Scientific Annals of Economics and Business
67 (1), 2020, 15-32
DOI: 10.2478/saeb-2020-0008

The Transmission of Global Commodity Prices to Consumer Prices in a Commodity Import-Dependent Country: Evidence from Morocco

Mounir El-Karimi*, Ahmed El-Ghini**

Abstract

This paper uses the Breitung and Candelon (2006) causality test to examine the effect of global oil and food price changes on the inflation in Morocco over the period from 1998Q1 to 2018Q1. The results show significant transmission from oil and food prices to domestic inflation. Specifically, the food prices are shown more important than oil prices in explaining inflation in the short-run, which reflects the high weight of food in the consumption basket. However, the effect of oil prices on inflation is much more persistent than the effect of food prices. Furthermore, the impact of commodity price shocks on inflation exhibits asymmetries. The oil price hikes affect more weakly the inflation than oil price decreases, whereas the food price increases are more transmitted to inflation than food price decreases. Our findings may provide useful information to researchers and policymakers in formulating more appropriate monetary policy.

Keywords: oil and food prices; inflation; Granger causality; frequency domain; Morocco.

JEL classification: C32; E31; Q02.

1. INTRODUCTION

The world economy experienced large shocks in food and oil prices during the recent years, such as the sharp spikes occurred over the 2007-2008 global crisis and the 2010-2011 period. Occurrence of these events had a great cause of concern for the policymakers in most of the countries given that the world commodity prices shocks could affect the consumer prices dynamics in an economy. Discounting oil and food price changes relative to core inflation fluctuation can lead to an underestimation of the inflation level, particularly in emerging countries that are highly dependent on commodity imports (e.g. Walsh, 2011).

* Faculty of Law, Economics and Social Sciences, Souissi, Mohammed V University in Rabat, Morocco; e-mail: *mounir.elkarimi@um5s.net.ma* (corresponding author).

** Faculty of Law, Economics and Social Sciences, Souissi, Mohammed V University in Rabat, Morocco; e-mail: *aelghini@gmail.com*.

The transmission of world commodity price shocks to consumer prices could be affected by certain factors. For instance, the weakening of domestic currency against the US dollar can generate inflationary pressure since oil trade is denominated by the US dollar. Moreover, subsidizing commodity prices, which is applied in many emergent and developing economies to protect the household's purchasing power, could contribute to reduce the inflation's response to external price shocks (e.g. Jongwanich and Park, 2011; Ianchovichina *et al.*, 2014). In Morocco case, the government was subsidizing fuel prices before January 2015, and subsidizes until the present the prices of soft wheat and sugar (see Verme and El Massnaoui, 2015). The aim of this paper is not to evaluate the relative role of price subsidies in mitigating external shocks, but rather to assess the impact of oil and food prices changes on inflation.

Morocco's central bank adopted a relatively more flexible exchange rate from January 2018 and is preparing to transition gradually from a pegged exchange rate to a floating exchange rate. The country aims also to move towards inflation targeting so that the nominal anchor would be the consumer price index instead of exchange rate pegging. In this context, the issue of what forces drive inflation dynamics constitutes a crucial concern of policymakers. It is worth mentioning that, on one hand, the country is a net oil importer, and the fossil fuels accounted in 2017 for larger than 80% of local electricity generation mix (EIA - Energy Information Administration, 2017). On the other hand, the country is highly dependent on food imports, as it reveals much larger ratios of cereals import dependency[1] in Africa (see Figure no. A1 in Annex 1). Particularly, the country was in 2016 top 10 largest importers in the world of wheat, barley, soybean oil, tea, and products of natural milk constituents. It was also top 20 largest importers of maize, maize oil, raw centrifugal sugar, butter, and coffee husks and skins (see Table no. 1a in Annex 2). Therefore, it would be very important to conduct an empirical analysis that deals with the analysis of the relative contributions of world oil and food prices to inflation dynamics.

Some previous studies analyzed the transmission effect of commodity prices to consumer prices through the analysis of the Granger causality and/or cointegration in the time-domain framework (e.g. Belke and Dreger, 2015; Misati *et al.*, 2013). Nevertheless, they provide no clear explanation of 'short-run' and 'long-run' causal links between the variables. In contrast, the causality analysis in the frequency domain by using the Breitung and Candelon (2006) test allows examining the causal effects over several time cycles.

The contribution of this paper is important for three reasons. Firstly, to our best knowledge, this paper is the first to employ the Breitung and Candelon (2006) causality test with the incremental R^2 statistic for analyzing the global commodity prices pass-through to consumer prices. This test procedure allows us to evaluate the causal effects over diverse time cycles, and then provide pertinent information about consumer prices vulnerability to external shocks. Secondly, our paper is the first to provide a study on inflation dynamics in Morocco that explicitly accounts for the impacts of both external and domestic shocks. Thirdly, this paper provides useful information that can help to suitably targeting inflation and determining appropriate strategies and timings of policy actions for macroeconomic stability.

The remainder of the paper is organized as follows. Section 2 gives a brief overview of the existing literature. Section 3 provides theoretical insights of possible transmission channels of oil and food price shocks to inflation. Section 4 presents the data along with the methodology used in the study. The discussion of the results is done in Section 5. Finally, Section 6 concludes the paper with some relevant policy implications.

2. EMPIRICAL REVIEW

The existing empirical literature on the oil price-inflation nexus is mixed. Despite oil price changes are theoretically an important driver of inflation variability, a number of studies provide evidence of a decreased pass-through from oil prices to domestic inflation. LeBlanc and Chinn (2004) argue, by using augmented Phillips curves, that oil price shocks have only a moderate impact on inflation in G5 countries. De Gregorio *et al.* (2007) find that the decline of the oil pass-through is more pronounced in advanced economies than developing economies. They attribute this decline to a reduction in the use of oil per unit of GDP and the low exchange rate pass-through. Gronwald (2009) conclude, by employing the Breitung and Candelon (2006) causality test, that the oil price changes exert significant impact on the consumer price index in Germany at frequencies corresponding to cycle lengths higher than 6 months. Also by using the same frequency causality test, Albulescu *et al.* (2017) display that the oil price changes significantly affect the overall inflation in Romania over the medium run. Sun *et al.* (2019) find that there is a significant effect of oil price shocks on producer price index of petroleum-related industrial sectors in China. Wei (2019) concludes that oil prices can predict China's producer price index in the short-run, but fail to predict China's consumer price index at any period.

In a set of studies, oil price fluctuations are found significantly affect domestic inflation changes. For example, Barsky and Kilian (2004) show that oil price increases generated high inflation in the U.S from 1970s to the beginning of 2000. In the context of six Asian countries, Cunado and Perez de Gracia (2005) conclude that oil price changes have significant short-run effects on both economic activity and consumer prices, over the period 1975-2002.

In European Union framework, Égert (2011) emphases that commodity prices have a stronger effect on inflation in a higher inflation environment. Chen (2009) shows, by using data from 1960 to 2004 for 19 industrialized countries, that oil price pass-through into inflation is larger in the countries with more energy imports. However, he concludes that the pass-through has declined over time.

The transmission of global food prices to domestic inflation has not attracted much attention until the price spike of 2007-2008. Liu and Tsang (2008) evaluate the effects of global commodity price shocks on consumer prices in China by intermediation of domestic producer prices effect. They find that a 10% increase in global commodity prices would increase China's producer prices by 1.2% in 3 months later, which in turn would increase domestic inflation by 0.24% during the same period. Al-Shawarby and Selim (2013) examine whether the spikes in domestic inflation and food prices in Egypt were primarily the result of external food price shocks. Their study, based on data from 2001 to 2011, concludes that the spillover from global food prices to domestic food prices is higher in the short-term, while it is weak in the long-term. Nevertheless, they show that external food prices explain only a small portion of overall inflation in Egypt. In the context of Asian developing countries, Jongwanich and Park (2011) show that international oil and food prices pass-through to domestic inflation has been limited, and attributes this weak transmission to the public subsidies and the price controls. Zaremba *et al.* (2019) display, by using wavelet analysis, that UK inflation is significantly affected by commodity prices. In panel European countries, Ferrucci *et al.* (2012) find that global commodity price changes are the main determinant of producer and consumer food price, with a transmission coefficient of 0.3. Furceri *et al.* (2016) study the world food prices pass-through to inflation in a large panel of countries, by using data for the periods 1960-1999 and 2000-2013. They find that food price shocks have a significant impact on inflation in advanced economies. However the effect declines over time and becomes less persistent. Moreover, they assert that the global food price shocks occurred in the 2000s have a much larger impact on domestic inflation in emerging and developing economies than in advanced economies. Khan and Ahmed (2014) reveal, by using data from 1990 to 2011, that oil and food price shocks significantly affect inflation rate in Pakistan. Tule *et al.* (2019) show that agricultural commodities prices have a prediction power for headline and food inflation in Nigeria. Rivero and Ramírez (2019) analyze the monetary policy response to the inflation and economic activity changes in Bolivia, and find that interest rates display a sensitive response to output gap and an inelastic mechanism to inflation. Pourroy *et al.* (2016) argue that overall inflation targeting seems to be optimal in low and medium income countries, while non-food inflation targeting is the more accurate option in high-income countries.

Some studies argue that food price shocks are particularly more important than oil price shocks in explaining domestic inflation. For instance, Misati *et al.* (2013) find that the effect of food prices is more important than the effect of oil prices in explaining inflation in Kenya over the period 1996-2011. Belke and Dreger (2015) identify, by using data from 1990 to 2011, long-run effects of both oil and food prices on inflation in MENA countries, but they asses that the effect of food price shocks dominates. According to Helbling *et al.* (2008), the global food price pass-through exceeds its counterpart from oil price for emerging markets, whereas the ordering is reversed for advanced economies.

The literature provides very little empirical insight into the impacts of oil and food prices on the inflation in Morocco. For instance, Ianchovichina *et al.* (2014) evaluate the pass-through of global food prices into domestic food prices in a sample of 18 Arab countries, including Morocco. This paper conducts country-by-country studies by using data from 2000 to 2011, and found that the global prices transmission to Morocco's domestic prices builds up after eight months with a pass-through coefficient 0.4. Belke and Dreger (2015) identify, by using data from 1990 to 2011, long-run effects of world oil and food price changes on domestic inflation in overall countries, particularly in Morocco. They denote that the effect of food price shocks is more important than the effect of oil price shocks. However, domestic factors namely demand shocks and monetary policy shocks are not taken into account in this study.

Some previous studies explain inflation with a Phillips curve in which the inflation rate depends on expected inflation, the deviation of output from trend, as well as oil and food price shocks (e.g. Ball *et al.*, 2016; Peeters and Albers, 2013). However, the Phillips curve equation does not include other variables that can affect inflation, namely those related to the monetary policy and external sector. Omitting these variables may lead to an underestimation of the external shocks pass-through into inflation. The estimation of a VAR model including the aforementioned variables as additional is a pertinent solution to overcome this limitation. The more common approach used in this framework is the impulse response analysis (e.g. Alom *et al.*, 2013; Bhat *et al.*, 2018; Jongwanich and Park, 2011; Khan and Ahmed, 2014; Misati *et al.*, 2013; Osorio and Unsal, 2013). However, it covers only the effect of shocks up to 10 time lags (months or quarters). Some other studies uses conventional tests to analyze the Granger causality and/or co-integration in the time-domain framework (e.g. Alom *et al.*, 2013; Bhat *et al.*, 2018; Misati *et al.*, 2013). Although the

Granger causality analysis in the time domain provides useful information about the effect of commodity prices on inflation, it offers no clear explanation of 'short-run' and 'long-run'. However, the Granger causality analysis in the frequency domain offers an intuitive interpretation of short- and long-run causal links by examining the later along different time cycles. As a pertinent alternative of the methods used in previous studies, we carry out in this paper a frequency domain causality analysis, by using Breitung and Candelon (2006) test, in a VAR model that includes a set of additional variables corresponding to the foreign trade, monetary policy and domestic demand.

3. TRANSMISSION CHANNELS

The higher global commodity prices can lead to higher domestic consumer prices through various direct and indirect channels. Several studies assert that the oil price hikes cause upward pressures on the inflationary tendency of an economy (e.g. Alvarez *et al.*, 2011; Barsky and Kilian, 2004; Hooker, 2002; Tang *et al.*, 2010). The oil price shocks can indirectly affect consumer prices through supply-side. This reflects the use of oil and its derivatives as additional inputs in different production processes. Therefore, an increase in the cost of production resulting from higher oil prices, may lead to an increase in retail prices. Moreover, oil price changes may have second-round effects. Indeed, on one hand, first-round price fluctuations may lead to revisions in inflation expectation that may result in final price changes. On the other hand, an oil price shock may entail nominal wages reset since laborers demand for higher wages to maintain the existing standards. These indirect effects of oil price fluctuations are generally assumed to be observed in the long-term (e.g. Alvarez *et al.*, 2011). The oil price hikes can also directly affect the headline inflation through consumption channel. This reflects the fact that oil price changes immediately transmit to the prices of oil-based products, like as fuels or heating oil, which generally constitute an important share in the household consumption basket. The direct effect can be proxied by the share of consumer energy prices in the overall consumer prices index. It depends, among other factors, on the expenditure share of households on refined oil products over total expenditure. This transmission effect is generally related to the short- and the medium-term (e.g. Alvarez *et al.*, 2011).

Global food prices are related to domestic consumer prices mainly through commodity imports. This could be carried out directly through purchases of food products from wholesalers on global output markets, and indirectly, through purchases of agricultural inputs (feed, seed, raw commodities, etc.) from foreign producers on global markets. In general, the larger the share of commodity imports in domestic supply, the higher the correlation between the domestic prices and global prices. Furthermore, world prices can also affect domestic prices according to the law of one price due to the fact that local producers can arbitrate freely between selling their products on the local market or abroad (see Mankiw, 2011, p. 686). For instance, when the world price is sufficiently higher than the domestic price, local producers decide to sell their food products abroad and reduce the food supply on the domestic market. As a consequence, upward pressures on domestic prices would be generated.

Rocketing food prices can affect the real side of the economy depending on their transmission degree to the domestic price level. They may depress the household’s purchasing power and can cause production losses, as firms will choose labor and capital input to adjust to relative price changes (e.g. Belke and Dreger, 2015). As for price decreases, a reversal is generally expected. The effect of food price hikes could be even more accentuated in countries with less firmly anchored inflationary expectations (see Furceri *et al.*, 2016). Since food heavily weighs in the private household consumption basket, accelerating prices can lead to rising poverty and social instability in the country. For example, Breisinger *et al.* (2011) display that high food prices have been among factors contributing to social unrest in the eve of the 2011 Arab Spring.

The transmission of higher commodity prices into domestic consumer prices could be affected by some policy interventions. For example, tariffs on foreign trade could interfere with the connection between global and domestic prices (See Martin and Anderson, 2011). Higher import tariffs that may be implemented to reduce the relative price competitiveness of foreign goods and shelter local producers from foreign competition, could lead to lower price transmission to the extent that tariffs reduce import demand. Export tariffs could be also imposed to ensure that local producers sell a minimal or higher share of their products on domestic market, and their increasing over the period of high global commodity prices contributes to lower tensions on domestic prices. Furthermore, in a number of developing economies, the government subsidizes basic necessities and price commodities for economic and social reasons (e.g. Belke and Dreger, 2015). As a consequence, the consumer prices will not fully adjust to higher global commodity prices, and then the consumers do not really face the market price of the subsidized commodities. Otherwise, exchange rate movements that are usually assumed to affect trade and foreign direct investment (e.g. Wong *et al.*, 2019) can also amplify or absorb price shocks on global markets. For example, the weakening of the U.S. dollar against the domestic currency may lead to a reducing in the domestic oil price.

4. METHODOLOGY AND DATA DESCRIPTION

The analysis in this paper is built on the debated issue of whether or not a causal links exist between global commodities prices and domestic consumer prices, invoking the causality notion based on the pioneering work Granger (1969). Furthermore, Granger (1969) and Geweke (1982) emphasize that the extent of causality can differ between frequency bands (or period lengths). In this context, Geweke (1982) introduce a frequency domain causality measure on which Breitung and Candelon (2006) builds a new causality test in the frequency domain.

4.1 Methodology

Breitung and Candelon (2006) propose a test procedure that examine the hypothesis of no Granger causality from a time series to another one for each frequency λ in]0, π[.This test procedure has been used by a number of previous studies (e.g. Ciner, 2011; Gómez-González *et al.*, 2014; Gronwald, 2009; Joseph *et al.*, 2014; Kratschell and Schmidt, 2017; Tiwari *et al.*, 2015).

Breitung and Candelon (2006) introduce their causality test in the framework of two-dimensional VAR model, but they also state: “our approach can be generalized to test for causality in higher dimensional systems”. For example, they present a three-dimensional autoregressive equation for testing the causality from a given variable to another one conditionally to a third variable. In our study, we examine the causality running from world oil and food prices to consumer price inflation conditionally to the variation of three additional economic variables that can influence the price inflation dynamics. To this purpose, we implement the Breitung and Candelon (2006) frequency causality test within a six-dimensional VAR model.

Let us consider a six-dimensional vector of stationary series $X_t=[x_{1,t}, x_{2,t}, x_{3,t}, x_{4,t}, x_{5,t}, x_{6,t}]'$ observed at $t = 1,..., T$, and the following finite-order VAR model:

$$X_t = \Theta_1 X_{t-1} + \Theta_2 X_{t-2} + \cdots + \Theta_p X_{t-p} + \varepsilon_t, \quad (1)$$

where Θ_1, $\Theta_2, \ldots,$ Θ_p are coefficient matrices, and the error vector ε_t is a white noise with zero mean and positive definite covariance matrix.

According to Breitung and Candelon (2006), the null hypothesis of no Granger causality from x_2 to x_1 at frequency λ is expressed as

$$\begin{cases} \sum_{i=1}^{p} \theta_{12,k} \cos(k\lambda) = 0 & (2) \\ \sum_{i=1}^{p} \theta_{12,k} sin(k\lambda) = 0 & (3) \end{cases}$$

where $\theta_{12,k}$ denote the (1,2)-element of the coefficient matrices Θ_k, $k=1,\ldots,p$.

Therefore, we can examine the hypothesis of no Granger causality from x_2 to x_1 at frequency λ by testing the linear restrictions (2) and (3) on the following equation (first component of VAR model (1)):

$$x_{1,t} = \sum_{i=1}^{p} \theta_{11,k} x_{1,t-k} + \sum_{i=1}^{p} \theta_{12,k} x_{2,t-k} + \sum_{i=1}^{p} \theta_{13,k} x_{3,t-k} + \sum_{i=1}^{p} \theta_{14,k} x_{4,t-k} + \sum_{i=1}^{p} \theta_{15,k} x_{5,t-k} + \sum_{i=1}^{p} \theta_{16,k} x_{6,t-k} + \varepsilon_{1,t} \quad (4)$$

The restrictions (2) and (3) can be tested by performing a Fischer-test based on $F(2, T-2p)$ distribution where T is the time series length. For a level of significance α, fixed at 5% in our study, if the Fischer-test statistic value is found to be upper than the critical value $F(2, T-2p, \alpha)$, then there is a significant Granger causality at frequency λ from x_2 to x_1[2]. Equivalently, no Granger causality hypothesis can be examined using the incremental R-squared measure that quantifies the proportion of explained variability of x_1 lost due to the imposition of the linear restrictions (2) and (3). This measure is defined as the difference between the R-squared measure R^2 of the unrestricted model (4) and the R-squared measure R^{*2} of the regression equation (4) estimated under the linear restrictions (2) and (3) (see Greene, 2002, pp. 101-102):

$$Incremental\ R^2 = R^{*2} - R^2 \quad (5)$$

The incremental R-squared measure can be interpreted as the strength of the Granger causality from x_2 to x_1 at given frequency λ, and its values are always bounded between 0 and 1. By plotting the incremental R-squared for all frequencies λ between 0 and π, one can visualize the strength of the Granger causality over the entire frequency domain] 0, π [.

The null hypothesis of no Granger causality of x_2 on x_1 at frequency λ is rejected at level α if:

$$Incremental\ R^2 > F(2, T-2p, \alpha)\frac{2(1-R^2)}{T-2p} \quad \text{for } \lambda \epsilon]0,\pi[, \tag{6}$$

where $F(2,T\text{-}2p,\alpha)$ is the α upper critical value of the F-distribution with 2 and T-$2p$ degrees of freedom.

4.2 Data description

The study uses quarterly data covering the period 1998Q1-2018Q1. We use the change rates in consumer price index as proxy for inflation[3]. As for the international oil and food prices, they are presented, respectively, by the Brent oil price and World Bank's food price index. The later consists of cereals with 28% share, followed by meals and vegetable oils with 41% share, and other food items, including sugar, with 31% share.

In order to provide more insights about the sources of inflation, the exchange rate, the interest rate and the output gap are used as additional variables. The exchange rate is presented by nominal exchange rate Moroccan dirham per U.S. dollar, while the interest rate is proxied by the Money market rate. Output gap represents the gap between actual and potential output. Output is proxied by the industrial production index. Since there are large seasonal movements in Morocco's output over the period from 1998Q1 to 2004Q1, we seasonally adjust the output series using the U.S. Census Bureau's X-13 procedure and then the output is taken in the natural logarithm. Potential output is proxied by the trend of output, obtained using the Hodrick-Prescott filter. Our data sources are Global Economic Monitor- Commodities (GEM) database of the World Bank and International Financial Statistics (IFS) database of the International Monetary Fund (IMF). Time series plots are presented in Figure no. A2 in Annex 3. In summary, the data used in this study include

– Quarterly consumer price index (CPI) data measured by domestic currency (Moroccan dirham or briefly MAD) and base year 2010=100, IMF.

– Quarterly Brent oil price (OP) data per barrel in nominal USD, World Bank[4].

– Quarterly World Bank's food price index (FP) data based on nominal USD and base year 2010=100, World Bank[5].

– Quarterly average of nominal exchange rates (ER) expressed in terms of MAD per U.S. dollar, IMF

– Quarterly data for money market rate, IMF.

– Quarterly data for output gap calculated on the base of industrial production index in base year 2010=100, IMF.

In this study, real oil and food prices in national currency are used as in Alom *et al.* (2013). Nominal oil and food prices in US dollar are transformed to real prices in national currency by using nominal exchange rates and Morocco's CPI. We maintain the use of oil price and food price along the rest of the paper to mean real oil price and real food price. Oil and food price series are used in natural logarithms.

We estimate a VAR model for the vector $X_t=(INF_t, OP_t, FP_t, OG_t, IR_t, ER_t)$, and we are interested to the following equation related to INF_t:

$$INF_t = \sum_{i=1}^{p} \theta_{1,k} INF_{t-k} + \sum_{i=1}^{p} \theta_{2,k} OP_{t-k} + \sum_{i=1}^{p} \theta_{3,k} FP_{t-k} + \sum_{i=1}^{p} \theta_{4,k} OG_{t-k} + \sum_{i=1}^{p} \theta_{5,k} IR_{t-k} + \sum_{i=1}^{p} \theta_{6,k} ER_{t-k} + \varepsilon_{1,t} \tag{7}$$

where INF_t represents the inflation at *t*, which is the endogenous variable, and INF_{t-k} is the inflation at *t-k* (reflects inflation expectations). OP_{t-k}, FP_{t-k}, OG_{t-k}, IR_{t-k}, and ER_{t-k} are the oil price, food price, output gap, interest rate, and exchange rate at *t-k*, respectively. These represent the exogenous variables. We consider *OP* and *FP* to capture the external supply shocks, *OG* as proxy for the demand shock, *IR* as proxy for monetary policy, and *ER* is included for capturing the external shock. Next, we implement the Breitung and Candelon (2006) causality test as previously described.

A number of studies emphasized asymmetric effects of oil and food price shocks on consumer prices (e.g. Alom *et al.*, 2013; Belke and Dreger, 2015; Bhat *et al.*, 2018; Khan and Ahmed, 2014). Therefore, we consider increases and decreases in each oil price and food price following Hamilton (1996) measure[6] to derive the two-quarter net oil price increase (NOPI) and net oil price decrease (*NOPD*)[7]:

$$NOPI_t = Max\left(0, OP_t - Max\left(OP_{t-1},\ OP_{t-2}\right)\right) \tag{8}$$

$$NOPD_t = Min\left(0, OP_t - Min\left(OP_{t-1},\ OP_{t-2}\right)\right) \tag{9}$$

NOPI occurs if the oil price in the current quarter (*t*) exceeds the maximum price of the preceding 2 quarters. Similarly, *NOPD* occurs if the oil price over the quarter (*t*) is below than the minimum price of the past 2 quarters. We calculate also the series of net food price increase (*NFPI*) and net food price decrease (*NFPD*) in a similar way. Firstly, we estimate Equation (7) where *OP* and *FP* are replaced by *NOPI* and *NFPI*, respectively. Secondly, we estimate Equation (7) where *OP* and *FP* are replaced by *NOPD* and *NFPD*, respectively. In each time, we implement the Breitung and Candelon (2006) causality test.

5. EMPIRICAL RESULTS AND DISCUSSION

This section presents and discusses the size and speed of external shocks pass-through to consumer prices in Morocco. The Breitung and Candelon (2006) test based on the incremental R^2 statistic, is used to analyze the causality relationship as well as the extent of the predictive power across frequencies, in other words, over time cycles. For a preliminary analysis, the stationarity properties of data are examined using both ADF unit root test and KPSS stationary test[8]. The results show that output gap is stationary in levels, oil price, food price and exchange rate are stationary at the first differences, and finally the interest rate is found stationary at the second differences. As for the variables obtained by the transformation of Hamilton (1996), they are found stationary at the first differences. As consequence, we transform the interest rate to second differences and all other non-stationary variables to first differences in order to make them stationary. Since mixture of both I(0), I(1) and I(2) order is found among the series, the cointegration analysis was not considered and the analysis of the Granger causality in VAR model would be pertinent.

The six-dimensional VAR models are estimated using the different specifications of oil and food price series. We started with the differentiated series of oil and food prices. Next, we use Hamilton (1996) oil and food price net increases (*NOPI* and *NOFI*). Finally, we employ Hamilton (1996) oil and food price net decreases (*NOPD* and *NOFD*). According to the AIC criterion, all VAR models are estimated with the lag order p=4. Heteroscedasticity of residuals is examined by multivariate ARCH-LM test, and serial correlation in the residuals is tested by Box-Pierce and Ljung-Box Portmanteau tests. The assumption of white noise error terms is not rejected[9].

Figures no. 1 and no. 2 show the results gained from the six-dimensional VAR model estimated with the differentiated series of oil and food prices. Whereas, Figure no. 3 indicates the results obtained by estimating firstly a six-dimensional VAR model including oil and food price net increases (*NOPI* and *NOFI*), and secondly a six-dimensional VAR model including oil and food price net decreases (*NOPD* and *NFPD*)[10]. Figures no. 1, no. 2 and no. 3 report the incremental R-squared statistic of the Breitung and Candelon (2006) test, related to each considered variable for all frequencies λ in]0; π[along with its 5% critical value. The quarterly frequency can be translated into a periodicity of S quarters by $S = \frac{\pi}{2\lambda}$. The smaller frequencies reflect long cycles (long-run fluctuations) while the higher frequencies reflect short cycles (short-run fluctuations). The incremental R-squared at given frequency λ provides a measure of the predictive power of each commodity price and control variable for the consumer prices at the cycle of length $\frac{\pi}{2\lambda}$. The higher is the incremental R-squared, the more the predictive power is stronger.

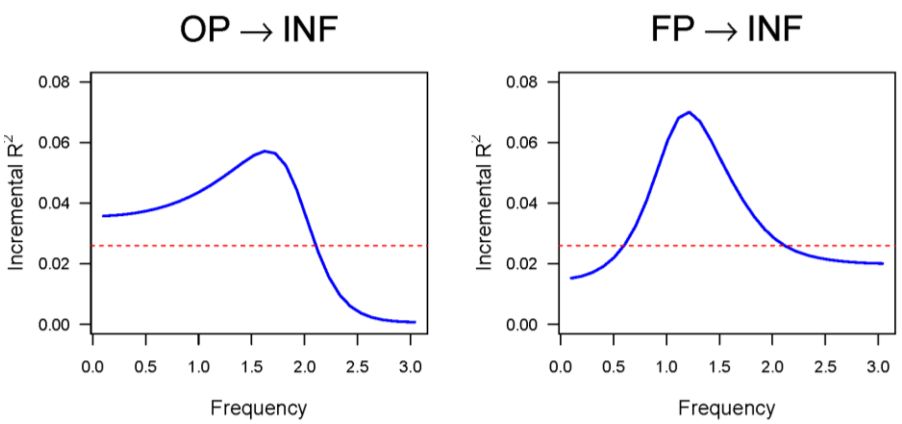

Figure no. 1 – Analysis of the causality from oil price and food price to headline inflation

Figures no. 1 shows that the incremental R-squared statistics related to oil price and food price exceed the level of significance at the frequencies in the intervals [0; 2,1] and [0,6; 2,1], respectively. This means that both oil and food price shocks affect the domestic inflation, but each effect only becomes significant after a lag of 3 quarters[11]. Although, the significant effect of food price shock persists only for 7 quarters[12], while innovations to oil prices persist for long-run cycles. The persistent effect of oil prices on consumer prices can be attributed to the supply side channel. Whereas, the food prices find their short-run pass-through in the consumption basket channel as food items constitute larger weight in Morocco's consumption basket.

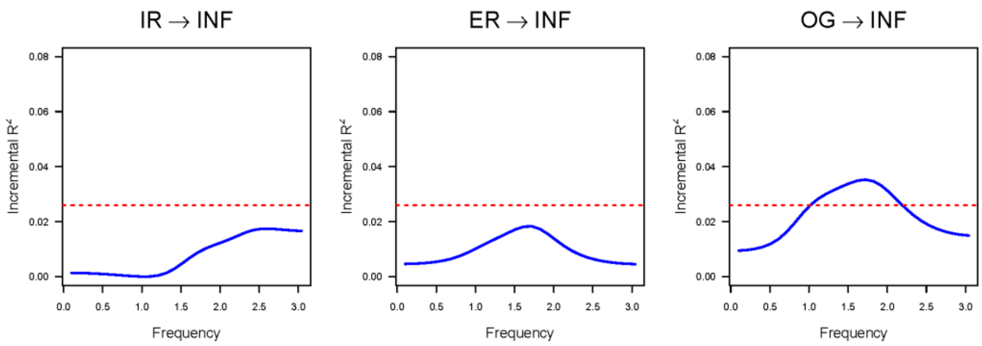

Figure no. 2 – Analysis of the causality from interest rate, exchange rate and output gap to headline inflation

Figure no. 2 shows, on one hand, that the incremental R-squared statistics related to the exchange rate and the interest rate do not reach the level of significance at any frequency in]0, π[. This indicates that exchange rate and interest rate have no significant effects on overall inflation even their effects over short-run cycles are found relatively more important than their effects over long-run cycles. On the other hand, the incremental R-squared related to the output gap exceeds the level of significance at the frequencies in the interval [1,1; 2,2]. This reflects that innovations to output gap significantly affect overall inflation after a lag of 3 quarters, but the effect lasts for only the next 3 quarters. Nevertheless, the relevance of the output gap series can be doubted given the relatively small weight of industrial production in the Moroccan economy.

Regarding the extent of oil and food price shocks effects, Figures no. 1 and no. 2 indicate that food price changes most explain fluctuations in inflation. The maximum average of food price shocks transmission to inflation, observed within the period from 4,5 to 5,5 quarters corresponding to frequency interval [1,1; 1,4], up to 6,7%. Whereas, the maximum average of oil price shocks pass-through to inflation, occurred within the period from 4 to 5 quarters corresponding to frequency interval [1,2; 1,7], up to 5.3%.

Let us now analyse the results reported in Figure no. 3 that corresponds to the effects of positive and negative shocks of oil and food prices on overall inflation. The results show that the inflation exhibits asymmetries in response to both increases and decreases in commodity prices, which is in accordance with the literature on this topic. The domestic inflation responds more steeply to food price increase than food price decrease. The extent of the pass-though from food price increases to the inflation, which becomes significant after 3 quarters, achieves a maximum up to 8% at around 4,5 quarters. Whereas, the extent of the pass-through from food price decreases to the inflation, which starts to be significant after 4 quarters, reaches only a maximum of 3% observed during the fifth quarter. Otherwise, domestic inflation responds more weakly to oil price increases than oil price decreases. The reaction of inflation following an oil price increase is revealed at first round temporary significant within the period from 2,5 to 3,5 quarters, and then it becomes again significant after 6 quarters and persists in the subsequent. However, throughout these periods the extent of positive shocks pass-through does not exceed 3%. As for the pass-through from negative oil price shocks to inflation, it starts to be significant after 3 quarters and then reaches a maximum up to 6% over the fifth quarter. Finally, to check the sensitivity of the results, the symmetric and asymmetric causality analyses are also conducted using nominal effective exchange rate (trade weighted), but relatively similar results are obtained.

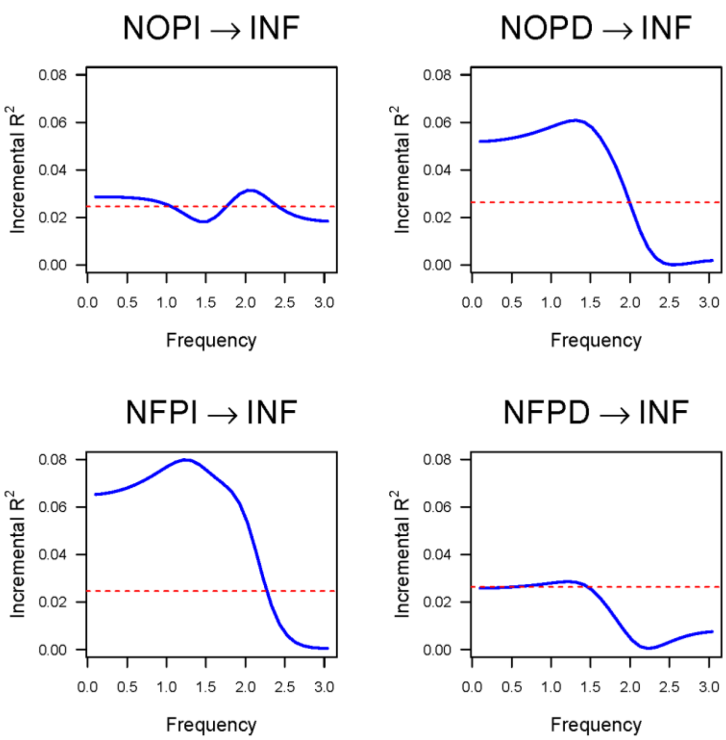

Figure no. 3 – Analysis of the causality from net increases and decreases of oil price and food price to the inflation

6. CONCLUSION

This study aimed to understand the role played by oil and food price shocks in inflation dynamics in Morocco as a net oil importer and highly dependent on food imports. To this end, the Breitung and Candelon (2006) causality test within a multivariate VAR framework is used. The study identifies significant pass-through of oil and food price shocks on overall inflation. Over the short-run, the effect of food price shocks is revealed higher than the effect of oil price shocks on headline inflation. However, the pass-through of oil price to inflation is shown more persistent. As for the interest rate and the exchange rate, their impacts are shown empirically no significant.

The paper emphasizes that the global commodity prices pass-through are asymmetric as headline inflation exhibits asymmetries in response to oil and food price increases and decreases. Indeed, the food price increases have more significant influence on inflation than the food price decreases. Whereas, the response of inflation to oil price increase is less important than the response related to oil price decrease. Government policy measures, particularly higher oil subsidies, may play a crucial role in reducing the pass-through of oil price hikes into consumer prices. The low volatility of the exchange rate that is controlled by Morocco's central bank may also play a role in reducing the inflation's response to the external supply shocks. According to the results, it would be pertinent to take into account the transient shocks as well as the permanent shocks of oil and food prices in the future inflation targeting policy aimed by the Morocco's central bank.

Based on the findings, a few policy implications are worth mentioning. First, due to the country's high dependence on oil and food imports and the significant transmission from the prices of these commodities to the inflation, commodities price shocks should require special attention in monetary policymaking. Second, it would be more relevant to distinguish between positive and negative price shocks for modelling the world commodities prices pass-through to domestic inflation. Third, we think that improving the local production of energy by exploiting diverse renewable resources would be useful for reducing the almost total dependence on energy imports (see de Arce *et al.*, 2012; Choukri *et al.*, 2017), and then mitigating the pass-through effect of oil price shocks. Especially that the country has natural and geographical advantages that favors a high production of green energies, namely hydraulic, wind, and solar (see IEA International Energy Agency, 2014, 2019). These energies could also be made use of for developing the agri-food sector (see Flammini *et al.*, 2016) in order to reduce the high dependence on food imports, and then alleviate the transmission effects of world food prices shocks. Food imports could be also reduced by developing irrigation given the high dependence of agricultural production on rainfall. Four, allowing more investments for enhancing strategic fuel reserves would be pertinent to mitigate oil price shocks.

ORCID

Mounir El-Karimi http://orcid.org/0000-0001-7268-477X

References

Al-Shawarby, S., and Selim, H., 2013. Are International Food Price Spikes the Source of Egypt's High Inflation? In M. Peeters, N. Sabri and W. Shahin (Eds.), *Financial Integration. Financial and Monetary Policy Studies* (Vol. 36, pp. 61-83). Berlin, Heidelberg: Springer. http://dx.doi.org/10.1007/978-3-642-35697-1_4

Albulescu, C. T., Oros, C., and Tiwari, A. K., 2017. Oil price-inflation pass-through in Romania during the inflation targeting regime. *Applied Economics, 49*(15), 1527-1542. http://dx.doi.org/10.1080/00036846.2016.1221041

Alom, F., Ward, B. D., and Hu, B., 2013. Macroeconomic effects of world oil and food price shocks in Asia and Pacific economies: Application of SVAR models. *OPEC Energy Review, 37*(3), 327-372. http://dx.doi.org/10.1111/opec.12015

Alvarez, L. J., Hurtado, S., Sanchez, I. S., and Thomas, C., 2011. The impact of oil price changes on Spanish and euro area consumer price inflation. *Economic Modelling, 28*(1-2), 422-431. http://dx.doi.org/10.1016/j.econmod.2010.08.006

Ball, L., Chari, A., and Mishra, P., 2016. *Understanding inflation in India* (Vol. w22948): National Bureau of Economic Research. http://dx.doi.org/10.3386/w22948

Barsky, R. B., and Kilian, L., 2004. Oil and the Macroeconomy since the 1970s. *The Journal of Economic Perspectives, 18*(4), 115-134. http://dx.doi.org/10.1257/0895330042632708

Belke, A., and Dreger, C., 2015. The transmission of oil and food prices to consumer prices. *International Economics and Economic Policy, 12*(1), 143-161. http://dx.doi.org/10.1007/s10368-014-0283-x

Bhat, J. A., Ganaie, A. A., and Sharma, N. K., 2018. Macroeconomic Response to Oil and Food Price Shocks: A Structural VAR Approach to the Indian Economy. *International Economic Journal, 32*(1), 66-90. http://dx.doi.org/10.1080/10168737.2018.1446038

Breisinger, C., Ecker, O., and Al-Riffai, P., 2011. Economics of the Arab Awakening: From Revolution to Transformation and Food Security. *IFPRI Policy Brief, 18*.

Breitung, J., and Candelon, B., 2006. Testing for short- and long-run causality: A frequency-domain approach. *Journal of Econometrics, 132*(2), 363-378. http://dx.doi.org/10.1016/j.jeconom.2005.02.004

Chen, S. S., 2009. Oil price pass-through into inflation. *Energy Economics, 31*(1), 126-133. http://dx.doi.org/10.1016/j.eneco.2008.08.006

Choukri, K., Naddami, A., and Hayani, S., 2017. Renewable energy in emergent countries: Lessons from energy transition in Morocco. *Energy, Sustainability and Society, 7*(1), 25. http://dx.doi.org/10.1186/s13705-017-0131-2

Ciner, C., 2011. Eurocurrency interest rate linkages: A frequency domain analysis. *International Review of Economics & Finance, 20*(4), 498-505. http://dx.doi.org/10.1016/j.iref.2010.09.006

Cunado, J., and Perez de Gracia, F., 2005. Oil prices, economic activity and inflation: Evidence for some Asian countries. *The Quarterly Review of Economics and Finance, 45*(1), 65-83. http://dx.doi.org/10.1016/j.qref.2004.02.003

de Arce, R., Mahia, R., Medina, E., and Escribano, G., 2012. A simulation of the economic impact of renewable energy development in Morocco. *Energy Policy, 46*, 335-345. http://dx.doi.org/10.1016/j.enpol.2012.03.068

De Gregorio, J., Landerretche, O., Neilson, C., Broda, C., and Rigobon, R., 2007. Another pass-through bites the dust? Oil prices and inflation. *Economia, 7*(2), 155-208.

Égert, B., 2011. Catching-up and inflation in Europe: Balassa-Samuelson, Engel's Law and other culprits. *Economic Systems, 35*(2), 208-229. http://dx.doi.org/10.1016/j.ecosys.2010.06.001

EIA - Energy Information Administration, 2017. Morocco. from https://bit.ly/2wv4sBj

Ferrucci, G., Jimenez-Rodriguez, R., and Onorante, L., 2012. Food price pass-through in the euro area: The role of asymmetries and non-linearities. *International Journal of Central Banking, 8*(1), 179-218.

Flammini, A., Dias Pereira, L., Santos, N., Bracco, S., Carita, A., Oze, D., and Theodorakis, G., 2016. Morocco: monitoring adoption of key sustainable climate technologies in the agrifood sector. *Country Highlights (FAO)*. http://www.fao.org/3/a-i6242e.pdf.

Furceri, D. P., Loungani, P., Simon, J., and Wachter, S. M., 2016. Global food prices and domestic inflation: Some cross-country evidence. *Oxford Economic Papers, 68*(3), 665-687. http://dx.doi.org/10.1093/oep/gpw016

Geweke, J., 1982. Measurement of linear dependence and feedback between multiple time series. *Journal of the American Statistical Association, 77*(378), 304-313. http://dx.doi.org/10.1080/01621459.1982.10477803

Gómez-González, J. E., Ojeda-Joya, J. N., Zarate, H. M., and Tenjo-Galarza, F., 2014. Testing for causality between credit and real business cycles in the frequency domain: An illustration. *Applied Economics Letters, 21*(10), 697-701. http://dx.doi.org/10.1080/13504851.2014.884689

Granger, C., 1969. Investigating causal relations by econometric models and cross-spectral methods. *Econometrica, 37*(3), 424-438. http://dx.doi.org/10.2307/1912791

Greene, W. H., 2002. *Econometric Analysis* (5th ed. ed.). New Jersey: Prentice Hall.

Gronwald, M., 2009. Reconsidering the macroeconomics of the oil price in Germany: Testing for causality in the frequency domain. *Empirical Economics, 36*(2), 441-453. http://dx.doi.org/10.1007/s00181-008-0204-3

Hamilton, J. D., 1996. This is what happened to the oil price-macroeconomy relationship. *Journal of Monetary Economics, 38*(2), 215-220. http://dx.doi.org/10.1016/S0304-3932(96)01282-2

Helbling, D. L., Mercer-Blackman, V., Dao, C. T. N., Erbil, N., and Oakes, E., 2008. Is inflation back? commodity prices and inflation. *World Economic Outlook*.

Hooker, M., 2002. Are oil shocks inflationary? Asymmetric and nonlinear specifications versus changes in regime. *Journal of Money, Credit and Banking, 34*(2), 540-561. http://dx.doi.org/10.1353/mcb.2002.0041

Ianchovichina, E. I., Loening, J. L., and Wood, C. A., 2014. How vulnerable are Arab countries to global food price shocks? *The Journal of Development Studies, 50*(9), 1302-1319. http://dx.doi.org/10.1080/00220388.2014.928698

IEA International Energy Agency, 2014. *Energy Policies Beyond IEA Countries: Morocco* Retrieved from https://bit.ly/2Umn4wp

IEA International Energy Agency, 2019. *Energy Policies Beyond IEA Countries: Morocco* Retrieved from https://bit.ly/3ao48Tp

Jongwanich, J., and Park, D., 2011. Inflation in developing Asia: Pass-through from global food and oil price shocks. *Asian-Pacific Economic Literature, 25*(1), 79-92. http://dx.doi.org/10.1111/j.1467-8411.2011.01275.x

Joseph, A., Sisodia, G., and Tiwari, A. K., 2014. A frequency domain causality investigation between futures and spot prices of Indian commodity markets. *Economic Modelling, 40*, 250-258. http://dx.doi.org/10.1016/j.econmod.2014.04.019

Khan, M. A., and Ahmed, A., 2014. Revisiting the macroeconomic effects of oil and food price shocks to P akistan economy: A structural vector autoregressive (SVAR) analysis. *OPEC Energy Review, 38*(2), 184-215. http://dx.doi.org/10.1111/opec.12020

Kratschell, K., and Schmidt, T., 2017. Long-run waves or short-run fluctuations-what establishes the correlation between oil and food prices? *Applied Economics, 49*(54), 1-12. http://dx.doi.org/10.1080/00036846.2017.1313948

LeBlanc, M., and Chinn, M. D., 2004. Do high oil prices presage inflation? The evidence from G5 countries. *Business Economics (Cleveland, Ohio), 34*, 38-48.

Liu, L., and Tsang, A., 2008. Pass-through Effects of Global Commodity Prices on China's Inflation: An Empirical Investigation. *China & World Economy, 16*(6), 22-34. http://dx.doi.org/10.1111/j.1749-124X.2008.00135.x

Mankiw, N. G., 2011. *Principles of Economics* (6th ed. ed.). Mason, OH: South-Western Cengage Learning.

Martin, W., and Anderson, K., 2011. *Export restrictions and price insulation during commodity price booms*: The World Bank. http://dx.doi.org/10.1596/1813-9450-5645

Misati, R. N., Nyamongo, E. M., and Mwangi, I., 2013. Commodity price shocks and inflation in a net oil-importing economy. *OPEC Energy Review, 37*(2), 125-148. http://dx.doi.org/10.1111/opec.12010

Mork, K. A., 1989. Oil and the macroeconomy when prices go up and down: An extension of Hamilton's results. *Journal of Political Economy, 91*, 740-744.

Osorio, C., and Unsal, D. F., 2013. Inflation dynamics in Asia: Causes, changes, and spillovers from China. *Journal of Asian Economics, 24*, 26-40. http://dx.doi.org/10.1016/j.asieco.2012.10.007

Peeters, M., and Albers, R., 2013. Food prices, government subsidies and fiscal balances in south Mediterranean countries. *Development Policy Review, 31*(3), 273-290. http://dx.doi.org/10.1111/dpr.12007

Pourroy, M., Carton, B., and Coulibaly, D., 2016. Food prices and inflation targeting in emerging economies. *Inter Economics, 146*, 108-140. http://dx.doi.org/10.1016/j.inteco.2015.12.001

Rivero, R. A. B., and Ramírez, M. A. N., 2019. Discretion of the Monetary Policy: An Exemplification with Bolivia. *Scientific Annals of Economics and Business, 66*(1), 101-115. http://dx.doi.org/10.2478/saeb-2019-0006

Sun, Q., An, H., Gao, X., Guo, S., Wang, Z., Liu, S., and Wen, S., 2019. Effects of crude oil shocks on the PPI system based on variance decomposition network analysis. *Energy, 189*, 116378. http://dx.doi.org/10.1016/j.energy.2019.116378

Tang, W., Wu, L., and Zhang, Z., 2010. Oil price shocks and their short-and long-term effects on the Chinese economy. *Energy Economics, 32*, S3-14. http://dx.doi.org/10.1016/j.eneco.2010.01.002

Tiwari, A. K., Mutascu, M. I., Albulescu, C. T., and Kyophilavong, P., 2015. Frequency domain causality analysis of stock market and economic activity in India. *International Review of Economics & Finance, 39*, 224-238. http://dx.doi.org/10.1016/j.iref.2015.04.007

Tule, M. K., Salisu, A. A., and Chiemeke, C. C., 2019. Can agricultural commodity prices predict Nigeria's inflation? *Journal of Commodity Markets, 16*, 100087. http://dx.doi.org/10.1016/j.jcomm.2019.02.002

Verme, P., and El Massnaoui, K., 2015. *An evaluation of the 2014 subsidy reforms in Morocco and a simulation of further reforms*: The World Bank. http://dx.doi.org/10.1596/1813-9450-7224

Walsh, J., 2011. Reconsidering the role of food prices in inflation. *IMF Working Paper, WP/11/71*. http://dx.doi.org/10.5089/9781455227082.001

Wei, Y., 2019. The relationship between oil and non-oil commodity prices and China's PPI and CPI: An empirical analysis. *Energy Sources. Part B, Economics, Planning, and Policy, 14*(4), 125-146. http://dx.doi.org/10.1080/15567249.2019.1630032

Wong, M. F., Fai, C. K., Yee, Y. C., and Cheng, L. S., 2019. Macroeconomic policy and exchange rate impacts on the foreign direct investment in ASEAN economies. *International Journal of Economic Policy in Emerging Economies, 12*(1), 1-10. http://dx.doi.org/10.1504/IJEPEE.2019.098629

Zaremba, A., Umar, Z., and Mikutowski, M., 2019. Inflation hedging with commodities: A wavelet analysis of seven centuries worth of data. *Economics Letters, 181*, 90-94. http://dx.doi.org/10.1016/j.econlet.2019.05.002

ANNEX 1

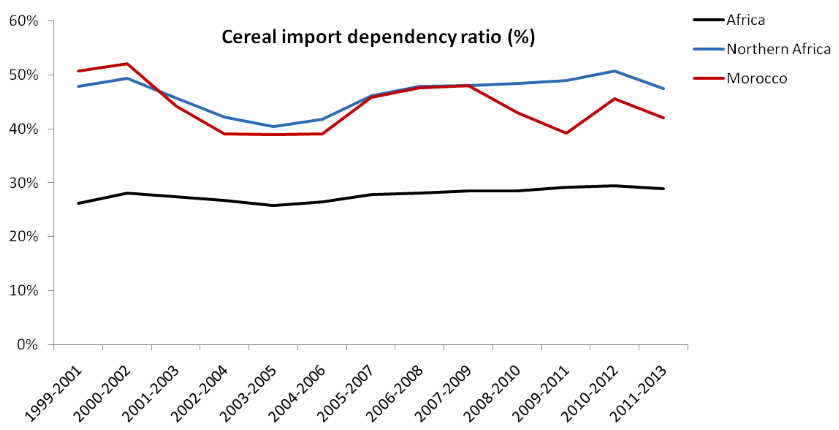

Figure no. A1 – Cereals import dependency ratio (3-year average) in Morocco and Africa region
Source: by authors based on data from FAOSTAT database

ANNEX 2

Table no. A1 – Major world rankings of Morocco's food imports in 2016[13]

Food product	Import (1000 tonnes)	World ranking
Wheat	6288	7
Maize	2029	20
Barley	977	9
Soybean oil	452	5
Maize oil	16	17
Products of natural milk constituents	17	9
Butter (crow milk)	24	13
Tea	67	7
Coffee (husks and skins)	<0,1 (54 tonnes)	12
Sugar (raw centrifugal)	1059	12

Source: by authors based on data from FAOSTAT database

ANNEX 3

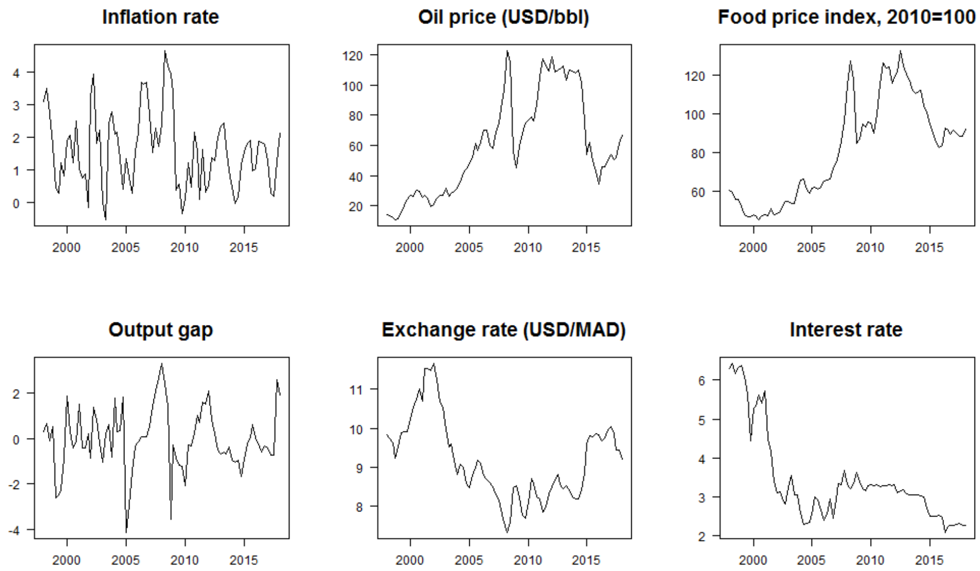

Figure no. A2 – The time plots of the considered variables

Notes

[1] The ratio of cereals imports over cereals consumption.
[2] The Granger causality at frequency λ from each of the other variables (x_3, x_4, and x_5) to x_1 can be examined in a similar way
[3] Using also the core inflation will provide more insights about the role of monetary policy, but we didn't use this measure because of the unavailability of the data in monthly or quarterly frequencies.
[4] They are calculated through basing on monthly data series.
[5] They are calculated through basing on monthly data series.
[6] Mork (1989) approach also provides measures of oil price increases and decreases. However, Hamilton (1996) show that his proposed measure is more pertinent by making a comparison between the two measures. Hamilton (1996) approach is also adopted in Bhat *et al.* (2018) and Alom *et al.* (2013).
[7] The use of net increase and net decrease for more of two quarters provides a time series where the number of the values different from zero is very negligible, which cannot allow the causality analysis in frequency domain giving pertinent results.
[8] The results are not reported, but are available from the authors upon request
[9] The results are not reported, but are available from the authors upon request. and then all estimated VAR models are valid
[10] Only the incremental R-squared statistics related to the variables of interest are reported
[11] This lag corresponds to a frequency equal to 2,1.
[12] This is because the frequency 0,6 corresponds to a lag of 10 quarters.
[13] The last year of the available data.

Copyright