of the transformation of abundant natural materials, which should be a blessing not a curse to the economy. In this regard, Gylfason (2001) has some explanations. First, Dutch disease, and the marginalization of human, material and social capital. For some researchers, natural resources curse has an institutional nature. Both Sala-I-Martin, X., and Subramanian (2003) explained that if institutions are well controlled, they do not have a direct and negative impact on economic growth. For their part, Mehlum, Moene and Torvik (2006) explained that if the quality of institutions is good (encouraging productive activities), natural resources are conducive to economic growth. If the institutions are poorly performing, this will allow the spread of negative rent behaviors.

As documented in El Badawi and Gelb (2010) the received literature suggests that most Arab countries especially the oil-dependent ones have experienced volatile, short-run growth and long-term stagnation. This has been linked to the failure of most countries to undertake medium-term, counter-cyclical macroeconomic policies. It is also linked to their failure to mediate conflicting interests during post oil booms due to their glaring lack of democracy, transparency, and accountability. Among the unfavorable economic effects on these economies, we can summarize the worsening budget deficit due to lower hydrocarbon revenues, the erosion of foreign exchange reserves and the reduction of public expenditure as a direct response to lower budget revenues. These effects impact the rate of economic growth directly and inflation as well. In this paper, we try to study the effect of oil price fluctuations on the inflationary path in oil-exporting countries. This is by studying the case of Algeria, based on the hypothesis that inflation is a characteristic of rentier economies and that the decline or rise in oil prices leads to high levels of inflation.

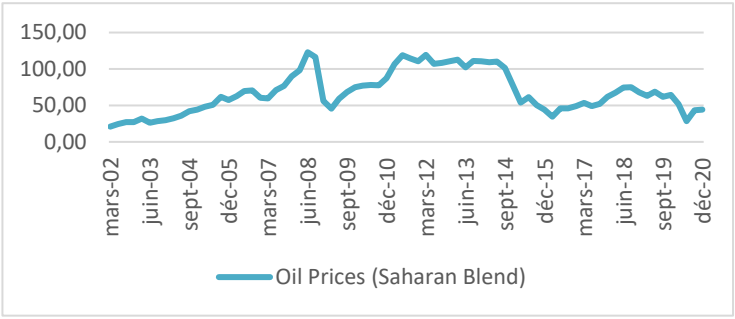
2- ALGERIA AND THE COLLAPSE OF OIL PRICES, A NEW-OLD NIGHTMARE

The oil markets witnessed many shocks, in some, prices have fallen by about 70% of its value since June 2014, and even before that, five shocks, where prices dropped by 30% or more. In 1986, the first significant drop in oil prices occurred as a result of OPEC policy change. Other declines were the result of the decrease in global demand for oil due to the economic recession experienced by the United States (1990, 1991 and 2001), the Asian crisis (1997-1998) and the financial crisis (2008-2009) and finally the pandemic in 2020 in which the world witnessed a fall in global demand which affected the oil markets.

These have caused great damage to oil-dependent economies, including Russia, Venezuela and Algeria, after prices remained for years above $100 per barrel. This decline cannot be attributed only to supply and demand factors. Some authors (Baffes et al, 2016) gave some interpretations of the current oil market situation. In addition to the factors of supply and demand, the change in the objectives of OPEC

member countries[4], the geopolitical changes in the Middle East, the rise in the dollar exchange rate against other currencies[5], and the speculation in the oil market contributed to the deterioration of prices. We can add to these factors the entry of non-conventional oil production (shale) into the market, which reduced the dominance of the OPEC countries.

Figure 1. Evolution of Oil Prices (Saharan Blend) (2002-2020)



Source: International Energy Agency (IEA)

After falling to $ 46.15 per barrel in the first half of 2016, oil prices have steadily strengthened to $ 53.38, on average, first half of 2017 and reach $ 74.42 in the first half of 2018 ($ 61.77 in the second half of 2017). This increase has been continuous since the second quarter of 2017. The second half of 2019 recorded a decrease to reach $ 64.26 and this tendency remained in 2020 from $ 51.79 in the beginning of the first half passing by$ 43.54 to reach $ 44.16 by the end of the year. The year 2021, was the start of the recovery for oil market in which a price of $ 70.71 on average was registered.

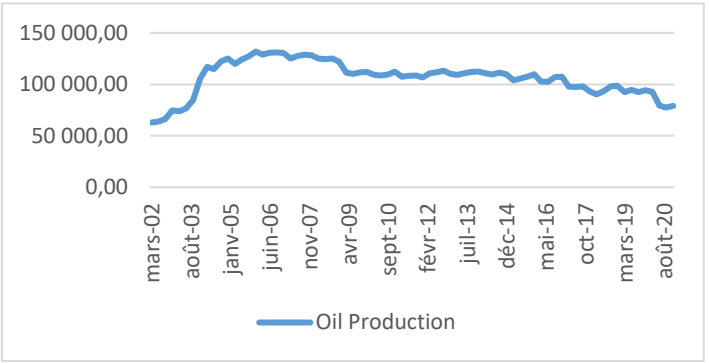
On the other hand, the drop in the quantities of oil production (Figure 2) and consequently the amount of oil exported began for the

[4] OPEC maintained the same level of production despite a surplus of about 2 million barrels per day in world supply, reversing the trend that has been put in place to reduce production in case of low prices.

[5] The exchange rate of the dollar rose by 10% compared to other currencies between January 2014 and January 2015.

first time in the first quarter of 2009 and remained relatively stable till the first half of 2017, registering then 53.27 million TEU in the second half of the same year and 51.40 million tonnes in the first half of 2018, ie a decrease of 6.48% between the first half of 2017 and 2018. This tendency continued to be recorded during 2019 and 2020. The year 2021 was marked by certain stability of around 831 kbbl/day.

Figure 2. Evolution of Oil Production (2002-2020)



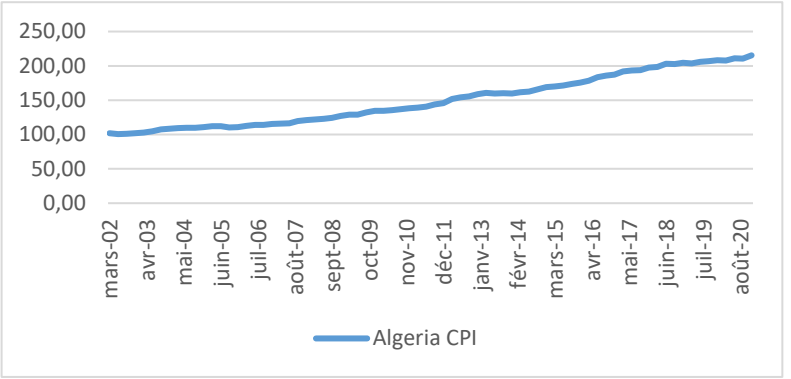
Source: JODI-Oil World Database

In connection with the decline in the overall balance of payments deficit, foreign exchange reserves contracted by $ 8.72 billion from $ 97.33 billion at the end of December 2017 to $ 88.61 billion at the end of June 2018, slightly more than the overall balance of payments deficit because of the negative valuation effect of nearly $ 790 million, linked to the appreciation of the dollar vis-à-vis the euro between January and June 2018.

It is worth noting that despite the recovery in the average price of oil nearly $ 64 per barrel during the first half of 2021, context of declining quantities exported, the deficit of the balance of payments (and correlatively the erosion of foreign reserves) still remains relatively high.

In the first decade of this century, inflation has known a stabilized situation (Figure 3). In 2005, the inflation rate dropped to 1.6% after hitting an unprecedented level Algeria never experienced since its independence estimated at 0.34% in 2000.

Figure 3. Evolution of Algeria CPI (2002-2020)



Source: National Office of Statistics (ONS)

Between 2005 and 2011, inflation rate in Algeria registered a slight increase to reach 4.5% in 2011 but in 2012 a very important hike was recorded of about 11%, which was explained by the increase in food prices (+19.6% for fresh food) and manufactured goods prices. Higher prices were spurred by the excess liquidity resulting from the surge in current public spending and large hydrocarbon income (IMF 2012). In 2013, inflation rate reached 4.5%, which was the rate targeted by the bank of Algeria. While it retreated in 2014 to average 2.9 %, average year-on-year inflation exceeded the 4 % target of the Bank of Algeria in 2015. It was partly driven by higher import price inflation, suggesting some degree of exchange rate pass-through as the dinar depreciated significantly against major currencies in 2015.

In fact, starting from mid-2014, inflation started accelerating again gradually to reach 6.9 % average year-on-year by December 2016 as a consequence of a sustained rise in manufactured goods prices, which represented 55% on average to overall inflation. In 2016, a significant fluctuation in food prices was the origin of the peak of inflation registered in July of about 8.1 % before decreasing for a while, then increased once again toward the end of the year.

An IMF study on the causes of inflation in Algeria, (IMF,2013) pointed out that a decrease of loans to the public sector by more than

20% in 2012, contributed to increase the inflationary pressures, while loans growth to the private sector decreased by 10% in 2012. The monetary authorities raised the mandatory reserve on deposits in the banking system from 9 to 11% by expanding the absorption of liquidity estimated at 250 billion AD (23%). This study was preceded by the one of Koranchelian, (2004), who found that both real and monetary factors have an impact on inflation. Inflation is associated in the long term positively with money supply and the exchange rate and negatively with income. Thus, the rising incomes of the families do not have a positive impact on the high rate of Inflation. The author suggested that the monetary authorities must continue a prudent monetary policy to cope the inflationary pressures. Ben Naceur (2012) by studying the short and the long-run determinants of inflation in Algeria for the period from 2002 to 2011 found that only non-oil GDP gap explains inflation in the short run and, in the long run, he found money supply and real GDP to be the most important determinants of inflation.

After two years of acceleration, the average annual growth rate of the consumer price index slowed in 2017 to decline to 5.6% from 6.4% in 2016. On the other hand, the growth of the index slightly increased to 5.9% from 5.8% in 2016. The fall in inflation has affected all product groups with the exception of the "various", "food" and "education-culture" groups» whose inflation rates rose to 11.1%, 5.0% and 2.9% respectively. The observed price increase is greater than inflation average for three of the eight groups, namely "miscellaneous", "clothing and footwear "and" health ".

As in 2015 and 2016, four of the eight product groups - "food", "clothing and footwear", "transport" and "miscellaneous" - with a combined weight of 75.0% in the overall index, generated the bulk of inflation in 2017, up to 86.7%.

By category of goods, the rise in food product inflation to 5.0% (3.4% in 2016) increased their contribution to headline inflation to 41.4%, a relative weight of 43.1%, compared to 25.2% in 2016. Moreover, and conversely of the year 2016 when manufactured goods and services had generated together almost three-quarters of inflation, in 2017, they contributed to inflation up to 58.6%.

Rising food prices are linked to high price inflation fresh agricultural products in the year under review increased by 2.0% in 2016 to 6.6% in 2017 despite the decline in price, inflation in industrial food products rose from 3.5% to 4.8% in 2016. Agricultural Products contribute up to 64.7% of food weight of 39.2% and for 26.8% in overall inflation for a weight of 16.9%.

With inflation of 7.2%, down from 2016 (10.0%) and for a relative weight 39.9% in the trend household consumption, manufactured goods contribute up to 47.0% to headline inflation compared to 54.8% in 2016. declines in inflation group "clothing and shoes', by 13,7% in 2016 to 8.9% in 2017, and to a lesser extent that of the group " furniture "explains, for the most part, the decline in inflation of manufactured goods.

The upward propensity of service prices, which began in 2015, continued in 2016 to reach a peak of 7.4% (annual average) in February 2017, a maximum for eleven years. This trend has turned since and service price inflation has dropped to reach in the end 3.7% compared to 7.3% in 2016. As a result, the contribution of overall inflation declined by 8.3 percentage points in one year. A year, to stand at 11.7%, driven by a 50% decline in transport and communications group whose price inflation has sharply down, from 11.7% in 2016 to 4.7% in 2017.

The upward trend in regulated product price inflation, observed in 2015 and 2016, stopped in 2017, to fall to 1.3% annual average, down 6.0 percentage points. This index which represents one quarter of the overall index (26.1%) contains fourteen (14) products, of which six (06) food products.

This moderate rise in the prices of regulated products is the result of price deflation of regulated food products (-0.2%) than disinflation of regulated non-food products (by 12.0% in 2016 to 3.1% in 2017); moderate increases in fuel prices and readjustment of the levels of consumption of electricity and gas explain the decline in the rate of growth of product prices regulated non-food.

The rise in inflation in the euro area (18 countries), from 0.2% in 2016 to 1.5% in 2017, and the deceleration of domestic inflation have resulted by reducing the differential inflation with the main 2.1 trading partners points bringing it back to 4.1 points percentage against 6.2 points in 2016.

The acceleration of inflation structural change in the years 2015 and 2016 at rates of 4.8% and 7.8% ended in February 2017 to fall to 5.3% in 2017, lower than overall inflation. This inflation, measured by the total average annual index excluding agricultural products expenses (83.1% of household consumption) contributed 73.2% to headline inflation versus 92.5% in 2016.

Another measure of core inflation by the price index to the consumption excluding farm products and products at regulated prices gives a better idea on the persistence of the structural character of inflation. This index, which represents 57.0% of the consumption basket, grew on average year-over-year by 6.8% in 2017 (versus 7.9% in 2016), still higher than overall inflation (5.6%) and generates more two-thirds of overall inflation (68.3%).

3- METHODOLOGY ANDDATA

3.1- Related literature

The impacts of oil price changes on economic activities have long been studied using different approaches.

For the case of Iran, Farzanegan and Markwardt (2008) through a VAR approach confirm the vulnerability of the Iranian economy to oil price fluctuations. By focusing on the asymmetric effects of oil price shocks where both a positive and a negative oil price shock increase inflation significantly. They unexpectedly identify a marginal impact of oil price fluctuations on real government expenditures and conclude by confirming the existence of "Dutch disease" through the appreciation of the real exchange rate.

Chen (2009) finds that a 10% increase in oil prices increases the overall price level by approximately 0.05% points after one-quarter. He concludes that the effect has declined over time, and attributes this decline to improvements in the conduct of monetary policy and higher trade openness.

De Gregorio et al. (2007) also provide evidence on a decreased in pass-through from oil prices to domestic inflation by estimating an augmented Phillips curves using data from both advanced and developing economies. They find that the decline in the pass-

through is more pronounced in advanced economies and attribute this decline to a reduction in oil intensity and the degree of exchange rate pass-through.

Valcarcel and Wohar (2013) by using US quarterly data from 1948:Q1 to 2011:Q2 find that aggregate supply ('AS') shocks have a meaningful effect on oil prices only during the 1970s and early 1980s. Also, they find oil prices respond more to aggregate demand ('AD') than 'AS' shocks and the volatility in oil prices does not seem to be contagious for the volatility in overall inflation.

Siok (2017) applies a linear and nonlinear autoregressive distributed lag (ARDL) models to examine the symmetric and asymmetric pass-through effect of oil price changes on four domestic price indices in Malaysia. He finds evidence of symmetric and asymmetric passthrough effects of oil price changes on domestic prices across sectors. Oil price changes lead to the positive effect of higher output growth but may directly cause higher import and production prices in the long-run through cost channels.

Sangyup et al. (2018) studied the relationship between oil prices and the dynamics of inflation in advanced and developing countries based on an unbalanced panel over the period from 1970 to 2015. Their results pointed out that the transport share in the CPI basket across countries is the most robust determinant of inflation response. An unexpected finding in this paper states that the conduct of monetary policy is not a major factor in explaining the cross-country differences in the magnitude of the pass-through. Besides, energy subsidies distort oil price shocks signals by reducing the pass-through from global oil price shocks to domestic inflation.

Otoakhia (2020), by applying an SVAR framework investigate the responses of consumer price index to crude oil price shocks in the pre- and post- 2008 global financial crisis in Nigeria on the basis of monthly data (2000:M01 – 2019:M12). The author finds that the consumer price index response vary in terms of intensity for pre- and post- crisis periods. However, both pre- and post- crisis oil price shock on inflation are insignificant.

Kelesbayev et al. (2022) investigated the effect of oil prices on inflation and real exchange rate in Kazakhstan. Based on data spanning from 2015:M1 to 2021:M1, they apply an SVAR model and find that while the REER mostly affects the oil prices, the consumer price index variable affects the REER.

3.2- Methodology

In order to assess the relative importance of the transmission channels of the oil price pass-through into inflation, a structural VAR-X approach is used. Our choice for this method is motivated by the fact that VAR-X method which is due to Pesaran et al (1997), explicitly accounts for the exogenous I(1) variables. This procedure allows for the inclusion of dummy variables in both the short and the long run parts of the model to account for international financial crisis of 2008, oil price chock of 2014 and Covid-19's shock. Besides, there is a gap in the literature regarding the application of this approach (VAR-X) to deal with the issue of oil price pass-through into inflation, especially that the theoretical advantages previously mentioned seem promising in order to obtain reliable results. The VAR-X approach is in fact an extension of the VAR model that allows for strictly exogenous variables. VAR-X can be considered as a specific case of VAR methodology by allowing the imposition of restrictions, and that is by setting some variables as exogenous and by also imposing certain restrictions on the relationship among endogenous variables.

Conventionally, the structural representation of a VAR model can be written as follows:

$$A_0 x_t = A(L) x_{t-1} + B\varepsilon_t \quad (1)$$

With:

A_0: Matrix of contemporaneous influence between the variables;

x_t: $(n \times 1)$vector of the endogenous variables;

$A(L)$: $(n \times n)$ matrix of lag-length L representing impulse-response functions of the shocks to the elements ofx_t;

B: $(n \times n)$ matrix capturing the linear relations between structural shocks and those in the reduced form;

ε_t: $(n \times 1)$vector of structural shocks. The structural shocks are uncorrelated and identically normally distributed.

VAR-X as previously explained, is a vector autoregressive with exogenous variables in the model. VAR-X (p,q) model can be written as follows:

$$y_t = v + \sum_{i=1}^{p} \mathrm{B}_i\, y_{t-i} + \sum_{i=1}^{q} \Theta_i^{*}\, x_{t-i} + \varepsilon_t \qquad (2)$$

$$y_t = \mathrm{B}(L) y_t + \Theta(L) x_t + \varepsilon_t \qquad (3)$$

We define $\Psi(L) = \Psi_0 + \Psi_1 L + \cdots = [I - B(L)]^{-1}$ with $\Psi_0 = I$

The VMA-X representation of the model is the following:

$$y_t = \Psi(1)v + \Psi(L)\Theta(L)x_t + \Psi(L)\varepsilon_t \qquad (4)$$

From the above, we can extract the structural VAR-X model. Instead of the residuals ε_t, that can be correlated between them, the structural model contains structural disturbances that have economic interpretation e_t, which is useful in conducting policy analysis.

The Vector Moving Average (VMA-X) form of the model is the following:

$$y_t = \mu + \Lambda(L)x_t + \mathrm{C}(L)e_t \qquad (5)$$

The endogenous variables are expressed as a function of a constant n-vector (μ), past and current values of the structural shocks e_t and the exogenous variables.

We assume that $e_t$is a vector of white noise Gaussian disturbances with an identity covariance matrix ($e_t \sim N(0, I)$). $\mathrm{C}(L)$is of a seize (n x n) and $\Lambda(L)$ of a size n x m.

The identification of structural shocks in presence of exogenous variables is no different from what is usually done in the SVAR literature. From equation 4 and 5 above, we have

$$\mu + \Lambda(L)x_t + \mathrm{C}(L)e_t = \Psi(1)v + \Psi(L)\Theta(L)x_t + \Psi(L)\varepsilon_t$$

We can infer the following equalities:

$$\mu = \Psi(1)v \qquad (6)$$

$$\Lambda(L) = \Psi(L)\Theta(L) \qquad (7)$$

$$\mathrm{C}(L)e_t = \Psi(L)\varepsilon_t \qquad (8)$$

We can estimate v, $\mathrm{B}(L)$ and $\Theta(L)$ from the reduced form of VAR-X representation. μ and $\Lambda(L)$ are known values (Lütkepohl, 2005). $\mathrm{C}(L)$

parameters are left to be identified which in turn depends on the imposed restrictions. It is obvious when having a look on equation 6, 7 and 8 that the inclusion of exogenous variables will have no effect when identifying the structural shocks and equation 8 remind us of a structural VAR model. To identify the structural shocks (Oil price shocks), an identification scheme is given using Cholesky decomposition of variance-covariance matrix of SVAR-X residuals. For more details about estimation and inference, see Pesaran et al. (1997).

3.3- Data description

The data we use here are quarterly ranging from 2002:Q1 to 2021:Q4. In order to study oil price shocks pass-through into inflation we use the following variables : Oil prices of Saharan Blend (SB), Trading partners' CPI (CPIF), Real public expenditure (DPR), Real GDP, Real Effective Exchange Rate (REER), Money supply (M2) and Algeria CPI (CPIAL). Time series for Saharan Blend Oil Prices were taken from International Energy Agency (IEA), data on Oil Production were taken from JODI-Oil World Database. Given the importance of imported inflation, a measure of foreign price level or CPI of the trading partners of Algeria was constructed by using the CPI of each of the trading partners which were taken from World Economic Outlook (WEO) database. We measured foreign price level as follows :

$$P_t^* = \sum_{k=1}^{s} w_{kt}\, P_{kt}^* \text{ where } w_{kt} = \frac{GDP_{kt}}{\sum_{k=1}^{s} GDP_{kt}}$$

where time variant weight $w_{kt}$is given by trading partners' GDP share and $\sum_{k=1}^{s} w_{kt} = 1$.

Data on real public expenditure were obtained by dividing nominal public expenditure by the GDP deflator and all these were taken from International Financial Statistics (IFS). The Real Effective Exchange Rate (REER) was drawn from bruegel database and finally Algeria CPI was taken from both ONS and IFS.

Based on a special ranking of the variables, an identification strategy in structural VAR-X is set, we get the « *Unrestricted* » impulse-responses of the variables to oil price shocks and this represents the entire effect. To get the « *Restricted* » impulse-responses of the variables, we take into

account the oil shock, to be placed as the most exogenous (1st rank) followed by the second most exogenous variable, namely, trading partners' inflation[6], we muffle then the transmission channel (the exchange rate channel, the public expenditure channel and the money supply channel) that should be put in the 3rd position, at two levels[7]. We repeat this procedure by putting each time another channel variable in the place of the previous, as follows:

- Oil prices, international inflation, exchange rate...
- Oil prices, international inflation, public spending...
- Oil prices, international inflation, money supply...

In order to measure the importance of each of the channel variables, the difference of the responses of domestic inflation and the other variables under « *Unrestricted* » and« *Restricted* »impulse-responses to oil price shocks are obtained, this difference would give us the answer regarding the relative strength and the significance of the channel variable in the process of oil price pass-through into inflation.

All the variables in this paper were used on a logarithm basis. The first step is the stationarity of the data or the existence of unit roots.

The results of the Augmented Dickey-Fuller test(Table 1) indicate that there is a unit root in the level of variables but when it comes to the series in first difference the null hypothesis can be rejected. Meaning that the series are non-stationary and the structural VAR-X model was estimated in levels of first differences.

[6] The order of trading partners' inflation will be discussed in the coming subsection.

[7] By muffling at two levels, we differ our methodology from the one applied by Karimli et al. (2016) who set the transmission channels close to zero one by one. In our paper, we measure the relative importance by focusing on the sensitivity of the channel (muffling at two levels) and the amount of the pass-through.

Table 1. Stationarity test

Variables	SB (Oil Price)		RGDP		CPIF		REER	
	statistic	prob	statistic	prob	statistic	prob	statistic	Prob
Level	-2,4256	0,1383	-1,5988	0,478	-2,9444	0,1551	-4,3099	0,0009
1st difference	-6,8675	0	-5,4578	0	-6,7533	0	-6,9888	0
Variables	**DPR**		**M2**		**CPIAL**			
	statistic	prob	statistic	prob	statistic	Prob		
Level	-1,5988	0,478	-2,4361	0,3585	-2,2612	0,4493		
1st difference	-5,4578	0	-7,8871	0	-8,8547	0		

Source: by the authors

4- EMPIRICAL RESULTS

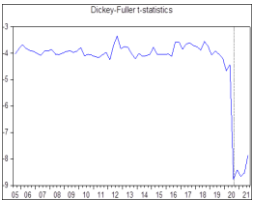
4.1- Preliminary analysis

We start our analysis by performing a breakpoint test (Figure 4). The objective is to detect the existence of breakpoints in the series of our study. By observing Figure 4,we notice that both Algeria CPI and its real GDP marked breakpoints in 2020. Besides, money supply (M2), real effective exchange rate (REER) and real public expenditure (RPEXP), the breakpoints were recorded in 2008, 2015 and2018 respectively.

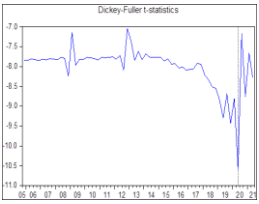
The dates we mentioned above are in fact related to relevant economic facts. The year 2020 represents the advent of Covid-19, 2008 corresponds to the subprime crisis, which is consistent with the impacted variable (the exchange rate).

Figure 4. Breakpoints test results

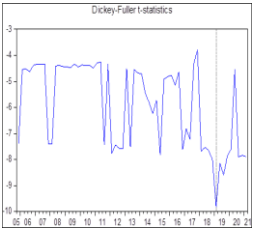
CPIAL



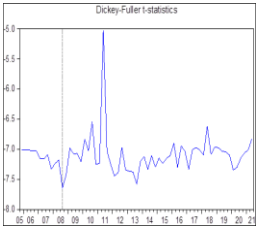
RGDP



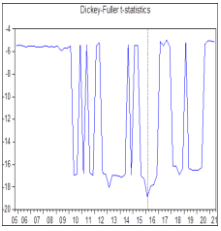
M2



REER



DPR



Source: by the authors

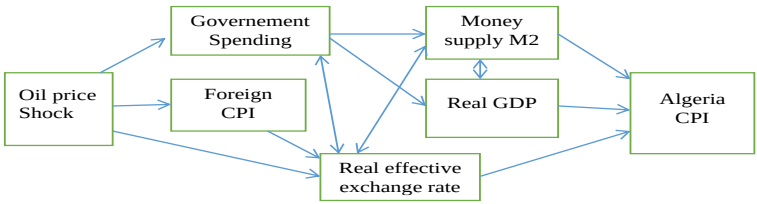
2015 and 2018 were the years where the consequences of the negative shock in oil prices of 2014 and the contraction of public treasury receipts. The delay might be interpreted by the existence of the revenues regulatory fund (FRR in French), which served as a bumper absorbing then the shocks in oil prices.

The scheme below (Figure 5) was constructed on the basis of the analysis done following the calculation of the coefficient of determination and the results of granger causality (Appendix 1). Our scheme is consistent with the Dutch disease theory, which states that public expenditure is an important channel in transmitting shocks. For that, we place it in the first position after oil price and foreign CPI. By putting foreign CPI in the second position, we assume that this variable is influenced only by oil prices and is considered as the most exogenous one compared to the remaining variables. Besides, the fact that Algeria depends largely on the importation of intermediate and final products, especially food products with a ratio of 66.22%[8] in 2020, and given the

[8]Statistics of Customs Department (2020)

volatility of these products on the international markets constitute an argument for us to put it in that position.

Figure 5. Oil price shocks transmission mechanism scheme



Source: by the authors

4.2- Analysis of transmission channels to Algeria CPI

We estimate in this subsection a VAR-X and structural VAR-X model, at the same time. For the latter, we study the estimation without restrictions and with restrictions in the short and the long-run.

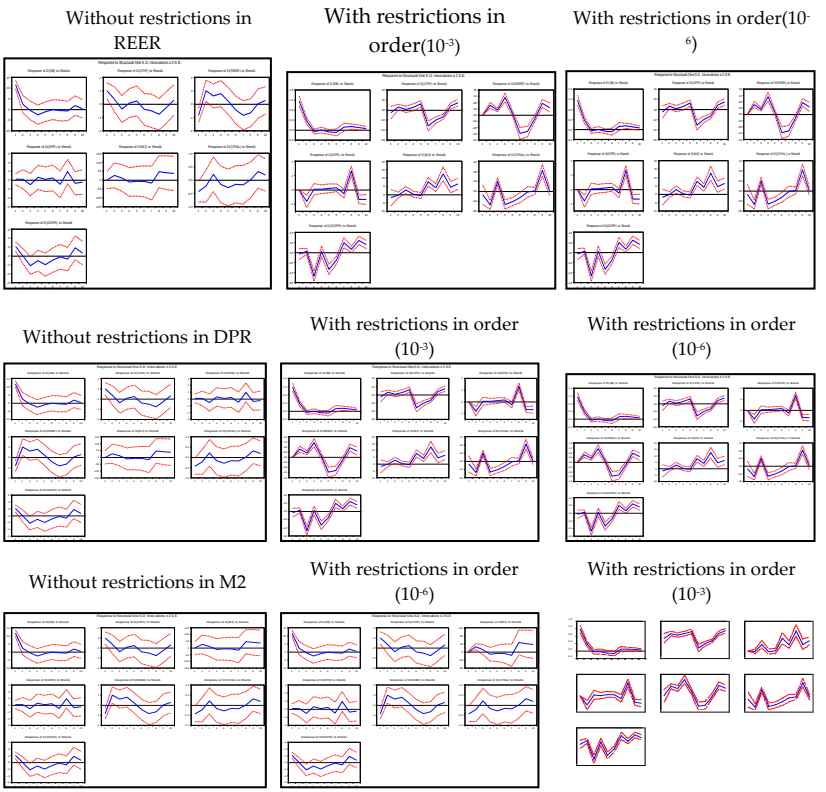
To introduce the restrictions, we use the transmission matrices, A and B, as illustrated in appendix 2. We give the values $\mathbf{10^{-3}}$ and $\mathbf{10^{-6}}$ for the parameters c(16) and c(24). These parameters represent the coefficients of the shocks (innovations) relative to the desired variable for which we consider as the transmission channel. For these variables, we change the order each time by placing the desired variable at the most exogenous level, after the oil prices and trading partners' inflation. The assessment of the importance of the transmission channels is done through a comparison between the results of the estimation (*Restricted* vs *Unrestricted*). For that purpose, we base our interpretation on the outcome of the impulse response functions.

(1) Structural VARX

(a) In the short-run

Foreign consumer price index: Part of the oil price shock passes through international prices but with a delay to the national economy. The response of international prices to an oil price shock is instantaneous.

Figure 6. Impulse response functions in the short-run



Source: established by the authors

In the short-run our results indicate that:

- Algeria CPI responds positively to: CPIF, M2 and REER.
- Public spending is the channel that has the most impact on the rest of the macroeconomic variables. We observe that there is a significant response from different variables, in particular domestic inflation and economic growth as outcome variables. The response of these variables can be seen when the third-order restriction is introduced. This is visible by the contraction of the confidence interval of the different variables.
- The exchange rate can be considered as the most powerful channel in the short run after public spending. The different variables respond with less sensitivity to the third-order restriction than their responses to public

spending. We note that the effect of this channel appears in the sixth order, notably for domestic inflation and economic growth.

- Lastly, we place the money supply channel. This channel responds with delays to exogenous shocks compared to the above-mentioned channels. We shouldnote that the various macroeconomic variables respond only to the sixth-order restriction.
- It is possible to schematize the short-run transmission of a negative oil price shock to inflation as follows:

A shock on oil prices >>>>>>>Public spending >>>>>>> Algeria CPI

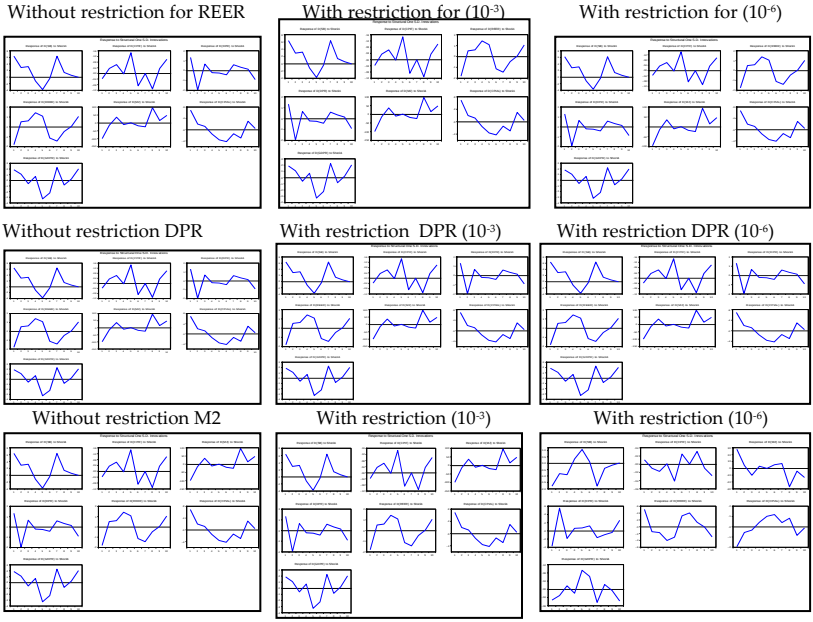
A shock on oil prices >>>>>>>> REER >>>>> Algeria CPI

A shock on oil prices >>>>>>>M2>>>>>REER>>>>>> Algeria CPI

(b) In the long-run

In the long run, trading partners' inflation responds instantaneously with less degree to an oil price shock compared to the short run case. We also observe that this shock generates waves in the relative IRF.

Figure 7. Impulse response functions - Structural VARX– Long-run



Source: established by the authors

In the long-run our results indicate that:

Algeria CPI responds to several variables. We record a weak impact of an oil price shock compared to the others. This, is explained by the fact that the shock is not transmitted directly to the CPI. For the other variables, except the exchange rate having a weak effect, we notice different levels of response.

Public expenditure responds in the long-run to different variables, much more to foreign CPI, RGDP and Algeria CPI. However, the response is weak to an oil price and negatively relative to the exchange rate, which is consistent.

- Real GDP responds instantly and according to the following order: money supply (M2), foreign CPI, REER and real public expenditure (DPR).

The transmission of shocks to money supply (M2) is achieved based on the following ranking: real GDP, foreign CPI, oil price SB (Saharan Blend), Algeria CPI, REER and then real public expenditure (DPR).

For REER, a negative relationship between the exchange rate and various variables is consistent with the economic reality of the country. Except for a positive relationship with inflation, which is also compatible with the expected relationship between these two variables.

Following this advanced reading of the different transmissions between the macroeconomic variables and looking at the IRF curves, it will be possible to classify the long-term transmission channels as follows :

First, we observe that the money supply channel is the most powerful, as we notice a change in the structure of the different IRFs. This change is due to the restrictions introduced.

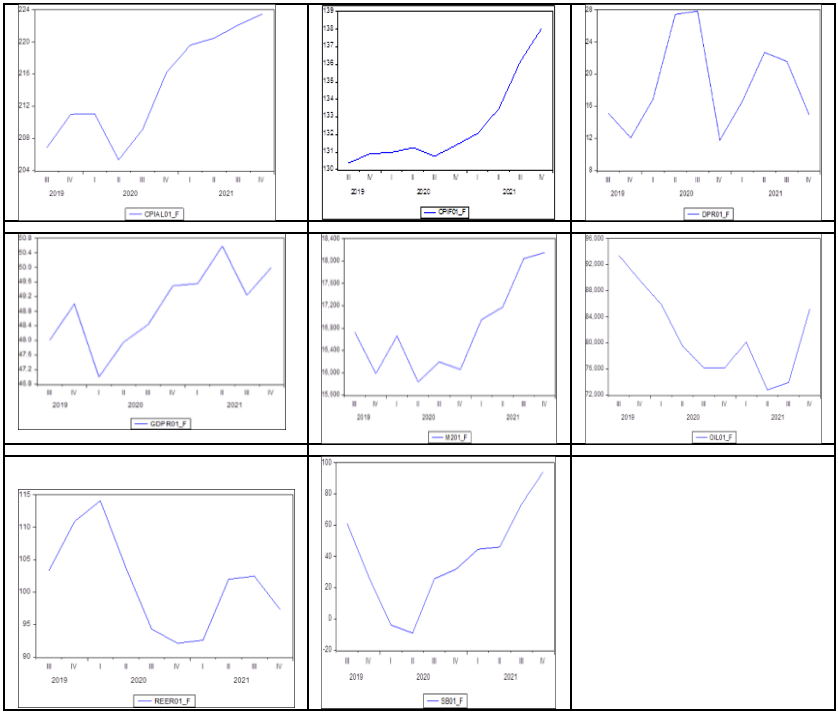
Secondly, we place the exchange rate channel, because this channel influences only government expending. Others variables stay without responses to exchange restrictions.

Lastly, we place the government spending, because this channel in our results is without impact to all others variables. This finding is appealing but consistent with the Algerian economic reality and needs to be explored in the future.

4.3- The Covid-19 effect

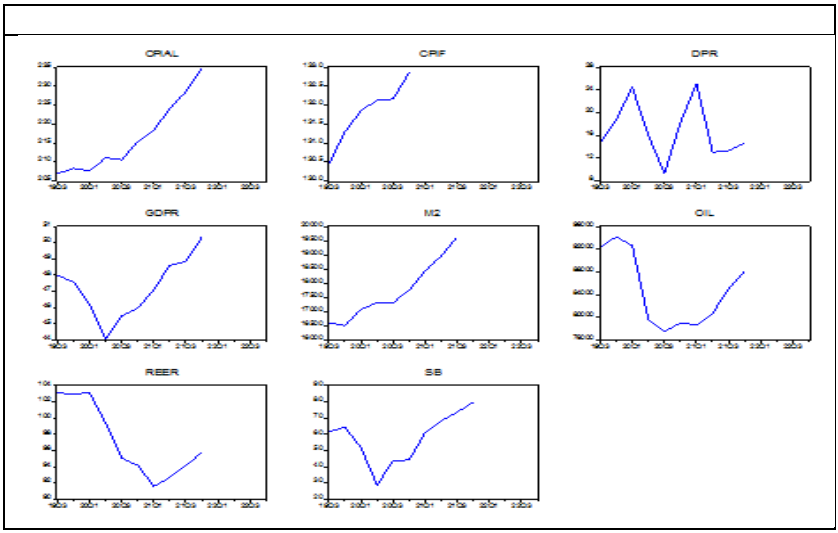
We compare in this subsection two series, the first is simulated on the basis on the non-existence of Covid-19 (Figure 9) and the second is simply the original series with Covid-19 (Figure 10). We notice that Algeria CPI in the series with Covid-19 registers more acceleration to increase than in the simulated series (without Covid-19).

Figure 9. Forecasting without Covid-19



Source: established by the authors

Figure 10. Original series with Covid-19



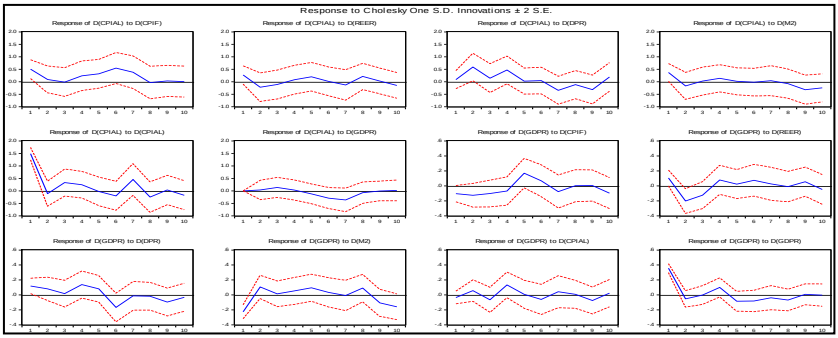
Source: established by the authors

The last indicates that inflation in Algeria would have registered a drop during 2020, which is not the case in the series with Covid-19. Our results also show the differences between the other series of our paper in the case of Covid-19 and non-Covid-19, namely, money supply (M2), foreign CPI, real public spending (DPR), the amount of oil production, and real effective exchange rate (REER).

4.4- Dummy variables analysis

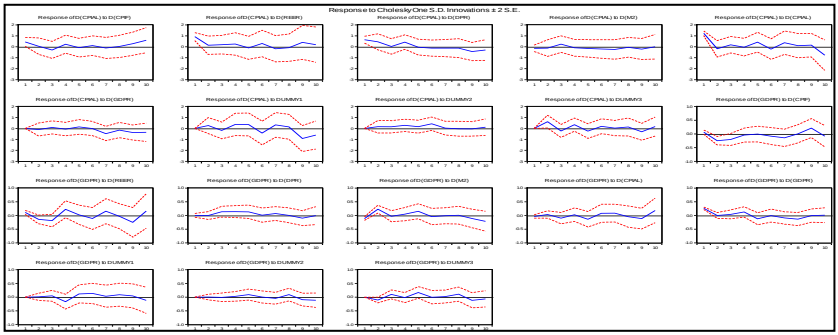
In this subsection, we introduce dummy variables to measure the effect of the different shocks mentioned above. For each shock, we introduce a dummy variable. Then, we simulate impulse responses with and without these dummy variables using our VAR-X model.

Figure 11. IRFs in VAR-X with and without dummy variables without dummy Variables With dummy variables[9]



Source: established by the authors

Figure 11. IRFs in VAR-X with and without dummy variables Variables With dummy variables[10]



Source: established by the authors

The results indicate modifications in the impulse response functions. These modifications are after the introduction of the dummy variables. It is possible to notice, after the IRFs, that the relationships between the different variables changed.

[9] Dummy 1 represents the subprime crisis, Dummy 2 represents the negative oil price shock and Dummy 3 represents the Covid-19 health crisis.

[10] Dummy 1 represents the subprime crisis, Dummy 2 represents the negative oil price shock and Dummy 3 represents the Covid-19 health crisis.

Our endogenous variables CPIAL RGDP, have almost achieved the same responses. They responded more for the 2020 shock (Covid-19) and the 2008 shock (subprime crisis) than for the 2014 shock (negative shock on oil prices).

Our results indicate that the exchange rate and money supply channels are the most sensitive. This is because they respond with a lag of one period to an oil price shock. At the same time, the exchange rate channel is more powerful.

On the other hand, the most powerful and the least sensitive channel, is the public expenditure channel. This channel responds to the so-called shock with a lag of 5 periods. This response is with a higher coefficient than the other channels.

CONCLUSION

An analytical and empirical analysis was carried out to investigate how oil price changes impact the Algerian economy, which is an oil and gas exporter. This paper aims at focusing on the channels through whichoil prices pass into inflation. Assessing the relative importance of the transmission channels using a structural VAR-X allowed us to rank the transmission channels, which are: The exchange rate channel, the public spending channel and the money supply channel.

The relative importance of each channel is a consequence of the structure of the Algerian economy. The findings of this paper pointed out that, in the short-run, the public spending channel is the first channel through which oil prices passes into inflation and has the most impact on the other macroeconomic variables. The second is the exchange rate channel, yet, less sensitive to restrictions compared to the public spending channel and the last one is the money supply channel, whose response to exogenous shocks is with a delay. In the long-run, the money supply channel is considered as the most important one, followed by the exchange rate channel that influences only the last channel, namely, the public spending channel. The last has no impact on the other variables which is appealing and needs further explorations.

In the last part of our paper, we explored the effect of introducing Covid-19 and then the effect of different important events, such as, the 2008 subprime crisis, the 2014 negative oil price shock and again the Covid-19 health crisis. For the case of only Covid-19, we noticed some differences in the results. In this regard, the money supply channel remained the first one as in the case of the long-run results, in the second position, the public spending channel and the last channel was the exchange rate channel. When we introduced the other pertinent events in the history of the Algerian economy between 2002 and 2021, we noticed the sensitivity of the exchange rate and money supply channels. However, the exchange rate channel was more important. Despite the fact that the public spending channel was the least sensitive, its importance was clear compared to the previous ones.

All the channels we studied in this paper contribute to pass oil price shocks to domestic inflation. As mentioned in the work of Gelos and Ustyugova (2017),countries like Algeria, can, however, influence the degree to which domestic inflation reacts to international commodity price movements: better overall governance, greater Central Bank autonomy, and, to a lesser extent, the adoption of inflation targeting frameworks seem to help anchor inflation expectations and reduce second-round effects. The inflation targeting framework cannot be a success without necessary fiscal discipline. The monetary authorities will be assisted in achieving lower inflation and stable economic growth targets by adopting counter-cyclical fiscal measures and legally binding fiscal restrictions. Moreover, as the economy is further diversified and import substitution tactics are improved, the cost channel's influence on the transmission of oil price shocks is expected to be diminished. Thus, Algeria may strengthen its economy over time by implementing reform programs that are effective.

Considering the priority of inflation transmission channels will undoubtedly be useful when deciding on monetary policy instruments. However, this study must be followed by another study dealing with monetary policy transmission channels.

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Appendix 1

Table 1. Granger causality

Matrix A							Estimated A matrix:						
1	0	0	0	0	0	0	1	0	0	0	0	0	0
C(1)	1	0	0	0	0	0	-0.0172	1	0	0	0	0	0
C(2)	C(7)	1	0	0	0	0	0.0809	-0.4951	1	0	0	0	0
C(3)	C(8)	C(12)	1	0	0	0	0.0423	-2.3347	0.1371	1	0	0	0
C(4)	C(9)	C(13)	C(16)	1	0	0	-0.0776	16.4022	-0.1039	-26.9279	1	0	0
C(5)	C(10)	C(14)	C(17)	C(19)	1	0	0.0362	-0.9759	-0.2475	-0.0030	-0.0017	1	0
C(6)	C(11)	C(15)	C(18)	C(20)	C(21)	1	-0.0280	0.2624	-0.0760	-0.0442	0.0010	0.0039	1
Matrix B							Estimated B matrix:						
C(22)	0	0	0	0	0	0	11.6503	0	0	0	0	0	0
0	C(23)	0	0	0	0	0	0	0.4889	0	0	0	0	0
0	0	C(24)	0	0	0	0	0	0	2.1133	0	0	0	0
0	0	0	C(25)	0	0	0	0	0	0	2.3423	0	0	0
0	0	0	0	C(26)	0	0	0	0	0	0	192.7129	0	0
0	0	0	0	0	C(27)	0	0	0	0	0	0	1.3780	0
0	0	0	0	0	0	C(28)	0	0	0	0	0	0	0.2972

Source: authors' estimates

Table 1. Coeffcient of determination

	D(CPIAL)	D(CPIF)	D(DPR)	D(GDPR)	D(M2)	D(REER)	D(SB)
R-squared	59%	73%	87%	89%	82%	76%	68%
Adj. R-squared	-37%	10%	57%	62%	38%	19%	-6%

Source: authors' estimates

Tale 3. Roots of Characteristic Polynomial

Endogenous variables: D(LSB) D(LDPR) D(LGDP) D(LGDPR) D(LM2) D(LREER) D(LCPIAL) D(LCPIF)
Exogenous variables: C
Lag specification: 1 2
Date: 09/16/23 Time: 00:11

Root	Modulus
-0.745307	0.745306968043
0.701425	0.701424917455
0.322908 + 0.579993i	0.663823243527
0.322908 - 0.579993i	0.663823243527
-0.658352	0.658351865429
0.027879 - 0.640419i	0.641025929339
0.027879 + 0.640419i	0.641025929339
-0.125453 + 0.594173i	0.607273011835
-0.125453 - 0.594173i	0.607273011835
0.456612 + 0.270663i	0.530804389264
0.456612 - 0.270663i	0.530804389264
-0.426807 - 0.241487i	0.490388165261
-0.426807 + 0.241487i	0.490388165261
0.275093	0.275093450368
-0.031839 - 0.130628i	0.134452184709
-0.031839 + 0.130628i	0.134452184709

No root lies outside the unit circle.
VAR satisfies the stability condition.
Source: authors' estimates

Appendix 2

"Restrictions"

Matrix A							Estimate d A matrix:						
1	0	0	0	0	0	0	1	0	0	0	0	0	0
C(1)	1	0	0	0	0	0	-0.0172	1	0	0	0	0	0
C(2)	C(7)	1	0	0	0	0	0.0809	-0.4951	1	0	0	0	0
C(3)	C(8)	C(12)	1	0	0	0	0.0423	-2.3347	0.1371	1	0	0	0
C(4)	C(9)	C(13)	C(16)	1	0	0	-0.0776	16.4022	-0.1039	-26.9279	1	0	0
C(5)	C(10)	C(14)	C(17)	C(19)	1	0	0.0362	-0.9759	-0.2475	-0.0030	-0.0017	1	0
C(6)	C(11)	C(15)	C(18)	C(20)	C(21)	1	-0.0280	0.2624	-0.0760	-0.0442	0.0010	0.0039	1
Matrix B							Estimated B matrix:						
C(22)	0	0	0	0	0	0	11.6503	0	0	0	0	0	0
0	C(23)	0	0	0	0	0	0	0.4889	0	0	0	0	0
0	0	C(24)	0	0	0	0	0	0	2.1133	0	0	0	0
0	0	0	C(25)	0	0	0	0	0	0	2.3423	0	0	0
0	0	0	0	C(26)	0	0	0	0	0	0	192.7129	0	0
0	0	0	0	0	C(27)	0	0	0	0	0	0	1.3780	0
0	0	0	0	0	0	C(28)	0	0	0	0	0	0	0.2972

Source: authors' estimates

Appendix 3

« Channel assessment »

Difference between impulse responses of structural VAR-X (restricted) / structural VAR-X (unrestricted)

Table 3. Public expenditure channel

Period	Shock1	Shock2	Shock3	Shock4	Shock5	Shock6	Shock7
1	638238%	407%	60376%	8274%	45092090%	190811%	25934%
2	-688520%	4202%	166084%	-272%	-591205%	14987%	1025%
3	-2907601%	-17343%	12586%	-5171%	885541%	-56271%	-6161%
4	595419%	3265011%	-34261%	-1723%	680508%	104845%	14237%
5	4178878%	4586%	-110904%	-7747%	-732126%	-92734%	-13401%
6	-262057%	-4977%	-109433%	11798%	-165601%	-103793%	19426%
7	-4519181%	-8810%	17815%	-23958%	-1111197%	240992%	-6062%
8	-45789270%	7388%	-473%	-99%	-2343399%	-56540%	-105671%
9	-650656%	-234%	-34587%	1548%	147907%	3461%	11143%
10	47290%	11035%	-419978%	-159897%	-16822587%	720192%	9094%

Source: authors' estimates

Exchange rate channel

Period	Shock1	Shock2	Shock3	Shock4	Shock5	Shock6	Shock7
1	-59243%	101%	139575%	1691684%	-1033%	4314%	16986%
2	375466%	1124%	11199%	########	-32%	-13342%	526%
3	122492%	973%	-81368%	180724%	288%	3456%	-597%
4	-34143%	972%	-145393%	-65399%	-42%	4929%	1492%
5	-90143%	729%	43403%	-731235%	-6826%	2253%	-2300%
6	22042%	-919%	41044%	47710%	-4006%	8194%	5747%
7	-87225%	957%	-274525%	115962%	-1828%	5823%	-507%
8	-51865%	248%	-220176%	########	33%	-387%	-8617%
9	-229888%	-27%	4266%	117527%	832%	-1884%	3712%
10	3711%	-9035%	-30291%	-887991%	-3269%	-10996%	-20218%

Source: authors' estimates

Global demand channel

Period	Shock1	Shock2	Shock3	Shock4	Shock5	Shock6	Shock7
1	6530%	-4%	164%	1426%	15444%	-588%	-739%
2	126602%	-500%	-12%	-176%	2461%	-89%	51%
3	17534%	-204%	189%	68%	-2007620%	-188%	70%
4	35492%	21%	26%	-83%	-1921%	1075%	38%
5	3663%	-26%	-423%	1034%	14360%	665%	359%
6	1409%	-40%	193%	-105%	-922%	3120%	213%
7	6817%	-17%	886%	-110%	-7378%	1801%	14%
8	291040%	10%	70%	-1%	18878%	-554%	-352%
9	2257%	1%	-146%	56%	-1340%	-49%	-89%
10	172%	-316%	-763%	-331%	-52459%	-1656%	-1405%

Source: authors' estimates

Money supply channel

Period	**Shock2**	**Shock3**	**Shock4**	**Shock5**	**Shock6**	**Shock7**
1	0%	-44%	0%	-23%	-12%	-2%
2	1%	-4%	0%	-136%	1%	0%
3	1%	1%	0%	15%	-1%	0%
4	0%	12%	0%	26%	3%	0%
5	1%	-8%	0%	-22%	-2%	-10%
6	0%	-88%	0%	10%	-2%	-1%
7	0%	1%	0%	88%	-14%	0%
8	0%	0%	0%	-35%	-2%	-1%
9	0%	0%	0%	-3%	0%	1%
10	0%	6%	0%	-82%	-3%	-1%

Source: authors' estimates