Pass-through of global food commodity prices to food inflation in Morocco: A structural VAR approach

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Abstract

This paper examines the pass-through of world food commodity prices to food inflation in Morocco, over the period 2004-2018, by using Structural Vector Autoregression (SVAR) model on monthly data. Several interesting results are found from this study. First, the impact of global food prices on domestic food inflation is shown significant, which reflects the large imported component in the domestic food consumption basket. Second, the transmission effect is found to vary across commodities. Consumer prices of cereals and oils significantly and positively respond to external price shocks, while those of dairy and beverages are weakly influenced. Third, there is evidence of asymmetries in the pass-through from world to domestic food prices, where external positive shocks generate a stronger local prices response than negative ones. This situation is indicative of policy and market distortions, namely the subsidies, price controls, and weak competitive market structures. Our findings suggest that food price movements should require much attention in monetary policymaking, especially that the country has taken preliminary steps towards the adoption of floating exchange rate and targeting inflation regimes.

Keywords: *Food commodity prices, Food inflation, SVAR model, Asymmetry, Morocco, Cereals, Vegetable oils, Dairy, Beverages.*

1. Introduction

In Morocco, food inflation is the main driving of headline inflation due to the large weight of food (around 38%[1]) in the household consumption basket. In fact, it is being all the time much higher than overall inflation, and its movements raise concern about their link with global food price shocks. This was particularly revealed over the 2008 food crisis, when Morocco's consumer price index for food and for each of cereals and oils[2] was highly increased following the surge in world prices (see Figure A2 in Appendix 3). In addition, the domestic food consumption basket has a great imported component. In 2016[3], Morocco was in top 10 largest importing countries of wheat, barley, soybean oil and tea, and in top 20 regarding the import of maize, maize oil, and raw centrifugal sugar (see Table 1 in Section 3). Therefore, it is claimed that external prices could play a key role in food consumer price fluctuation.

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[1] According to the national statistics office.
[2] Oilseeds and vegetable oils.
[3] The last year of the available data.

The food price booms occurred in 2007-2008 and 2010-2011 have mainly driven by prices of cereals and oilseeds products. These commodities account together a share larger than two thirds in the world food price index. Abbott and Borot de Battisti (2011) highlight that soaring world commodity prices are mainly related to competition for grains and oilseeds as food against fuel, supply, currency changes, and speculation in commodities. 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 labour and capital input to adjust to relative price changes. As for price decreases, a reversal is generally expected. The effects should be much important in low-income net importing countries, such as Morocco. As food heavily weighs in the private household consumption basket, accelerating prices can lead to rising poverty and social instability. 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. Otherwise, Salvatore (2018) suggests that boosting growth and reducing high unemployment and poverty could be useful measures for mitigating social and political instability.

In order to rehabilitate the agricultural sector, Morocco launched, in 2008, an agricultural strategy named the Green Morocco Plan. Through a new wave of private investment, the plan aims to make the agricultural sector more competitive, more suitable to market rules, and has a high value-added. It also aims to offer, under an anti-poverty approach, a solidarity support to small and medium-sized agriculture, and significantly improve in the income of the most vulnerable farmers.

To protect the consumers' purchasing power for staple foods against prices shocks in the global market, the domestic prices of soft wheat and sugar are subsidized. Moreover, several interventions are put in place for the politically sensitive wheat/bread value chain (production, storage, transport, etc.). Otherwise, in order to promote the oilseeds sector, the government signed, in 2012, a contract program with the Inter-professional Federation of Oilseeds for the period from 2013 to 2020. Under this program, subsidies are offered to the storage and the acquisition of agricultural materials of production, a premium is provided to bulk selling, and a guaranteed minimum producer price is imposed (see Jackson *et al.*, 2014).

Several studies suggest that, in developing economies, food commodity prices changes should be included in the monetary policymaking due to their large share in the domestic consumption (e.g., Furceri *et al.*, 2016; Durevall *et al.*, 2013; Walsh, 2011). In Morocco, the central bank's monetary policy consists in an exchange rate anchor vis-à-vis a composite basket comprising the euro and the U.S. dollar. In the aim to move to the floating exchange rate regime, the country initiated, in January 2018, preliminary step to more flexible exchange rate. Meanwhile, targeting inflation strategy is under preparation. Unfortunately, there is lack of studies focused on the issue of imported food inflation despite the country's high dependency on food imports.

Our paper makes four new contributions to the literature. First, to the best of our knowledge, this is the first paper that addressed and deepened the imparted food inflation issue in Morocco. Second, it provides much more in-depth investigation of food price pass-through than these made in the previous studies including Morocco in their panel of countries, such as Belke and Dreger (2015) and Ianchovichina *et al.* (2014). Indeed, our study takes into account the country's specific characteristics by distinguishing the price pass-through across the main imported food products. This could be an important input for national regulatory authorities because the country's import dependency is high for some food items, while it is low for some others. Third, we model several departures from the linear transmission pattern by using asymmetry and volatility measures. Four, this study uses recent data incorporating the global food price spikes occurred in 2007-2008 and 2010-2011, and the 2016 Morocco's drought.

The remainder of the paper is structured as follows. Section 2 gives a brief review of the empirical literature. Section 3 provides an overview of agricultural and food sector in Morocco. Section 4 presents the data and used methodology. A discussion of the results is carried out in

Section 5. Finally, Section 6 concludes the paper with some relevant policy implications.

2. Empirical review

The transmission effect from the global food prices to domestic prices has been less investigated until the spike in 2007-2008, while the pass-through of oil price changes to domestic prices has attracted much attention since the first oil price shock in the 1970s. The issue of food prices volatility is becoming more and more intersting due to the rise of global food consumption during the recent years and the expectations that the corresponding increasing trend will continue in the future (Gouel and Guimbard, 2019).

In Euro area framework, Porqueddu and Venditti (2014) examine the impact of world commodity price shocks on food inflation in Germany, France, and Italy as well as in the euro area. The authors show that the effects are heterogeneous across economies and food products, while there is little evidence of asymmetries. Ferrucci *et al.* (2012) analyse the transmission from upstream to downstream prices of food commodities in the euro area. They highlight important differences in the structure of price pass-through for the various food items. They also conclude that asymmetries are significant, where positive shocks generate a stronger response than negative ones. As a consequence, they suggest that putting the common agricultural policy in Europe into the picture is the key to a better understanding of food prices pass-through. Davidson *et al.* (2016) find that UK food inflation has an important long-term elasticity to the global food prices, exchange rate and oil prices, and low responses to domestic demand pressures and food chain costs.

The global food prices pass-through was also studied in the Latin American economies framework. For instance, Jalil and Esteban (2011) examine how world food price shocks affect inflation in Brazil, Chile, Colombia, Mexico, and Peru. They find that an external price shock significantly transmits to domestic inflation, through both food and core prices, after a period varying from one to six quarters depending on the country.

In the context of Asian countries, Jongwanich and Park (2011) argue that global oil and food prices transmission to domestic inflation has been limited, and they attribute this conclusion to the public subsidies and price controls. Liu and Tsang (2008) analyse the transmission of commodity price shocks to China's consumer prices by taking into consideration their effects on domestic producer prices. They show that an increasing of 10% in world commodity prices would raises China's producer prices by 1.2% in 3 months later, which in turn increases inflation by 0.24% during the same period. Khan and Ahmed (2014) reveal that, by using data for the period from 1990 to 2011, Pakistan's inflation was significantly affected by oil and food price shocks. Bobokhonov *et al.* (2017) argue, by employing vector error correction model, that the cointegration between global and domestic food prices in Tajikistan is strong, whereas it is not significant in Uzbekistan.

In a mixed panel of developed, emerging, and developing countries, Furceri *et al.* (2016) analyse the world food prices pass-through to domestic inflation in two periods, namely 1960-1999 and 2000-2013. They argue that world food price shocks have significant effect on inflation in advanced economies, but the impact declines over time. Nevertheless, the 2000s global food price shocks have more important effect on inflation in emerging and developing economies than in developed economies.

The pass-through from the upstream to downstream food prices in African economies also attracted much attention. For instance, Ianchovichina *et al.* (2014) assess the global food prices pass-through to food inflation in 18 Arab countries, including Morocco, for the period from 2000 to 2011. They find that international food price movements passed-through to various degrees into domestic food prices, and the transmission is mostly asymmetric. Belke and Dreger (2015) examine, by using quarterly data from 1990 to 2011, the impact of global oil and food price shocks on inflation in Morocco, Tunisia, Algeria, Egypt, and Jordan. They find, in most countries, including Morocco, that food price shocks most explain domestic inflation than those of oil price. In Morocco framework, El-Karimi and El-Ghini (2020a) use the Breitung and Candelon (2006) causality test to examine the effect of global oil and food price changes on domestic inflation over the period from 1998 to 2018. They conclude that there are significant transmission effects from oil and food prices to domestic inflation, and these inflationary effects exhibit asymmetries. In the context of Sub-Saharan Africa, Ackello-Ogutu (2011) point out that inelastic supply, exacerbated by market imperfections and poor distribution networks, increases the vulnerability to external commodity price shocks.

The issue of food inflation response to world commodity prices shocks has also been analysed in the framework of individual African countries. For example, Al-Shawarby and Selim (2013) examine whether external food price shocks were behind the frequent spikes in overall and food inflation in Egypt. They display that world food prices have important short-run effects, mostly asymmetric, on food inflation, and only low impact on headline and core inflation. Misati *et al.* (2013) find, by studying Kenya's data for the period from 1996 to 2011, that the effect of world food prices is more important than that of oil prices in explaining inflation. Bleaney *et al.* (2020) show that the monetary policy and food prices were not behalf the gap between the observed and target inflation levels in Ghana, but the gap was probably due to weak institutions. Bangara and Dunne (2018) examine the macroeconomic effects of commodity price shocks in Malawi over the period from 1980 to 2012. By adopting SVAR approach, the authors conclude that a positive tobacco price shock has a significant positive impact on Malawian gross domestic product, decreasing consumer prices and inducing real exchange rate appreciation. Durevall *et al*. (2013) show that changes in global food and goods prices determined the long-run evolution of consumer prices in Ethiopia. They also conclude that in the short run, agricultural supply shocks caused large deviations of food inflation from long-run price trends.

3. Agriculture and food sector in Morocco

The domestic agricultural sector constitutes a large part of Morocco's GDP, as it has oscillated, according to the World Bank, between 11% and 14% over the period 2000-2018. The sector is the largest employer of the country's workforce (40% of employment), and accounts over 10% of total good exports.

3.1. *Production and trade*

The composition of Morocco's agricultural food production and trade is reported in Table A1 in Appendix 2. In addition, a comparison of productions in 2016 and 2017 is displayed in Figure A1 in Appendix 1. We begin with the analysis of the country's agricultural production. The local cereals harvest, over 2016, 2017, and 2018,[4] was evaluated at 3.6, 9.8, and 10.3 million tonnes, respectively. We can note that it was substantially affected by the 2016 drought. Otherwise, the cereals storage infrastructures, mainly concern soft wheat, reached only a capacity of 4.9 million tonnes in 2018.[5] The gap in storage capacity, assessed to about half of local crops, makes domestic cereals prices more vulnerable to external prices shocks and supply variations. As for the fruits production, it mainly consists of citrus fruits which accounts 42% of the total crops, succeeded by melons (11%), watermelons (9%), and apples (8%). Vegetables crops are primary tomatoes, amounting a third of the total production, followed by dry onions (19%), and carrots and turnips (11%). The production of primary sugar is mostly composed of sugar beet with a share of 91%. Some other agricultural commodities, such as milk, potatoes, olives, olive oil, and chicken, are also much produced, but with quantities lower than those of the above-mentioned commodities.

The country's agricultural commodities exports are primarily shared between three items, namely citrus fruits, tomatoes, and sugar refined, with quantities up to 607, 525, and 351 thousand tonnes, respectively. These are

[4] According to the National Inter-professional Office for Cereals and Pulses, called ONICL, http://www.onicl.org.ma/.
[5] As declared by ONICL.

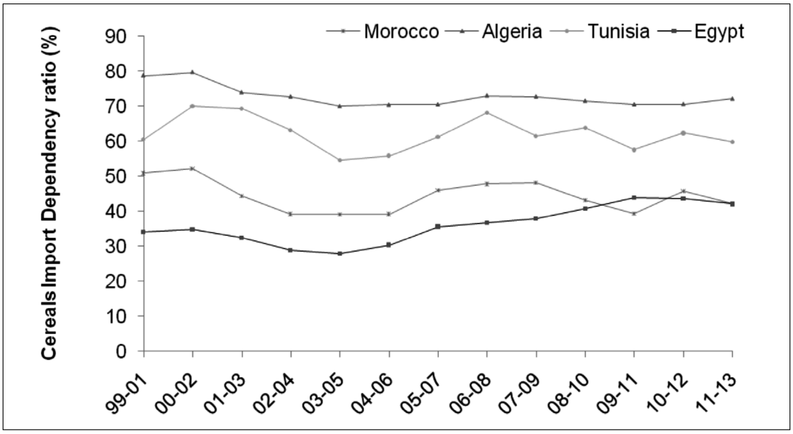


Figure 1 - Cereals import dependency (3-year average) in Morocco, Algeria, Tunisia, and Egypt. *Source: by authors based on data from FAOSTAT database.*

succeeded by olives, potatoes, and olive oils with export quantities equal to 90.5, 46.3, and 26.2 thousand tonnes, respectively. As for food commodities imports, cereals and raw centrifugal sugar are top imported items with import quantities amount to 9.3 and 1.1 million tonnes, respectively. At a second level, vegetable oils import quantity accounts for about 622 thousand tonnes (73% are soybean oils), followed by fruits imports with 148 thousand tonnes (47% are dates). In addition, the country is a net importer of stimulant beverages, importing up to 113 thousand tonnes, primarily composed of tea. Oilseeds are also highly imported where soybeans import quantity was evaluated at 90 thousand tonnes.

Table 1 displays the evolution of Morocco's major food imports between 2004 and 2016. The country was, in 2016, top 10 largest importing countries of wheat, barley, soybean oil, tea, and products of natural milk constitutes. From 2004 to 2016, wheat and barley import quantities are multiplied nearly by 2.5 and 5 to be world ranked 7th and 9th, respectively. Soybean oil and tea imports stagnate at world rankings 5th and 7th, respectively. Morocco was also top 20 major importing countries of maize, maize oil, raw centrifugal sugar, butter, and coffee (husks and skins). We can note that maize oil imports were exponentially grown from 1.6 to 16 thousand tonnes to be world ranked 17th in 2016. Sunflower oil imports have also soared from 10 tonnes to 52 thousand tonnes because the country has moved to import vegetable oils rather than seeds.

Some indicators highlight a considerable vulnerability of food security in Morocco. For instance, the annual average of Morocco's cereals import dependency ratio[6] between 1999 and 2013 is 44%. As displayed in Figure 1, it is better than those of Algeria and Tunisia, but poor with regard to this of Egypt (36%) which has only a wheat area of 1.34 million hectares versus 3 million hectares in Morocco. Furthermore, according to the 2018 Global Food Policy Report,[7] the Morocco's global food security index[8] was ranked, in 2016, 62nd of 113 countries. It was better than this of Algeria (66th) but less than those of Tunisia (53th) and Egypt (58th).

Based on all presented data, the efficiency of

[6] The ratio of cereals imports over cereals consumption.

[7] Nin-Pratt A., El-Enbaby H., Figueroa J.L., El Didi H., and Breisinger C., 2018. *Agriculture and economic transformation in the Middle East and North Africa: A review of the past with lessons for the future*. International Food Policy Research Institute (IFPRI).

[8] Combines the indices of affordability, availability as well as quality and safety of food. Affordability reflects the ability of consumers to purchase food, their vulnerability to price shocks, and the presence of policies protecting them from food shocks. Availability represents the domestic food supply sufficiency, the supply disruption risk, food capacity distribution, and efforts to expand agricultural output. Quality and safety depict the variety and nutritional quality measures of average diets, and the safety of food.

Table 1 - World ranking of Morocco's major food imports. Comparison: 2004 vs. 2016.[9]

	2004		*2016*	
Food product	*Import (1000 tonnes)*	*World ranking*	*Import (1000 tonnes)*	*World ranking*
Cereals	**4077**		**9308**	
Wheat	2646	14	6288	7
Maize	1223	17	2029	20
Barley	200	>20	977	9
Vegetable oils	**395**		**622**	
Soybean oil	335	5	452	5
Maize oil	1,6	>20	16	17
Sunflower oil	<0,1	>20	52	>20
Palm oil	22	>20	40	>20
Dairy	**50**		**62**	
Milk (total)	13,4	>20	22	>20
Products of natural milk constituents	<0,1	>20	17	9
Butter (crow milk)	31	11	24	13
Cheese (whole cow milk)	6	>20	15,8	>20
Stimulant beverages	**79**		**113**	
Tea	46	7	67	7
Cocoa	2,8	>20	6,4	>20
Coffee (total)	30	>20	40	>20
Coffee (husks and skins)	<0,1 (7 tonnes)	12	<0,1 (54 tonnes)	12
Sugar	**605**		**1066**	
Sugar (raw centrifugal)	593	13	1059	12

Source: by authors based on data from FAOSTAT database.

the Green Morocco Plan, agricultural strategy launched in 2008, could be called into question. For example, Akesbi (2012) advanced three main criticisms that invite to rethink this agricultural strategy. The first concerns the relevance of the measures recommended by the plan-based study. The second emphasizes that the Green Morocco Plan much promotes large-sized farms to the detriment of small-sized farms whose constitute a large share. The third addresses the production promotion at the expense of the environment and natural resources. Akesbi (2012) even notes that the food security protection does not really seem taken into consideration in the choices made at production levels.

3.2. *Food price policy in Morocco*

Food products constitute a share of 38% in the consumption basket in Morocco. As a result, the High Commission for Planning (HCP) has often explained in its reports[10] on the consumer price index that an important part of general price level movements is due to food price changes. For instance, the HCP announced that a drop of the consumer price index by 0.2% from August to September 2019 would be due to a decrease of 1% in food consumer price index. Before, it also announced that consumer price index rose by 0.3% between in July and August due to the increase of the food consumer price index by 0.7%.

[9] The last year of the available data.
[10] Published on www.hcp.ma.

Morocco's government sets up a number of price policy measures related to food products. To maintain low consumer prices of flour and bread that are considered as the most consumed food products, the government administrates the price of soft wheat. In this context, a reference was fixed for local wheat prices in 2018 at 2800 Moroccan Dirham per tonne. Moreover, diverse wheat classes are subject to import taxes. In fact, wheat imports are not subject to simple ad valorem tax but to double ad valorem tax that takes into account the CIF[11] prices and the reference prices targeted on the national market. However, when world prices exceeded local producer prices of cereals in 2008, the country temporarily abandoned tariffs and allowed local producer price of cereals to rise in the same way as on the global market. As for the consumer prices of oilseeds products, the government ceased their administration in 2000, and then they become liberalized. Moreover, the government removed tariffs on imports of oilseeds and their products that come from the US. This policy measure makes local prices of oilseeds products more exposed to external price changes. However, the government only imposes a simple guaranteed minimum producer price ranging between 4000 and 5000 MAD per tonne.

Given that Morocco has large import dependency on wheat and sugar, their prices are subsidised through the ONICL and Compensation Fund[12], respectively. The existent subsidy system was principally implemented to mitigate the world price shocks pass-through to consumer prices.

Under the 1996 liberalization phase of several food prices in Morocco, the price subsidies of imported soft wheat was removed, but wheat imports were subjected to an administered pricing mechanism in order to protect local production. In 2007, due to the sharp increase of world wheat prices, and the need to satisfy the increasing demand for bread, the government subsidized again imported soft wheat once its price exceeds the target price. In addition, a set of support measures has been implemented for wheat at the production and value chain levels. For instance, in 2018, Morocco's government set up a reference selling price of local wheat, fixed at 2800 Moroccan Dirham (MAD) per tonne, and also allocates a storage premium.

The local and imported sugar is a subject of lump-sum subsidy mechanism since the 1996 food prices liberalization. In 1999, the government imposed on industries using sugar as input in their production process, such as biscuit, chocolate, soft drinks, etc., to refund the lump-sum subsidy. However, the refund was abandoned in 2006, except for soft drinks industry. In 2006 the government provided an additional subsidy to the imported sugar once its price exceeds the price target. In 2010, sugar exports have been subject to a refund of the allocated subsidy. For more details about the price subsidies of wheat and sugar, see Verme and El-Massnaoui (2017).

At the same time as protection measures are implemented for soft wheat flour and sugar at the value chain and price levels, local oilseeds did not receive significant supports. Their subsidy system has been removed in 2000, and their guaranteed minimum producer prices have also ceased in 1996 and then re-introduced at a much lower level in 2003. Moreover, in 2006, Morocco implemented a bilateral free trade agreement (FTA), which includes oilseeds and vegetables oils, with the U.S. As a consequence, local oilseeds production has substantially declined due to its weak competitiveness (e.g., Jackson *et al.*, 2014). In 2012, the government signed a contract program with the Inter-professional Federation of Oilseeds[13] for the period 2013-2020, implementing four support measures for local oilseeds: first, subsiding acquisition of agricultural materials devoted to oilseed production; second, providing a premium on bulk selling; third, allocating a 10 percent subsidy of storage unit investment costs; four, imposing guaranteed minimum producer price in a range between 4000 and 5000 MAD per tonne (see Jackson, 2014). However, as displayed in Table 1 and

[11] Cost, insurance and freight.
[12] http://cdc.gov.ma.
[13] It is a professional association composed of the key oilseed supply chain actors.

also in Table A1 in Appendix 2, it seems that the aforementioned measures have not practically reduced the country's import dependency on oilseeds and vegetable oils.

4. Data and methodology

In this section, we describe the data used in our aggregate and disaggregate food price analyses as well as the employed econometric model.

4.1. *Data description*

The raw data are organized, with respect to the estimated SVAR models, as follows. In the aggregate food price analysis, we estimate a SVAR model on monthly data from January 2004 to September 2018[14] for the following variables:

- Food Inflation[15] (FINF): Morocco's inflation of food CPI, the national statistics office (HCP[16]);
- Global Food Price (FP): the world food price index[17], the World Bank;
- Exchange Rate (ER): the nominal effective exchange rate (Moroccan Dirham per U.S. dollar), International Monetary Fund (IMF);
- Crude Oil Price (COP): Brent oil price per barrel in nominal USD, the World Bank.

In the disaggregate food price analysis, we are interested to the prices of four food categories: "bread and cereals", "oilseeds and vegetable oils", "milk, cheese, and butter", and "coffee, tea, and cocoa", which are briefly called in the next as cereals, oils, dairy, and beverages, respectively. Hence, we estimate four SVAR models on monthly data from January 2004 to February 2018[18] for the below variables:

SVAR for cereals

- Cereals Inflation (CINF): the CPI inflation for cereals, HCP;
- Cereals Price (CP): the world price index for cereals, the World Bank.
- SVAR for oils
- Oils Inflation (OINF): the CPI inflation for oilseeds and vegetable oils, HCP;
- Oils Price (OP): the world price index for oilseeds and vegetable oils, the World Bank.
- SVAR for dairy
- Dairy Inflation (DINF): the CPI inflation for dairy, HCP;
- Dairy Price (DP): the world price index for dairy, FAO.
- SVAR for beverages
- Beverages Inflation (BINF): the CPI inflation for stimulant beverages, HCP;
- Beverages Price (BP): the world price index for stimulant beverages, the World Bank.

All indices are based on U.S. dollar and base year 2010=100. The plots of all brut time series are presented in Figure A2 in Appendix 3. In the empirical analysis, all the series other than inflation ones are put in natural logarithm.

In order to examine the asymmetry and volatility of food inflation sub-component response to world food commodities prices, we estimate the above SVAR models with replacing each commodity's world price by its net increases, net decreases, and volatility.

According to Hamilton (1996), Net Cereals Price Increase (NCPI) and Net Cereals Price Decrease (NCPD) are derived by using the following formulas:

$$\mathrm{NCPI}_t = Max(0, \mathrm{CP}_t - Max(\mathrm{CP}_{t-1}, ..., \mathrm{CP}_{t-12})),$$
$$\mathrm{NCPD}_t = Min(0, \mathrm{CP}_t - Min(\mathrm{CP}_{t-1}, ..., \mathrm{CP}_{t-12})).$$

NCPI occurs if the current cereals price exceeds all those in the preceding 12 months. Similarly, NCPD occurs if the current cereals price is below than all those in the past 12 months. The same definition is adopted for Net Oils Price Increase (NOPI), Net Oils Price Decrease (NOPD), Net Dairy Price Increase (NDPI), Net

[14] The period is chosen to begin from January 2004 so that the study could be comparable with the disaggregate analysis.
[15] Using also non-food or core inflation will provide more insights, but they are not employed due to the unavailability of sufficient data.
[16] High Commission for Planning
[17] Consists of cereals with 28% share, and oilseeds and vegetable oils with 41% share.
[18] Chosen according to the data availability.

Dairy Price Decrease (NDPD), Net Beverages Price Increase (NBPI), and finally Net Beverages Price Decrease (NBPD).

According to Lee *et al.* (1995), Cereals Price Volatility Increase (CPV) is generated by firstly estimating the following GARCH (1, 1) model:

$$\mathrm{CP}_t = \beta_0 + \beta_1 \mathrm{CP}_{t-1} + e_t, \quad (\beta_0, \beta_1) \in IR^2$$
$$e_t = \varepsilon_t \sqrt{h_t}, \ \varepsilon_t \sim N(0,1),$$
$$\text{where } h_t = \alpha_0 + \alpha_1 e_{t-1}^2 + \alpha_2 h_{t-1}.$$

Secondly, CPV series is calculated as follows:

$$\mathrm{CPV}_t = \max\left(0, \frac{\hat{e}_t}{\sqrt{h_t}}\right), \text{ where } \hat{e}_t \text{ are residuals.}$$

A similar definition is assumed for Oils Price Volatility Increase (OPV), Dairy Price Volatility Increase (DPV), and Beverages Price Volatility Increase (BPV).

4.2. *Methodology*

The SVAR model estimation is equivalent to the problem of estimating a simultaneous equation model with covariance restrictions. These later make the model privileged compared to VAR model because they allow to take into account the relationship specificity between the variables. Let consider SVAR(p) model presented in Breitung *et al.* (2004):

$$\mathrm{A}X_t = \mathrm{A}_1 X_{t-1} + \mathrm{A}_2 X_{t-2} + \ldots + \mathrm{A}_p X_{t-p} + \mathrm{B}\varepsilon_t,$$
$$\varepsilon_t \sim iid(0_k, I_k), \qquad (1)$$

where X_t is a vector of k variables, A is a $k \times k$ invertible matrix of real parameters, A_i are $k \times k$ matrices capturing dynamic interactions between the k variables in X_t. ε_t is a $k \times 1$ vector of error terms, and B is $k \times k$ matrix of structural parameters representing the structural shocks effects. The term "$\mathrm{B}\varepsilon_t$" indicates that the autoregressive equation for each variable in X_t includes a linear combination of all variables innovations.

To explain X_t vector according to its lagged terms, a reduced form of Equation (1) can be obtained by pre-multiplying both sides with the inverse of A matrix (A^{-1}), and written as follows:

$$X_t = \mathrm{A}_1^* X_{t-1} + \mathrm{A}_2^* X_{t-2} + \ldots + \mathrm{A}_p^* X_{t-p} + \mu_t,$$
$$\mu_t \sim iid(0_k, \Sigma), \qquad (2)$$

where $\mathrm{A}_i^* = \mathrm{A}^{-1}\mathrm{A}_i$, and $\mu_t = \mathrm{A}^{-1}\mathrm{B}\varepsilon_t$.

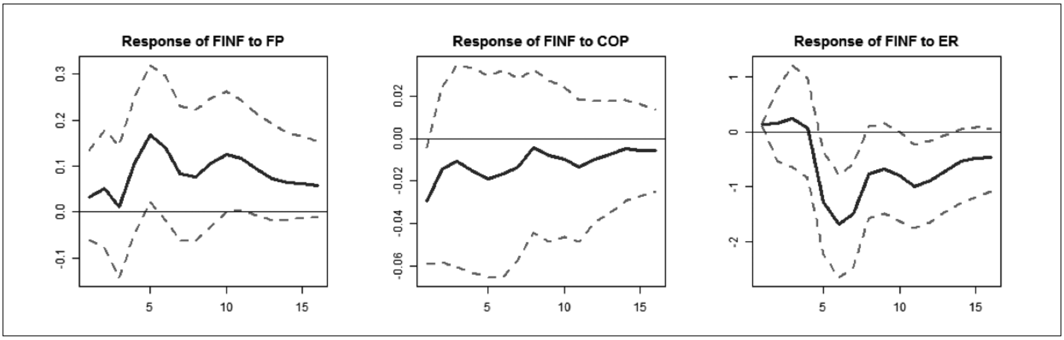
Before estimating the SVAR model by using economic data, it could be made compatible with the economic theory through introducing restrictions on the system parameters. For instance, if a shock in a certain variable in X_t vector does not practically impacts another variable; we can set the corresponding coefficient in B equal to 0.

At first, to set the variance–covariance matrix Σ of μ_t to an identity matrix, I_k, we assume that A is equal to I_k and B is a lower triangular matrix whose diagonal elements are ones. Next, we explain the restrictions incorporated through B matrix. In our empirical study, we lead a first analysis where X_t contains 4 variables and a second analysis where X_t comprises 2 variables. Let us begin by considering the first case where B can be written as follows:

$$B = \begin{pmatrix} 1 & 0 & 0 & 0 \\ b_{21} & 1 & 0 & 0 \\ b_{31} & b_{32} & 1 & 0 \\ b_{41} & b_{42} & b_{43} & 1 \end{pmatrix}.$$

According to the above formulation, we set a variables order as expressed in the following vector: $X_t = (\mathrm{COP}_t, \mathrm{FP}_t, \mathrm{ER}_t, \mathrm{FINF}_t)'$, where FINF_t is the variable of interest (the variable to be explained). The order reflects the following restrictions. The first row in B matrix means that world crude oil price, COP, is assumed to be affected only by its own previous shocks, highlighting its exogenous nature. The second row indicates that the global food price, FP, is considered to be contemporaneously affected by only its own innovations and those of COP. The third row implies that the exchange rate, ER, is explained by its own changes as well as those of COP and FP. Finally, the fourth row corresponding to the domestic food inflation, FINF, assumes that it is contemporaneously responsive to its own shocks and those of FP, COP, and ER. In fact, our restrictions made on the system parameters look like those assumed by Bhat *et al.* (2018).

Figure 2 - Impulse responses of food CPI inflation (FINF) to a unit standard deviation (SD) shock in FP, OP, and ER. The 95% confidence intervals (dashed lines) are calculated by using 1000 replications. The X-axis represents the months that follow the shock.



We turn now to the second analysis where X_t comprises 2 variables, namely, the world and domestic prices of a food item. In this case, B matrix is expressed as follows:

$$B = \begin{pmatrix} 1 & 0 \\ b_{21} & 1 \end{pmatrix}.$$

Therefore, the corresponding variables order is set as in the following vector X_t = (*commodity's world price at t, commodity inflation at t*)', where the commodity represents each of cereals, oils, dairy, and beverages. The only imposed restriction is that commodity's world price is not affected by shocks in commodity inflation. SVAR model with similar restriction matrix was also used by Porqueddu and Venditti (2014) and Ferrucci *et al.* (2012).

5. Empirical results

At first, we conduct an aggregate food price analysis by deriving the IRFs in an SVAR model including the domestic food inflation, world food price index, and also the crude oil price and exchange rate as additional variables. Second, we lead disaggregate food price analysis by generating the IRFs in four bivariate SVAR models concerning four food products, namely cereals, oils, dairy, and beverages. Each model includes the domestic inflation and world price of the food commodity. Furthermore, we examine asymmetric and volatility transmission effects by replacing world price level by its corresponding increase, decrease, and volatility measures.

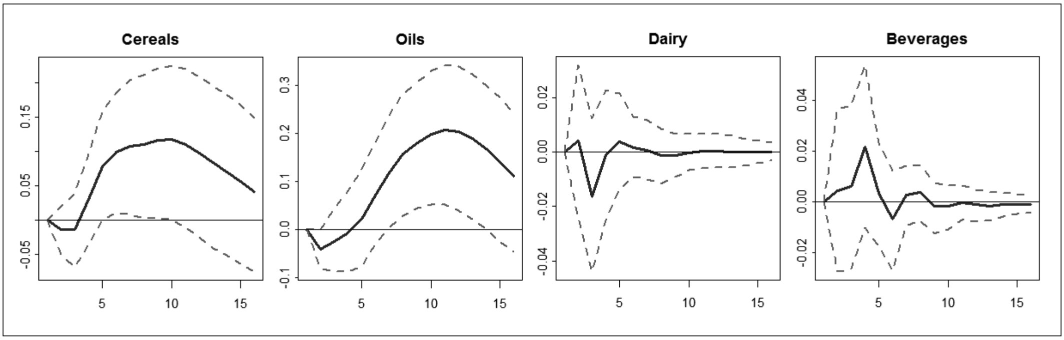
5.1. *Pass-through from world food prices to the aggregate food inflation*

We begin with examining the stationary properties of the data by using ADF unit root test and KPSS stationary test. The obtained results are reported in Table A2 in Appendix 4. FINF is found to be stationary at levels, I(0), while FP, COP, and ER are stationary at first differences, I(1). Next, the SVAR model is estimated with a lag order of p=5 selected according to the AIC criterion. The multivariate white noise assumption of the error vector is not rejected: the heteroscedasticity of residuals is examined by the multivariate ARCH-LM test and serial correlation is tested by Box-Pierce and Ljung-Box Portmanteau tests.19

Figure 2 reports the IRFs of aggregate food inflation. FINF is shown significantly affected by a shock in global food prices so that its response is positive and protracted. Specifically, the reaction of food inflation to a food price change is revealed temporary significant at first round within the 5th month after the shock. Thereafter, it becomes again significant at the 11th month, and dies out in the next months. FINF is found to be also signifi-

[19] The results are not reported, but are available from the authors upon request.

Figure 3 - Impulse responses of cereals, oils, dairy, and beverages prices inflation to a unit SD shock in world prices. The 95% confidence intervals (dashed lines) are calculated by using 5000 replications. The X-axis represents the months that follow the shock.



cantly affected by an exchange rate shock, where the effect is firstly positive and then becomes negative and lasts for around a year. Otherwise, the response of domestic food inflation to a shock in crude oil price seems to be statistically not significant at the 95% confidence level.

We also check the results' robustness by using the world food price index provided by the FAO[20] as an alternative to this of the World Bank. Both indices are similar, except that the FAO index shows higher peaks in 2008 and 2012. We found again similar empirical results.[21]

The results indicate that the dynamics of domestic food inflation is considerably influenced by global food price shocks. Higher food prices in the international market could lead to higher domestic food inflation. The exchange rate movements are also found to be a factor of food inflation. However, the later seems to be not affected by oil price changes.

Using aggregate price indices may hide the specificities of the price pass-through across food items. This limitation is emphasized by Ianchovichina *et al.* (2014) in the conclusion of their paper, as they write: "for a more in-depth understanding of pass-through effects, one would need to go beyond aggregate food price analysis, and estimate these effects by food commodity".

5.2. *Pass-through from world food commodities prices to the food inflation components*

In this sub-section, we analyse the transmission effect from global food commodities prices to domestic inflation sub-components, namely cereal, oils, dairy, and beverages. As reported in Table A2 in Appendix 4, we found that CINF and OINF are stationary at levels, I(0), while DINF,22 BINF, CP, OP, DP, and BP are stationary at first differences, I(1). The hypotheses of cointegration between DINF and DP, and between BINF and BP are analysed and found to be rejected.23 Finally, all asymmetry and volatility measures are found to be stationary at levels, I(0). Thereafter, the white noise assumption in all estimated SVAR models is not rejected.

5.2.1. *Baseline SVAR model*

The SVAR models for cereals and oils are estimated with p=6, while those for dairy and beverages are estimated with p=4. The IRFs of commodity inflation to an external price shock are presented in Figure 3. We begin by discussing the results for cereals and oils. The cereals inflation response following a shock in

[20] Since it is provided in base year 2002-2004, we rebased it to 2010 year basis.
[21] The results are not reported, but are available from the authors upon request.
[22] Before leading the stationarity analysis, we seasonally adjusted the DINF for the period from January 2003 to September 2009 by using the U.S. Census Bureau's X-13 procedure.
[23] The results are not reported, but are available from the authors upon request.

upstream prices begins to be significant in the 5th month and gradually increases to achieve a maximum in the 10th months, and then it dies out. Regarding the oils inflation response to a world price shock, it starts to be significant in the 6th month and rises to reach a maximum (larger than this of cereals) at around a year after the shock, and then the transmission effect appears to be completed in the 14th month.

The IRFs of dairy and beverages inflations to a world price shocks are shown to be no significant at the 95 percent confidence level. These findings could be partly due to the lower Morocco's import dependency on natural milk, and trade policy measures that concern tea (major imported beverage item).

The findings highlight a considerable heterogeneity across food products in the response to global commodity price shocks. The domestic prices of both cereals and oils are shown to be remarkably vulnerable to global prices shocks, while the opposite is displayed for domestic prices of dairy and beverages. Moreover, local oils prices are revealed to be more vulnerable to world prices changes, compared to local cereals prices. This could emphasize the large decline of local oilseeds sector started since the 2000s (see Jackson *et al.*, 2014), and also the fact that oils prices are not subject to subsidies contrarily to cereals prices. In conclusion, the imported food inflation previously identified in Sub-section 5.1 seems to be mainly carried out through cereals and oils markets rather than dairy and beverages markets.

Figure 4 - Impulse responses of the domestic inflation of cereals, oils, dairy, and beverages to net increase and net decrease shocks as well as volatility in world prices. The 95% confidence intervals (dashed lines) are calculated by using 5000 replications. The X-axis represents the months that follow the shock.

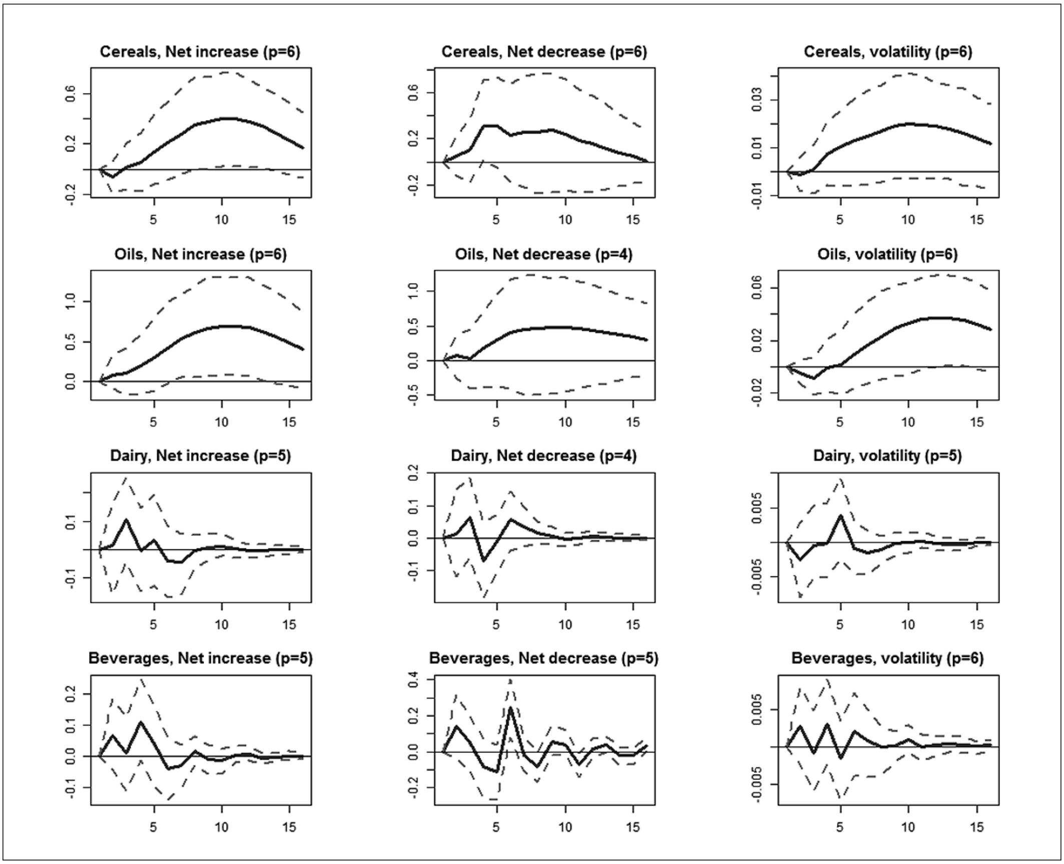


Table 2 - Variance decomposition of the food inflation sub-components in response to the different specifications of world price shocks.

Month	Cereals			Oils			Dairy			Beverages		
	NCPI	NCPD	CPV	NOPI	NOPD	OPV	NDPI	NDPD	DPV	NBPI	NBPD	BPV
4	0.14	1.99	<0.01	1.36	0.76	<0.01	1.04	0.83	<0.01	1.51	2.75	<0.01
8	2.77	3.60	0.01	11.81	6.68	0.01	1.43	1.23	<0.01	1.85	9.19	<0.01
12	7.47	4.61	0.02	26.12	11.35	0.03	1.45	1.24	<0.01	1.87	9.90	<0.01

Note: the values are expressed in percentage points.

5.2.2. *SVAR model of asymmetric price adjustment*

A number of studies has emphasized that world commodity price shocks could have asymmetric effects on domestic consumer prices (e.g., Belke and Dreger, 2015; Ianchovichina *et al.*, 2014; Ferrucci *et al.*, 2012). Regarding the question whether positive shocks generate more important responses than negative ones, we consider increases and decreases in each commodity's world price as separate variables. In the aim to generate these asymmetry measures, we use the formulations introduced by Hamilton (1996), as presented in Section 4.

Figure 4 reports the IRFs of Morocco's inflation of cereals, oils, dairy, and beverages to a net increase shock, net decrease shock, and volatility in global prices. The comparison shows evidence of asymmetric pass-through patterns from downstream to upstream prices. This particularly concerns cereals and oils. The IRFs of their domestic inflation to a positive shock in world prices start to be significant after half-year. Thereafter, the pass-through achieves a maximum at around the 10th month, and then it is completed after about a year. As for the IRFs of the domestic inflation of cereals and oils to a negative shock in their world prices, they are shown statistically no significant over all the time horizons. This indicates that decreases in the global prices of oils and cereals weakly affect their local prices. Regarding dairy and beverages, the IRFs of their downstream prices to a positive shock in the upstream prices are found to be much lower and no significant at the 95 percent confidence level. The same results are also obtained for the response of dairy and beverages inflation to a negative shock in upstream prices.

We turn now to the analysis of the volatility transmission from the world to the local food commodities prices. As displayed in the last column in Figure 4, the IRFs are shown no significant for all food items, even if they appear relatively more accentuated in the case of oils and cereals. As a consequence, the volatility in global food commodities prices seems to be weakly transmitted to food inflation sub-components.

In summary, the results gained from the analysis of asymmetric effects conclude that global cereals prices increases affect cereals inflation more heavily compared to global cereals prices decreases. The same result is obtained for oils commodities. This may indicate the existence of policy distortions, such as price controls, subsidies, and competitive market structures. Otherwise, dairy inflation and beverages inflation seem to respond similarly to world price increases and decreases. Finally, the price volatility in international commodity market does not appear to be considerably transmitted to the domestic inflation of each cereals, oils, dairy, and beverages.

5.2.3. *Forecast error variance decomposition results*

In order to assess the percentage of the variance in downstream prices due to each innovation in upstream prices, we lead forecast error variance decomposition (VDC). In Table 2, we mainly highlight the contribution of increases, decreases and volatility in world food commodities prices to the explanation of the food inflation sub-components. The results of VDC suggest that increases in global prices are more important than decreases in the explanation of oils and cereals inflation. During a year, upstream prices increases account for 26% of oils inflation variations, while they explain 7.5% of cereals inflation fluctuations. Along the same period, upstream prices decreases account for 11% of oils inflation innovations, and for 4.6% of cereals inflation changes. Otherwise, both increases and decreases in upstream prices do not constitute significant portions of domestic inflation variation for both dairy and beverages. Regarding word prices volatility, it seems to have negligible contribution in inflation movement for all food types.

In conclusion, global oils price hikes explain a greater share of oils inflation dynamics compared to global oils price decreases. Nearly similar result is obtained for cereals. As for dairy and beverages, global prices increases and decreases explain only small shares in the inflation of each commodity.

6. Conclusion

This paper investigates the transmission effects from world food commodities prices to Morocco's food inflation and its sub-components by leading the impulse response analysis in SVAR model. Our study highlights a number of interesting conclusions. First, the aggregate food price analysis shows that global food price shocks are significantly transmitted to food inflation.

Second, the disaggregate food price analysis emphasizes that the pass-through from the world to the domestic food prices vary across commodities. Indeed, cereals and oils price inflations are shown significantly affected by external price shocks, while dairy and beverages price inflations are weakly affected. Regarding cereals and oils, the results could be due to the country's high dependence on their imports, and also to inefficient agricultural policies. The world prices transmission is more accentuated for oils because, on one hand, their prices are not subsidized, and on the other hand, there is lack of local production. Otherwise, the weak beverages inflation response to upstream prices could be partly related to trade policy measures. As for dairy inflation, the results might be associated to low import dependency on milk.

Third, the analysis identifies asymmetric transmission from the upstream to the downstream prices for cereals and oils. Indeed, increases in world prices are significantly passed through to domestic prices, while declines are weakly transmitted. This situation is indicative of policy and market distortions, namely food subsidies and price controls, as well as weak competitive market structures. Nonetheless, identifying the underlying causes of the asymmetric price transmission process is complex and was not the main objective of this paper. The investigation of these causes could be a direction for future research.

Morocco's central bank aims to move towards targeting the inflation rate rather than the exchange rate. The first step was carried out by adopting a more flexible exchange rate from January 2018. In this conduct, it should be emphasized that the headline inflation in Morocco is substantially driven by food inflation as food constitutes a share of 38% in the consumption basket. At the same time, the country is still extremely dependent on food commodity imports, and the global food prices began to be remarkably volatile over the recent years. Thereby, the imported food inflation that is identified in this study, especially for cereals and oilseeds products, is heavily suggested to be taken into account by the inflation targeting policy.

A few implications of our study for economic agents and policy makers are worth mentioning. First, due to the country's high dependence on imported foods and their larger weight in domestic consumption, world food price changes should require special attention in monetary policymaking. In addition, it would be more relevant to distinguish between food products for modelling and evaluating the world commodities prices pass-through to domestic food inflation. It would be also preferred to differentiate between positive and negative external price shocks.

Second, to break the spiral of failure concerning the cereals production, and reduce the transmission from global to local cereals prices identified in this study, a reform program would be relevant. This may include, among others, diversification of production, appropriate strategies for small farmers, construction of silos for storage, and the exploitation of recent Morocco's renewable energy developements (e.g. El-Karimi and El-Ghini, 2020b) in the agricultural sector. Otherwise, given that supply chain cost for cereals imports amounts a large share in retail cereals prices due to poor logistics and infrastructure, improving the allocative efficiency could usefully reduce import prices.

Third, the domestic food prices vulnerability to external shocks identified in this paper could reflect the sharp increase of food imports to the detriment of food production. Thereby, it could be relevant to rethink the agricultural production policy implemented under the Green Morocco Plan. Particularly, the identified vulnerability of oils and oilseeds domestic prices to external shocks may reveal the negative effects of the US-Morocco FTA that has highly decreased the local oilseeds competitiveness (e.g. Jackson *et al.*, 2014). As a consequence, it would be crucial to reconsider the usefulness of the US-Morocco FTA.

References

Abbott P., Borot de Battisti A., 2011. Recent global food price shocks: Causes, consequences and lessons for African governments and donors. *Journal of African Economies*, 20(suppl. 1): i12-i62.

Ackello-Ogutu C., 2011. Managing food security implications of food price shocks in Africa. *Journal of African Economies*, 20(suppl. 1): i100-i141.

Akesbi N., 2012. Une nouvelle stratégie pour l'agriculture marocaine: Le Plan Maroc Vert. *New Medit*, 11(2), 12-23.

Al-Shawarby S., Selim H., 2013. Are International Food Price Spikes the Source of Egypt's High Inflation? In: *Financial Integration*. Berlin Heidelberg: Springer, pp. 61-83.

Bangara B.C., Dunne J.P., 2018. Macroeconomic Effects of Commodity Price Shocks in a Low-income Economy: The Case of Tobacco in Malawi. *South African Journal of Economics*, 86(1): 53-75.

Belke A., Dreger C., 2015. The transmission of oil and food prices to consumer prices. *International Economics and Economic Policy*, 12(1): 143-161.

Bhat J.A., Ganaie A.A., 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.

Bleaney M., Morozumi A., Mumuni Z., 2020. Inflation targeting and monetary policy in Ghana. *Journal of African Economies*, 29(2): 121-145. https://doi.org/10.1093/jae/ejz021.

Bobokhonov A., Pokrivcak J., Rajcaniova M., 2017. The impact of agricultural and trade policies on price transmission: The case of Tajikistan and Uzbekistan. *The Journal of International Trade & Economic Development*, 26(6): 677-692.

Breisinger C., Ecker O., Al Riffai P., 2011. *Economics of the Arab Awakening: From revolution to transformation and food security*. IFPRI Policy Brief 18, Washington.

Breitung J., Bruggemann R., Lutkepohl H., 2004. *Applied time series econometrics*. West Nyack, NY: Cambridge University Press.

Davidson J., Halunga A., Lloyd T., McCorriston S., Morgan W., 2016. World commodity prices and domestic retail food price inflation: some insights from the UK. *Journal of Agricultural Economics*, 67(3): 566-583.

Durevall D., Loening J.L., Birru Y.A., 2013. Inflation dynamics and food prices in Ethiopia. *Journal of Development Economics*, 104: 89-106.

El-Karimi M., El-Ghini A., 2020a. The Transmission of Global Commodity Prices to Consumer Prices in a Commodity Import-Dependent Country: Evidence from Morocco. *Scientific Annals of Economics and Business*, 67(1): 15-32.

El-Karimi M., El-Ghini A., 2020b. Renewable Energy Consumption-Economic Growth Nexus: Empirical Evidence from Morocco. In: *International Conference on Management Science and Engineering Management*. Cham: Springer, pp. 189-199.

Ferrucci G., Jimènez-Rodriguez R., 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.

Furceri D.P., Loungani P., Simon J., Wachter S.M., 2016. Global food prices and domestic inflation: some cross-country evidence. *Oxford Economic Papers*, 68(3): 665-687.

Gouel C., Guimbard H., 2019. Nutrition transition and the structure of global food demand. *American Journal of Agricultural Economics*, 101(2): 383-403.

Hamilton J.D., 1996. This is what happened to the oil price-macroeconomy relationship. *Journal of Monetary Economics*, 38(2): 215-220.

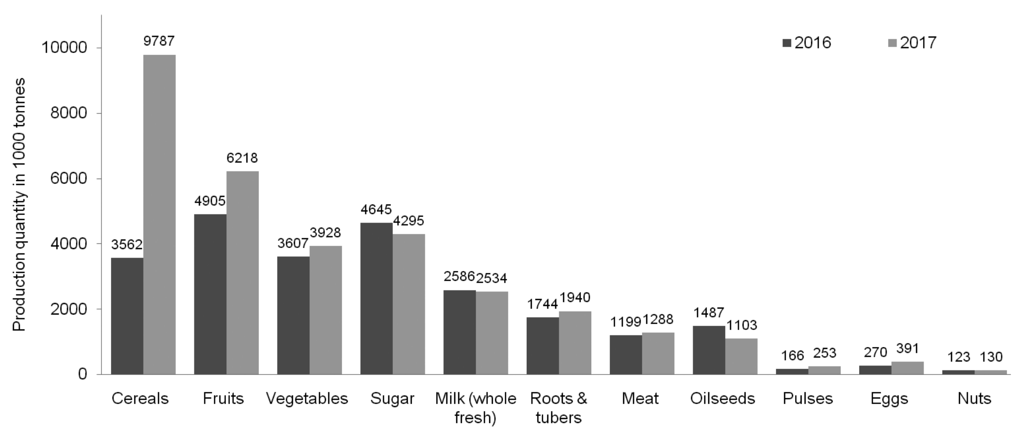
Helbling D.L., Mercer-Blackman V., Dao C.T.N., Erbil N., Oakes E., 2008. Is inflation back? commodity prices and inflation. In: International Monetary Fund, *World Economic Outlook Report*, pp. 83-128.

Holtemöller O., Mallick S., 2016. Global food prices and monetary policy in an emerging market econo-

my: The case of India. *Journal of Asian Economics*, 46: 56-70.
Ianchovichina E.I., Loening J.L., Wood C.A., 2014. How vulnerable are Arab countries to global food price shocks? *The Journal of Development Studies*, 50(9): 1302-1319.
Jackson D., Cherrou Y., Santos N., 2014. *Morocco: oilseeds sector review*. FAO Investment Centre. Country Highlights. Report no. 16. Rome: FAO.
Jalil M., Esteban T.Z., 2011. Pass-through of international food prices to domestic inflation during and after the great recession: evidence from a set of Latin American economies. *Revista Desarrollo y Sociedad*, 67: 135-179.
Jongwanich J., Park D., 2011. Inflation in developing Asia: pass-through from global food and oil price shocks. *Asian-Pacific Economic Literature*, 25: 79-92.
Khan M.A., Ahmed A., 2014. Revisiting the macroeconomic effects of oil and food price shocks to Pakistan economy: a structural vector autoregressive (SVAR) analysis. *OPEC Energy Review*, 38(2): 184-215.
Liu L., Tsang A., 2008. Pass-through Effects of Global Commodity Prices on China's Inflation: An Empirical Investigation. *China & World Economy*, 16(6): 22-34.
Misati R.N., Nyamongo E.M., Mwangi I., 2013. Commodity price shocks and inflation in a net oil-importing economy. *OPEC Energy Review*, 37(2): 125-148.
Porqueddu M., Venditti F., 2014. Do food commodity prices have asymmetric effects on euro-area inflation? *Studies in Nonlinear Dynamics & Econometrics*, 18(4): 419-443.
Salvatore D., 2018. Mediterranean challenge: Inclusive growth and sustainable development. *New Medit*, 17(3): 3-8.
Verme P., El-Massnaoui K., 2017. An Evaluation of the 2014 Subsidy Reforms in Morocco and a Simulation of Further Reforms. In: *The Quest for Subsidy Reforms in the Middle East and North Africa Region*. Cham: Springer, pp. 63-90.
Walsh M.J.P., 2011. *Reconsidering the role of food prices in inflation*. IMF Working Paper No. 11-71, International Monetary Fund.

Appendix 1

Figure A1 - Food commodity production in Morocco[24]. Comparison: 2016 vs. 2017.



Source: by authors based on data from FAOSTAT database.

[24] The data of dairy and vegetable oils production are not available.

Appendix 2

Table A1 - Production, import, and export of agricultural food commodities in Morocco in 2016[25]. Dairy and vegetable oils production are for 2014 because they are not available for the subsequent years.

Food product	*Production*		*Import*		*Export*	
	Quantity (1000 tonnes)	*The major food items*	*Quantity (1000 tonnes)*	*The major food items*	*Quantity (1000 tonnes)*	*The major food items*
Cereals	3561.6	Wheat (77%); Barley (17%)	9307.7	Wheat (68%); Maize (22%)	32.2	Flour wheat (67%)
Vegetables	3606.9	Tomatoes (34%); Dry onions (19%); Carrots and turnips (11%)	38.4	Garlic (29%); Green onions (22%); Tomato paste (21%)	928.4	Tomatoes (50%); Green beans (13%); Green chillies and peppers (10.5%)
Fruits	4904.9	Citrus fruits (42%); Melons; (11%); Watermelons (9%); Apples (8%)	148.4	Dates (47%); Pears (11%); Bananas (7.5%); Apples (6%)	743.4	Citrus fruits (82%); Prepared fruits nes (11%)
Sugar	4645.4	Sugar beet (91%); Sugar cane (9%)	1061.2	Raw centrifugal sugar (99.8%)	350.7	Sugar refined (100%)
Dairy	3541	Milk (98%); Cheese (1%). Butter (1%)	62.0	Butter (39%); Products of milk constituents (28%); Cheese (25.5%)	22.1	Cheese (75%); Milk (10.5%); Yoghurt (10%)
Roots & tubers	1743.6	Potatoes (100%)	69.6	Potatoes (100%)	46.3	Potatoes (100%)
Meat	1199.3	Chicken (51%); Cattle (21%); Sheep (13%)	12.8	Cattle (59%); Chicken (41%)	1.9	Chicken (46%)
Oilseeds	1487.4	Olives (95%); Groundnuts (2.4%); Sunflower seed (2%)	103.1	Soybeans (87%); Sesame seed (8%)	94.7	Olives (96%)
Vegetable oils	185.6	Olive oil (74%); Soybean oil (9.5%); Sunflower oil (9%)	621.8	Soybean oil (73%); Sunflower oil (8%); Palm oil (6.5%)	61.6	Olive oil (42%); Soybean oil (29%); Maize oil (24%)
Pulses	165.9	Lupins (37%); Chick peas (27%); Dry broad beans (16%)	56.7	Dry broad beans (50%); Lentils (34%)	9.8	Chick peas (73%); Dry beans (21%)
Nuts	123.3	Almonds (91%)	5.8	Walnuts (60%)	1.3	Almonds (46%)
Beverages	NA[26]	-	113.4	Tea (59%); Coffee (35%)	3.3	Coffee (69%); Tea (31%)
Eggs	269.5	Eggs	1.1	Eggs	1.4	Eggs

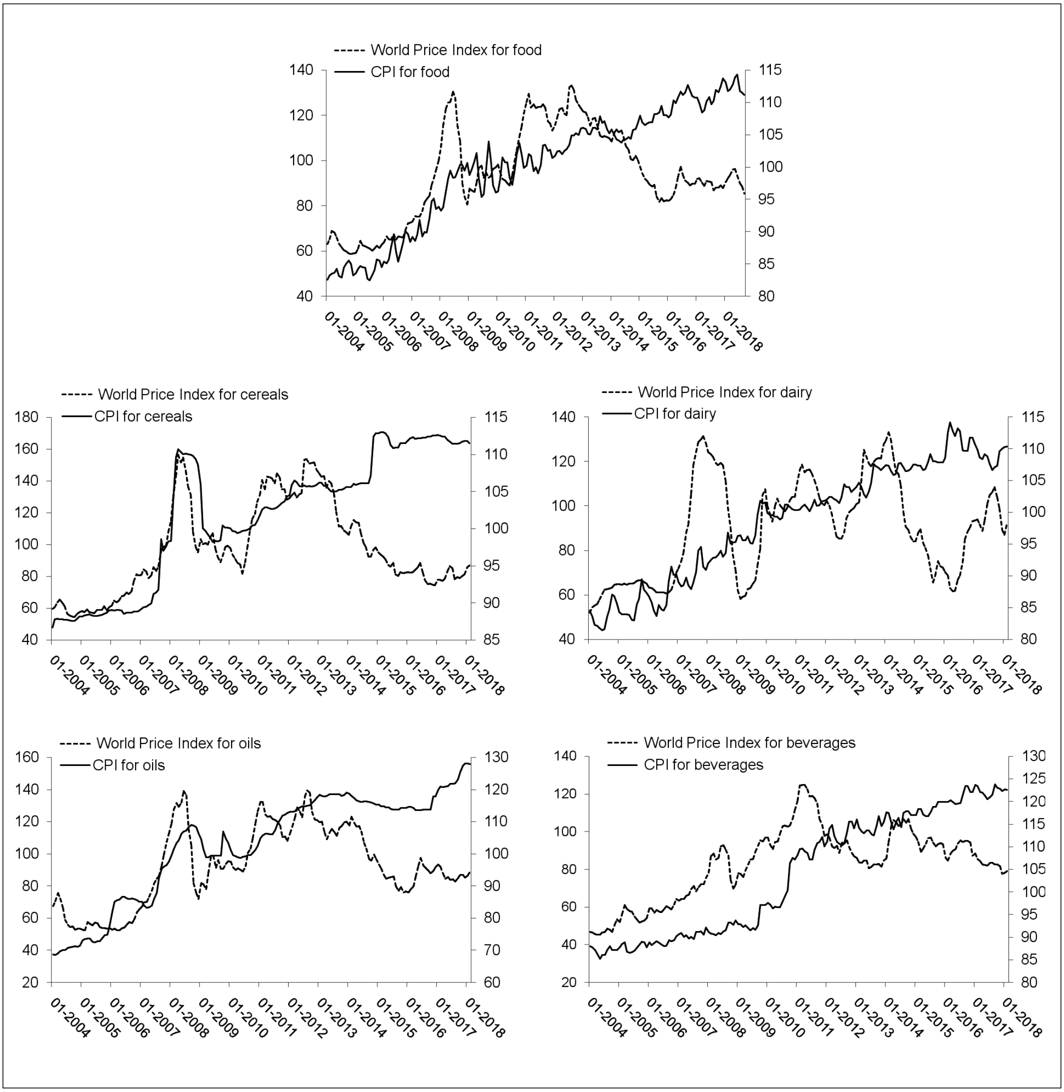
Source: by authors based on data from FAOSTAT database.

[25] Data of commodities trade are available only until 2016, and production data are reported for 2016 in order to carry out comparisons.

[26] The value is not available, but it is negligible because Morocco is a net importer of stimulant beverages (tea, coffee, and cocoa).

Appendix 3

Figure A2 - Time plots of the world price indices and Morocco's CPI for food, cereals, oils, dairy, and beverages. Right Y-axis is corresponding to the CPI values while left Y-axis is related to the World Price Index values.



Appendix 4

Table A2 - Stationarity analysis results. The lag orders used in the ADF test are in parentheses.

	Variable [a]	ADF test			KPSS test	Order
		None	Drift	Drift & trend	Level	
SVAR model for food	FINF	-2.420** (8)	-3.960*** (9)	-4.250*** (9)	0.200	I(0)
	ΔFP	--6.717*** (1)	-6.711*** (1)	-6.833*** (1)	0.317	I(0)
	ΔOP	-5.761*** (5)	-5.894*** (5)	-6.005*** (5)	0.226	I(0)
	ΔER	-5.227*** (3)	-5.286*** (3)	-5.512*** (3)	0.339	I(0)
SVAR model for cereals	CINF	-4.266*** (5)	-4.581*** (5)	-4.593*** (5)	0.062	I(0)
	ΔCP	-3.558*** (4)	-3.578*** (4)	-3.815** (4)	0.396	I(0)
SVAR model for oils	OINF	-3.068*** (2)	-3.684*** (2)	-4.321*** (5)	0.200	I(0)
	ΔOP	-4.471*** (4)	-4.491*** (4)	-4.627*** (4)	0.240	I(0)
SVAR model for dairy	ΔDINF	-9.930*** (2)	-9.900*** (2)	-9.884*** (2)	0.063	I(0)
	ΔDP	-4.518*** (5)	-4.553*** (5)	-4.598*** (5)	0.126	I(0)
SVAR model for beverages	ΔBINF	-12.534*** (1)	-12.497*** (1)	-12.486*** (1)	0.084	I(0)
	ΔBP	-3.318*** (3)	-3.447** (3)	-3.996*** (3)	0.502**	I(0)
Asymmetry and volatility measures	NCPI	-4.063*** (2)	-4.411*** (2)	-4.063*** (7)	0.449	I(0)
	NOPI	-3.917*** (2)	-4.235*** (2)	-4.228*** (2)	0.285	I(0)
	NDPI	-7.118*** (0)	-7.863*** (0)	-7.885 *** (0)	0.106	I(0)
	NBPI	-3.383*** (5)	-4.217*** (5)	-5.762*** (4)	0.338	I(0)
	NCPD	-3.127*** (7)	-8.399*** (0)	-8.588*** (0)	0.457	I(0)
	NOPD	-8.032*** (0)	-7.013*** (2)	-8.436*** (2)	0.096	I(0)
	NDPD	-3.300*** (6)	-3.825*** (6)	-3.806*** (6)	0.077	I(0)
	NBPD	-4.835*** (2)	-5.515*** (2)	-5.921*** (2)	0.500**	I(0)
	CPV	-2.131** (2)	-3.281** (1)	-3.409** (1)	0.509**	I(0)
	OPV	-2.981*** (3)	-4.038*** (3)	-4.088*** (3)	0.199	I(0)
	DPV	-2.910*** (1)	-4.254*** (8)	-4.248*** (8)	0.069	I(0)
	BPV	-2.184** (2)	3.599*** (2)	-4.597*** (2)	0.678**	I(0)

*The asterisks *** and ** denote significance at 1% and 5% level, respectively.*
[a] *For the variables explanations, see Data Sub-section 4.1.*