Agricultural Grain Markets in the COVID-19 Crisis, Insights From a GVARModel

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AGRICULTURAL GRAIN MARKETS IN THE COVID-19 CRISIS,
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Abstract

The objective of this paper is to combine cross-commodity and spatial price transmission analysis to study the dynamics of the global cereal feed market during the COVID-19 pandemic. After reviewing the nascent literature on the impact of COVID-19 on agricultural markets, we discuss the different impact channels on prices. Then we provide stylized market reactions of three relevant feed markets, wheat, barley and maize to a set of simulated possible future shocks on oil prices, stock-to-use ratios, and export restrictions. These three shocks are useful to assess what could be the consequences of policy responses to the COVID-19 (export restrictions) or disruptions due to the virus (stock-to-use reductions), in a context of lower oil prices. To generate these market reactions, we use a Global Vector Auto Regression (GVAR) model (Dees et al., 2007) where each market is modelled independently, and connected through trade based composite variables. We expand the work of Gutierrez et al. (2015) on the global wheat market by introducing maize and barley. The results of the empirical analysis indicate that the fall in the oil price may have contributed to the stability of the world grain market in early 2020, despite fears of supply chain disruption. We also note that export restrictions could significantly increase global prices, and that such restrictions could affect more than the targeted commodity, through significant cross-commodity price linkages.

Keywords: COVID-19, Feed markets, Global models
JEL Classification codes: G14, Q14, C12, C15.

1. Introduction

The COVID-19 pandemic generated a major economic shock in 2020. The crisis has affected most countries and most economic sectors, through the consequences of the necessary sanitary measures adopted by governments to contain the virus, and with a large potential impact on the global GDP and trade (IMF, 2020; Maliszewska, 2020). The crisis influenced food production, processing, distribution, and demand (Aday and Aday, 2020, Chenariedes et al., 2020), therefore affecting all dimensions of food security and warranting policy measures to maintain grain production and distribution (Laborde et al., 2020). However, despite numerous anticipated disruptions (Barichello, 2020), many agricultural markets have held up well (Deaton and Deaton, 2020; World Bank 2020). Panic buying is cooled and shifts in consumption habits arising from personal isolation were accommodated in the first half of 2020 (Kerr, 2020). However, at the time of writing, some concerns remain regarding the possible policy reactions if the pandemic was to last (Glauber et all, 2020), and the extent to which agricultural value chains would adapt (Morton, 2020).

In this paper, we look at the impact of the crisis on global grain markets. The global agricultural market in the first half of 2020 was hit by concerns over the supply chain disruptions and fears that some producing countries would decide to restrict their exports. These concerns came in the context of a major positive oil supply shock that sent crude prices to record low and the stocks to-use ratios to historically high levels for most grains and oilseeds (Baffes and Oymak, 2020).

Wheat, barley, and maize form a nexus of storable products, linked by their substitutability in both human and animal use. Their staple food status in most countries and their central role as input to the livestock sector make these grain products essential to global food security. We selected these three products for their large share of the global grain market and their inter-connectedness. The large number of concerned trade partners and the essential nature of these commodities also make them an important research topic. The global export market for wheat is now led by the Black Sea countries (Ukraine, Russia, and Kazakhstan), the European Union block, Canada, and the United States. Australia is also a major exporter, although with declining market shares since 2011. Barley is exported by the same group, although in lower volumes and with a smaller market share for the United States. Maize exports are dominated

by the United States, followed by Brazil and Argentina, but the Black Sea block has been building a presence on the global market since 2015.

To explore the effect of the potential impact of the COVID-19 on these three commodities, we start by reviewing the nascent literature on the issue, then we discuss the different impact channels on prices. We provide stylised market reactions of the global feed market (wheat, barley, and maize exports) to a set of simulated shocks on oil prices, stock-to-use ratio, and export. These market reactions are obtained through a multi-country time series modelling exercise. We use a Global Vector Auto Regression (GVAR) model (Dees et al., 2007) with each market modelled independently, and connected through trade based composite variables. We expand the work of Gutierrez et al. (2015) on the global wheat market by introducing maize and barley markets. Each market includes an export variable, a stock-to-use ratio variable, and the oil prices. These allow for simulating the impact of export restrictions, a reduction of stocks, and a negative oil price shock. These three shocks are useful to assess what could be the consequences of policy responses to the COVID-19 (export restrictions) or disruptions due to the virus (stock-to-use reductions), in a context of lower oil prices.

Section 2 of this paper reviews recent publications, section 3 discusses the impact channels, section 4 presents the GVAR model and discusses the results, and section 5 concludes.

2. Recent literature on agricultural markets and the COVID-19 pandemic

Limit to movements of the agricultural workforce, food stockpiling, panic buying, as well as cross-border and domestic restrictions have been identified as the main possible consequences of the virulent COVID-19 pandemic that can seriously affect the worldwide food supply chain (Espitia et al. 2020; Laborde et al, 2020a, 2020b; Torero 2020). Although only some of these disruptions were observed during the first half of 2020, and food prices did not appear to have been significantly affected, according to WHO (2020) daily reports, the COVID-19 outbreak was still accelerating in the first week of September 2020 at the global level. Therefore, it cannot be excluded that in the near future the same factors will negatively affect the food supply chain and the livelihoods of many farmers, inducing price spikes and increased price volatility. According to the International Trade Centre (ITC, 2020), 90 countries have introduced export prohibitions or restrictions as a result of the Covid-19 pandemic, and over three billion people in the world depend on international trade for food security. This situation raised significant concerns that the global health crisis caused by the COVID-19 epidemic could lead to a global

food crisis. If we focus on the cereals market, FAO (2020) reports that, in March 2020, Kazakhstan introduced export quotas on wheat and wheat flour, and an additional increase of the export quotas for both commodities were announced in April 2020. In March 2020, Ukraine introduced export restrictions for wheat until the end of marketing year 2019/20. Finally, Tajikistan introduced an export ban on all types of cereals. The purpose of these policies was to protect and insulate the domestic market from global market developments to avoid possible shortage of staple foods. However, they might have far-reaching impact at global level beyond their initial intended scope.

Export restrictions were also imposed during the 2007-08 and 2010-2011 food crises and according to some authors (Headey and Fan, 2010; Martin and Anderson, 2012; Giordani et al, 2016) they had a leading role in turning a critical situation into a worldwide crisis. For example, Giordani, Rocha and Ruta (2016) found that uncooperative trade policies alone were responsible for an increase in global food prices by 13 %, and Martin and Anderson (2012) reported that 30 % of the observed change of the international price of wheat in 2005-2008 had to be attributed to export restrictions.

However, the current 2020 situation seems different from the recent food crises, and global food markets appear less vulnerable than in 2007-08 and 2010-2011. In June 2020, world production levels of wheat, maize and barley were 3.2, 11.2 and 7.2%% above the average of the past three years (USDA, 2020). In the same period, global stocks of wheat were 17.0 % higher than the previous three years, with maize 25.5 % and barley 19 %. Domestic and foreign demands have grown at a slower pace than production, with only export of barley showing a contraction, -6.6%, see Table 1.

A second factor may have affected the food price dynamics in the first half of 2020. COVID-19 has strongly influenced the oil market. The sudden stop in economic activity and the breakdown of travel arising from lockdown measures with a reduced global fuel demand for transport (which accounts for two-thirds of global oil demand according to World Bank (2020)), as well as the uncertainty around production agreements among the oil producers, have caused one of the biggest decline of oil prices. World Bank "Pink Sheet" commodity prices show that WTI crude oil in April 2020 experienced the lowest quotation of the last twelve years with USD 16.52 per barrel. Since then, the oil markets were recovering but in June 2020, WTI oil price was still 30.0 % lower than the corresponding 2019 months and 79.5% with respect the average price of the previous three years.

Focusing on maize, wheat, and barley prices (Fig. 1), three of the most important cereal feeds,

quotations in June 2020 were lower than those of six months earlier due to favorable production conditions, small grow of global consumption, especially for wheat, and a good level of stocks (see Table 1).

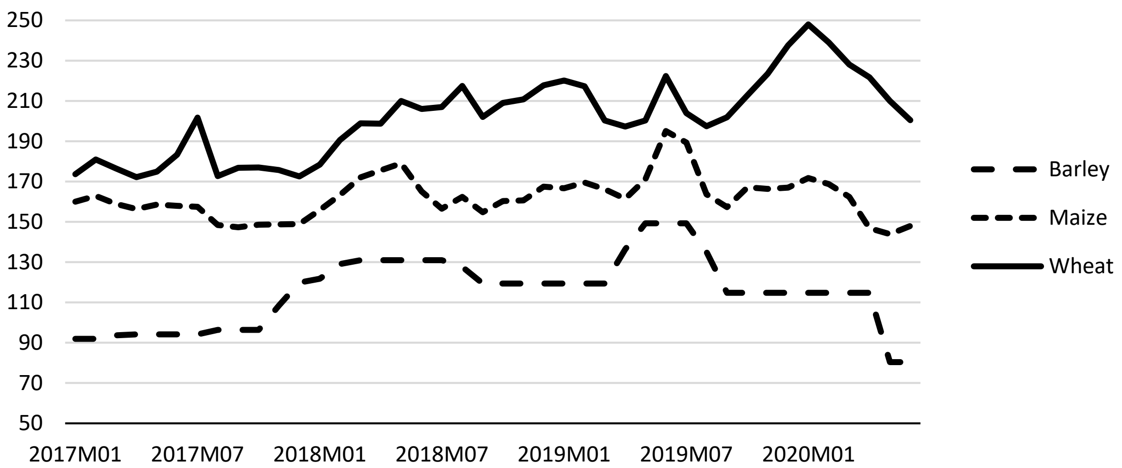


Figure 1 Wheat, Maize, Barley Commodity Prices ($/mt). Source: World Bank, the Pink Sheet

Table 1: World Production, Consumption, Exports and Ending Stocks for Wheat, Maize and Barley

	Production	Consumption	Exports	Ending stocks
Wheat				
Avg. 2017-2019	749 486	745 841	181 621	269 166
June 2020	773 434	753 185	187 491	314 840
Percentage change	3.20	0.98	3.23	16.97
Maize				
Avg. 2017-2019	1 068 754	1 093 282	157 952	269 166
June 2020	1 188 476	1 163 510	182 888	337 873
Percentage change	11.20	6.42	15.79	25.53
Barley				
Avg. 2017-2019	144 851	146 507	27 067	19 256
June 2020	155 259	154 114	25 288	22 920
Percentage change	7.19	5.19	-6.57	19.03

Source: USDA World Grain Markets and Trade, ‘000 tons

Nevertheless, concerns were raised about food security in the short-term (Glauber et al. 2020), due to the pandemic situation which is still accelerating at global level, and given the recent announcements of trade restrictions by key Black Sea country exporters and/or panic buying by some importers such as Egypt and Saudi Arabia for wheat. If such concerns were to spread, more adverse consequences of the pandemic might compound into a lower purchasing power

driven by unemployment, weaker access to credit and safety net mechanisms as well as the availability of food staples (Schmidhuber, Pound, and Qiao 2020).

In this environment, it seems relevant to investigate the impact of three main shocks on grain prices: (i) the implementation of new export restrictions in response to COVID-19 upsurge; (ii) The reduction of the stock-to-use ratios connected with a less favorable level of grain inventories and a stable demand, and (iii) new oil prices reduction, again connected with the COVID-19 spread. The simulation is obtained with a new global dynamic time series model that allows for the analysis of three relevant grain export markets, wheat, maize and barley.

4. Generalized Impulse Response Functions to COVID-19

4.1 A Global VAR model for the feed market

This subsection presents a Global VAR for the feed market. The GVAR is built on country specific vector error correction models (VEC). It connects country models through multiple channels of international linkages, uncovering the size and transmission speed of price shocks emanating from the global feed market. Introduced by Pesaran et al. (2004), it was updated and extended with a stronger theoretical background by Dees et al. (2007). There have been numerous application of the GVAR approach over the past decades, (among others di Mauro and Pesaran, 2013; Boschi et al., 2015). GVAR has also been applied to agri-food markets, with a focus on major wheat exporting countries (Gutierrez et al., 2015) and their sensitivity to El Nino effects (Gutierrez, 2017), then to assess regional price dynamics in African maize trade (Pierre & Kaminski, 2019). We follow a similar approach and proceed as follows.

Each country model combines a group of crop prices and domestic variables. The set is paired with exogenous variables accounting for the impact of global markets. Consider for the sake of simplicity the following structure VARX(2,2) structure applicable to *N* countries with *i = 0, 1, ..., N* :

$$x_{it} = a_{i0} + a_{i1}t + \Phi_{i1}x_{i,t-1} + \Phi_{i2}x_{i,t-2} + \Lambda_{i0}x^{\star}_{it} + \Lambda_{i1}x^{\star}_{i,t-1} + \Lambda_{i2}x^{\star}_{i,t-2} + \Psi_{i0}\omega_t + \Psi_{i1}\omega_{t-1} + \Psi_{i2}\omega_{t-2} + u_{it} \quad (1)$$

with a_{i0} a vector of constant country intercepts and a_{i1} a vector of coefficients of possible country specific deterministic time trends.

Equation (1) includes three different blocks of variables. The first building block is a set of domestic variables gathered in the x_{it} vector. Φ_{it} contains the associated temporal coefficients.

Domestic variables are the prices of wheat, maize, and barley, and the associated export and stock-to-use ratio estimates from the USDA. Domestic variables also include the food consumer price index and the US dollar exchange rate. Not all country models need to include all domestic variables. In the second block, $x_{it}^{\star}$ is a vector of foreign, weakly exogenous, variables with their vector of coefficients, Λ_{it}. They represent the influence of trade partners' markets on a given national market and are computed as $x_{it}^{\star} = \Sigma_{\mathrm{j=0}}^{\mathrm{N}} w_{ij} x_{jt}$, with $w_{ii} = 0$ and $j = 0,1,\dots,N$. The set of weights w_{ij}, is based on the relative size of the global market export share of country *j* from the perspective of country *i*. The relative weights are such that $\Sigma_{\mathrm{j=0}}^{\mathrm{N}} w_{ij} = 1$. Finally, in the third block, we assume that the international energy market is susceptible to influence all country models and the endogenous variables. Energy represents an important share of production costs, more than 30% of total expenditures for many cereals (Beckman et al., 2013), and can affect agricultural prices, with important implications for both consumers and farmers (see Myers et al, 2014; Gutierrez et al., 2015; Lundberg et al., 2020 among others). Hence, we include oil prices in all country models. Although this variable, ω_t, is common to all systems, it affects each domestic market to a different degree, as specified by the vector of associated autoregressive coefficients. The oil variable is endogenous in the US model.

Upon detection of cointegration, country models may be re-written with in the error correction form of the VARX(2,2):

$$\Delta x_{it} = c_{i0} - \alpha_i \beta_i' \left[z_{i,t-1} - \gamma_i (t-1) \right] + \Lambda_{i0} \Delta x_{it}^{*} + \Gamma_{\mathrm{i}} \Delta Z_{i,t-1} + u_{it} \tag{2}$$

where $z_{it} = (x_{it}', x_{it}'^{*})'$, α_i is a $k_i \times r_i$ matrix of adjustments parameters determining the speed of adjustment towards the long-run equilibrium and β_i is a $(k_i + k_i^{*}) \times r_i$ matrix of rank r_i containing the long-run relationships (cointegrating vectors) between local markets. Λ_i and Γ_{i} contain respectively the short-run responses to international and domestic variations. The rank of $\alpha\beta'$ allows one to determine the presence of cointegration. When $rank(\alpha\beta') = 0$, variables are not cointegrated, and the model becomes equivalent to a VARX in first differences

To solve for the GVAR, local and foreign variables are stacked in $z_{it} = (x_{it}, x_{it}^{*})'$ and a country model (equation 1) can be rewritten as:

$$G_{io} z_{it} = a_{i0} + a_{i1} t + G_{i1} z_{i,t-1} + G_{i2} z_{i,t-2} + \Psi_{i0} \omega_t + \Psi_{i1} \omega_{t-1} + \Psi_{i2} \omega_{t-2} + u_{it} \tag{3}$$

where $G_{io} = (I_{ki} - \Lambda_{i0}), G_{ij} = (\Psi_{ij}, \Lambda_{ij})$, for $j = 1,2$. We can then use all link vectors from matrix W_i, defined by the trade weights w_{ij}, to obtain the identity:

$$z_{it} = W_i x_t, \quad \forall i = 0,1,\dots,N \tag{4}$$

where $x_t = (x'_{0t}, x'_{1t}, \dots x'_{Nt})$ is the $k \times 1$ vector which collects all endogenous variables of the system, and W_i is a $(k_i + k_i^*) \times k$ matrix containing weights that will account for trade linkages. Therefore, all country-VARX equations modelled with (3) are connected to each other through identity (4), which yields a single country model of the form:

$$G_{i0} W_i x_t = a_{i0} + a_{i1} t + G_{i1} W_i X_{t-1} + G_{i2} W_i X_{t-2} + \Psi_{i0}\omega_t + \Psi_{i1}\omega_{t-1} + \Psi_{i2}\omega_{t-2} + u_{it} \tag{5}$$

for $i = 0,1,\dots,N$, and $G_{ij} W_i$ has dimensions $k_i \times k$. This country model is connected to all other country models of the GVAR through the weighted averages of the foreign variables (commodity prices) constructed in equation 4. This is the main channel for price chock propagation.

Finally, by stacking all seven country-specific models (5), we derive the Global VAR(2) model for all endogenous variables in the system, x_t:

$$G_0 x_t = a_0 + a_1 t + G_1 x_{t-1} + G_2 x_{t-2} + \Psi_{i0}\omega_t + \Psi_{i1}\omega_{t-1} + \Psi_{i2}\omega_{t-2} + u_t \tag{6}$$

For more details on obtaining the reduced form of the GVAR and on the estimation procedure, see Smith, L.V. and A. Galesi (2014). The GVAR Model (6) was estimated over the period March 2006 to May 2020.

In Table 2, we summarize the set of domestic, foreign and global variables included in the GVAR model for each of the export countries included in the analysis. The oil price is included in all models. Stock-to-use, exports, and foreign variables are included in country models when the price variables are also present. The CPI is included everywhere except in the Black Sea model that is a combination of three economies. The exchange rate with USD is included everywhere except in the USA model.

Table 2: Model structure

		ARG	AUS	BRA	CAN	EU	RUK	USA
Domestic variables	Wheat Price	1	1		1	1	1	1
	Maize Price	1		1	1	1		1
	Barley Price		1		1	1	1	1
	CPI	1	1	1	1	1		1
	Exchange Rate	1	1	1	1	1		
	Wheat stock-to-use	1	1		1	1	1	1
	Maize stock-to-use	1		1	1	1		1
	Barley stock-to-use		1		1	1	1	1
	Wheat exports	1	1		1	1	1	1
	Maize exports	1		1	1	1		1
	Barley exports		1		1	1	1	1
Foreign variables[1]	Wheat Price	1	1		1	1	1	1
	Maize Price	1		1	1	1		1
	Barley Price		1		1	1	1	1
Global var.	Oil	1	1	1	1	1	1	2

Note: 1: variable included in the country model. 2: oil is treated as endogenous in the US model.

The monthly commodity prices used in the analysis are obtained from the FAO/FPMA dataset, the IGC, and the European Commission's Grain Market Observatory. The stock-to use ratio and export variables are the monthly update USDA forecasts of the stocks and export for the marketing year. The CPI is sourced from the OECD database, the exchange rate from the IMF and the oil price from the World Bank's pink sheet. Using the total average annual export volume per country between 2006 and 2018, the trade weight matrix is built from the UN Comtrade data (Table 3). It represents the relative share of exports of trade partners (in rows) faced by each country in the model (in columns). Each column sums to 100%. Each row indicates the relative importance of each country for their trade partners. For wheat, Australia is the lead exporter, with the USA and the Black Sea countries generally being the next largest competitors for the other exporters. For maize, the USA and Brazil are the dominant players.

[1] The small country hypothesis is a requirement of the GVAR framework and implies that no single country should be able to affect global and foreign variables. Trade flows are by nature endogenous to prices equations but the foreign variables, product of weighted averages, are tested for weak exogeneity for countries where cointegration has not been ruled out. Test statistics, suggest that all foreign and global variables are weakly exogenous in all country models, except for oil prices in Argentina.

Table 3: Trade weight matrix

Wheat	ARG	AUS	BRA	CAN	EU	RUK	USA
ARG	0%	8%	6%	7%	7%	7%	8%
AUS	25%	0%	24%	29%	27%	29%	30%
BRA	1%	1%	0%	1%	1%	1%	1%
CAN	19%	23%	18%	0%	20%	22%	22%
EU	13%	16%	13%	15%	0%	15%	16%
RUK	20%	24%	19%	22%	21%	0%	23%
USA	22%	27%	20%	25%	23%	25%	0%
Maize	arg	aus	bra	can	eu	ruk	usa
ARG	0%	19%	24%	19%	20%	20%	36%
AUS	0%	0%	0%	0%	0%	0%	0%
BRA	27%	22%	0%	22%	23%	23%	42%
CAN	3%	2%	3%	0%	3%	3%	5%
EU	5%	4%	5%	4%	0%	4%	8%
RUK	6%	4%	6%	5%	5%	0%	9%
USA	60%	49%	62%	50%	50%	51%	0%
Barley	arg	aus	bra	can	eu	ruk	usa
ARG	0%	18%	10%	11%	12%	12%	10%
AUS	47%	0%	42%	48%	51%	51%	43%
BRA	0%	0%	0%	0%	0%	0%	0%
CAN	13%	20%	11%	0%	14%	14%	12%
EU	19%	30%	17%	19%	0%	21%	17%
RUK	19%	30%	17%	20%	21%	0%	18%
USA	2%	3%	2%	2%	2%	2%	0%

Note: Based on the total average annual export volume per country between 2006 and 2018. Data from UN Comtrade.

4.2 Results discussion

This section presents the GVAR empirical setting and estimate responses to a series of global shocks to the feed market model.

The GVAR lag structure varies across country VARs and is selected using the Akaike Information Criterion (AIC) (see Table 3). To save degrees of freedom, domestic variable includes up to 3 lags, and foreign commodity prices are influenced by up to 2 months of data. In addition to lagged reactions, contemporaneous linkages (within the same month) are key characteristics of the global grain market. Contemporaneous foreign variables coefficients, Λ_{i0}, can be interpreted as the sensitivity of domestic prices to price shocks in trade partners' markets. Overall, the results suggest a significant price sensitivity across key players of the global market. Table 4 presents the contemporaneous coefficients for the three commodities' foreign variables. Wheat prices generally exhibit a higher sensitivity to foreign prices than the other commodities. Barley is the least sensitive on average.

Table 4: Model settings and contemporaneous coefficients

	Model settings			Contemporaneous coefficients (Λ_{i0})					
	p	*q*	Cointegrating relations	Wheat Coeff.	S.E.	Maize Coeff.	S.E.	Barley Coeff.	S.E.
ARGENTINA	2	1	1	0,515	0,085	0,934	0,088		
AUSTRALIA	3	2	2	1,123	0,164			0,517	0,156
BRAZIL	3	1	2			0,735	0,096		
CANADA	1	1	2	0,877	0,196	-0,104	0,058	0,047	0,117
EU	1	1	4	0,708	0,105	0,450	0,149	0,633	0,120
BLACKSEA	2	2	2	0,456	0,092			0,577	0,104
USA	1	2	1	0,866	0,097	0,729	0,099	-0,126	0,138

Note: Country model lag orders are assessed with the AIC criteria. The lag for domestic endogenous variables, p, is allowed to differ from the lag of the weakly exogenous foreign vectors, q. The cointegration order is computed using Johansen's trace statistics. S.E. : standard error.

Generalised Impulse Response Functions (GIRFs) are obtained by examining the response of the model across several periods after a given shock to one variable of the system (see Pesaran and Shin (1998) for more on GIRFs adapted to VAR models). To get an indication of confidence around these responses, they are bootstrapped by generating samples of the series, using the variance-covariance matrix computed from the estimated residuals of the individual country models. Country level prices reactions are aggregated into a global market reaction for each market. The aggregation is performed through an export volume weighted averaging of the bootstrapped impulse responses (using the average annual export value over the period). In what follows, we discuss the reactions to the following scenario:

- a one standard error negative global shock to oil price, which is equivalent to an oil price reduction of – 4.4%
- a one standard error negative shock to stock-to-use ratios, a shock affecting stocks in all countries, which is equivalent to an average reduction between -0,2% to -6,6% (-2,9% on average), depending on the commodity and country.
- a one standard error negative shock to exports in Black Sea countries, which is equivalent to -3.8% exports reduction for wheat and -4.2% for barley.

Note that the global shocks are shocks affecting simultaneously all models while the Black Sea shocks are only imputed in the Black Sea model and not the other markets.

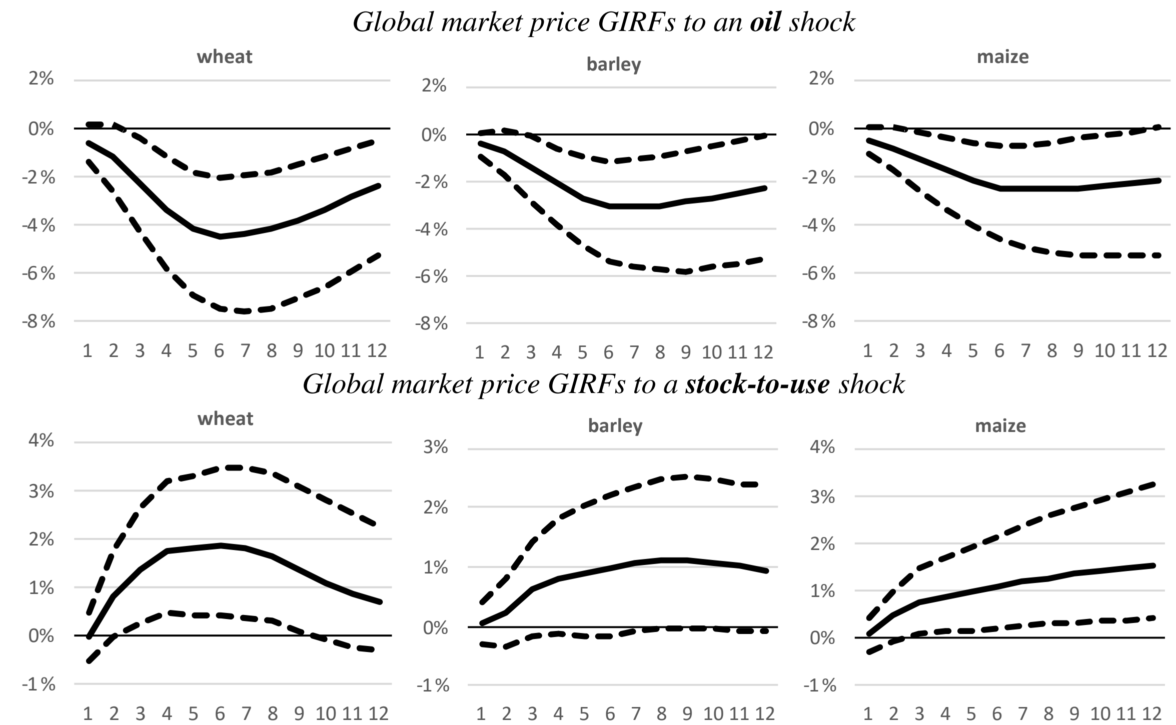
A global oil price shock, simultaneously affecting all feed exporters, leads to a 4% median price reduction after 6 months for wheat, 2% for barley, and 2% for maize. For wheat and barley, the effect dissipates after a 12-months horizon, when prices revert to their previous levels. Maize prices are slower to revert to their equilibrium. A significant impact of oil price on wheat price is reported in many articles including Cai et al. (2020) for agricultural

commodities, Baumeister et al. (2014) and Lundberg (2020) for wheat and maize and Gutierrez et al. (2015) for wheat.

A global negative stock-to-use shock simultaneously affecting all feed exporters leads to a significant price increase, for each product. Barley bootstrapped reactions suggest that the one standard deviation shock on stock-to-use ratio does not lead to a significant price reaction in the first few months, but a stronger disruption would lead to a significant price reaction.

Note that these results are based on a 1-month shock. If the disruption persists, the impact might be greater. Hence, these estimates should be taken as lower bound indications. The critical role of stocks-to-use ratios in driving price spikes and volatility has been studied and documented in various papers such as Bonberieth et al. (2013), Hockman et al. (2014) and Tadesse et al. (2014).

Figure 2: Global market GIRFs to global shocks affecting all countries

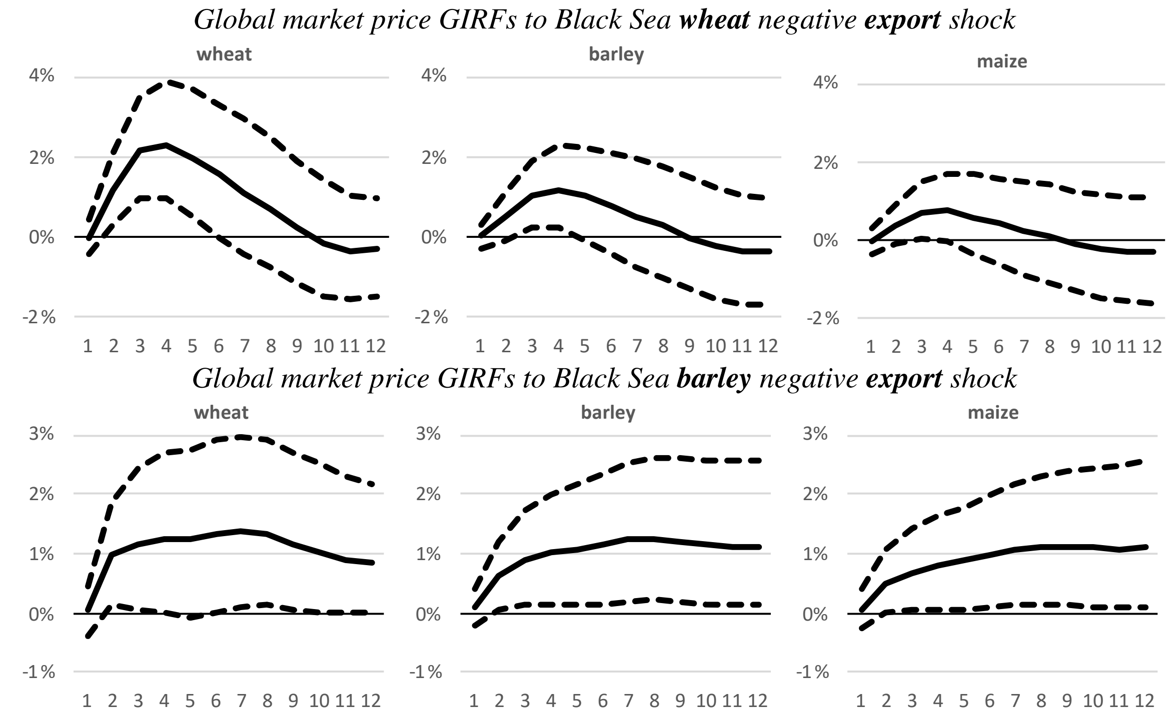


Note: 12-months horizon median response (plain line) and 10th and 90th precentiles (dotted lines) obtained from 3000 bootstrap replications of GIRFs.

We can summarize the findings from the global shocks:

- Oil price shocks generate the strongest price responses (compared to stocks and exports).
- The oil shock takes more time to fully affect prices than the stock-to-use ratio shocks.
- A one standard deviation reduction of exports has a stronger impact on prices than a similar shock to stocks.
- All things equal and in case they happen simultaneously, the price increasing effect of the reduction of stocks are compensated by the impact of lower oil prices, for up to 12 months.
- Maize prices exhibit a lower sensitivity than wheat prices, but the effect of a stock-to-use reduction does not dissipate over time (hysteresis).

Figure 3: Global market price GIRFs to export and stocks shocks in the Black Sea model



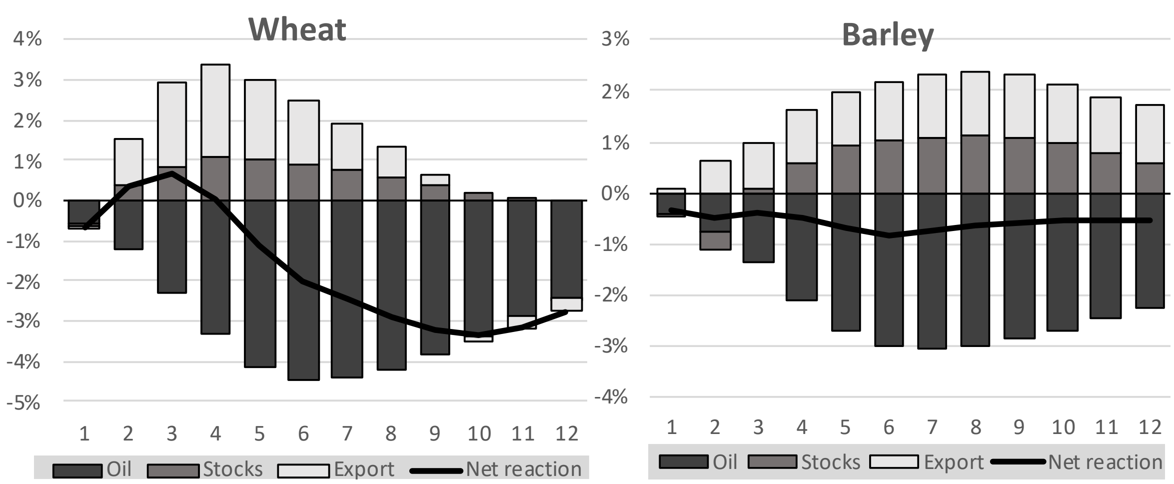
Note: 12-months horizon median response (plain line) and 10th and 90th precentiles (dotted lines) obtained from 3000 bootstrap replications of GIRFs.

A negative export shock in the Black Sea model pushes global wheat prices up to 2% higher in the median scenario (1% in the case of barley). Figure 3 presents the results of simulated export restriction for wheat and barley in the Black Sea model. This reaction represents the potential impact of export restrictions in this group of key exporters. At the time of writing, Kazakhstan, for instance, had suspended exports of several cereal products, as well as oilseeds and vegetables, during a few months of the first half of 2020. And Russia was also considering a

ban on wheat exports[2]. The results of the GVAR model suggest that the magnitude of a curb on Black Sea annual wheat exports equivalent to one standard deviation of the monthly USDA forecast would generate a global price reaction similar to the one of a global shock, but would dissipate faster.

Next, we combine the median global price responses to the two Black Sea shocks and combine them to the oil shock response to mimic the 1st half year of 2020 (oil shock) and the potential consequences of supply chain disruptions (stock-to-use reductions) and border closures or export restrictions (Figure 4). Note that, since the GVAR model is linear, the reaction to stronger (or weaker) shocks can easily be obtained by multiplying the impulse responses by a scaling factor, to design further stress scenarios.

Figure 4: Global market reactions to Black Sea shocks and low oil prices



Note: 12-months horizon median response obtained from 3000 bootstrap replications of GIRFs. The global market price reaction is obtained from a weighted sum of the country specific reactions. Shocks simulations are independent from each other. Disclaimer: Shocks are assumed independent, with no correlation across shocks. The total impact is therefore underestimated in these graphs.

Finally, an important element arising from this model, is the cross-commodity linkages. The results suggest that each commodity significantly reacts to developments affecting the others. Export restrictions or supply chain disruptions affecting stock levels can have spill over effects on other products than the targeted ones. When restrictions are applied to all products, the impact is compounded.

[2] IFPRI, Food Export Restrictions during the Covid-19 crisis. Available at https://public.tableau.com/profile/laborde6680#!/vizhome/ExportRestrictionsTracker/FoodExportRestrictionsTracker

5. Conclusion

In this paper, we discuss the possible impact of the COVID-19 pandemic on the global feed market. We use a Global Vector Autoregression model to assess the extent to which oil, exports, and stock-to-uses shocks might affect the main exporters of wheat, barley, and maize. The model brings together the tree commodities, endogenously modelled across each of the main exporters which are connected through trade matrices.

Results of the empirical analysis indicate that the oil market might have contributed the global grain prices remaining stable in early 2020, despite supply chain disruption concerns. We also observe that export restrictions such as those experienced in the first half of 2020 could significantly increase the global prices, and that such restrictions could affect more than the intended commodity, through significant cross commodity price linkages. Moreover, the results suggest that price shocks rapidly propagate across different grain markets and across countries.

Several policy implications might be derived. The estimates suggest a high level of sensitivity and interdependence between the different market players. In the event of lower levels of grain stocks, coupled with trade export restrictions and oil prices rebound, the global feed market could evolve towards significantly higher prices. These estimates suggest that maintaining appropriate stock levels without restricting exports can contribute to stabilising the global market. Concluding, to address the challenges of the COVID-19, the model suggests that any action designed at minimizing the disruption to food supply and guaranteeing trade of grains will mitigate price surges and, therefore, will have a positive impact on the food system and food security.

Ethics Declaration
Guillaume Pierre declares that he has no conflict of interest. Luciano Gutierrez declares that he has no conflict of interest.

Ethical approval
This article does not contain any studies with human participants or animals performed by any of the authors.

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Figures

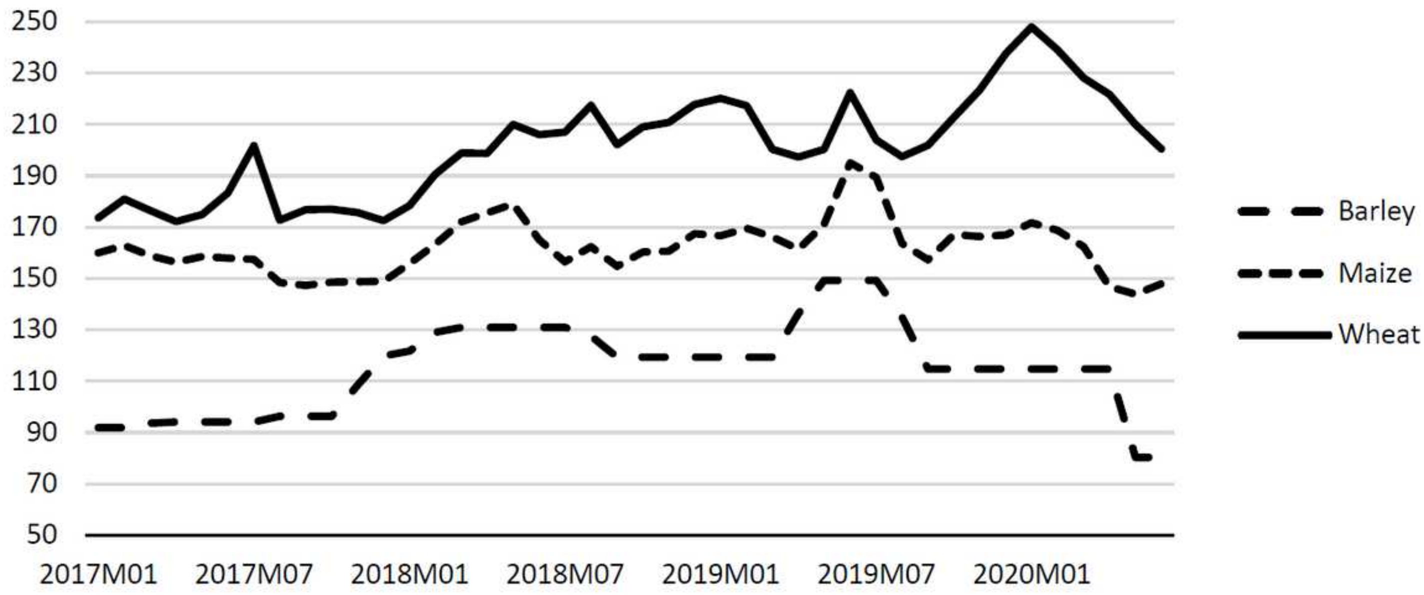
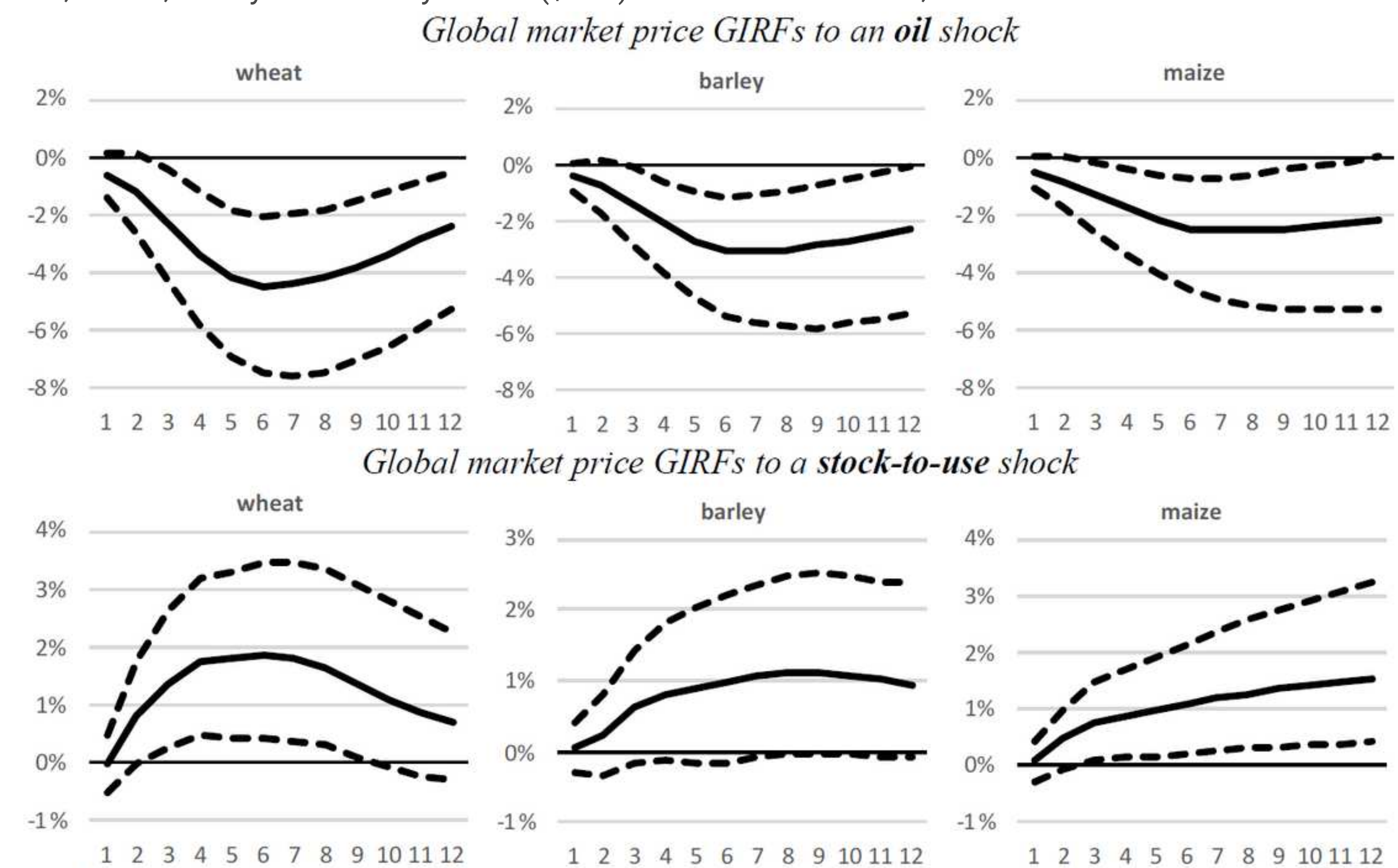


Figure 1

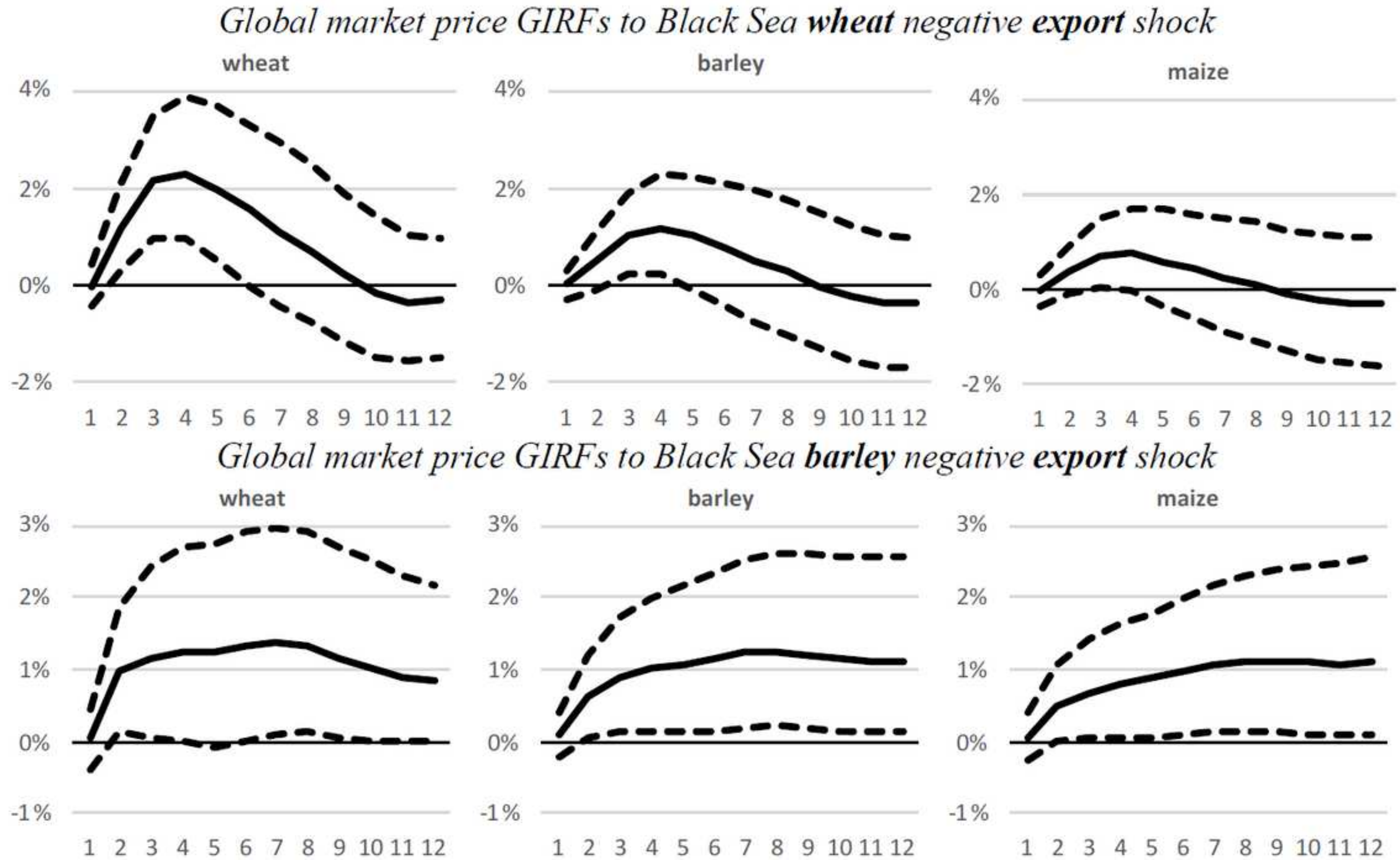
Wheat, Maize, Barley Commodity Prices ($/mt). Source: World Bank, the Pink Sheet



Note: 12-months horizon median response (plain line) and 10th and 90th precentiles (dotted lines) obtained from 3000 bootstrap replications of GIRFs.

Figure 2

Global market GIRFs to global shocks affecting all countries



Note: 12-months horizon median response (plain line) and 10th and 90th precentiles (dotted lines) obtained from 3000 bootstrap replications of GIRFs.

Figure 3

Global market price GIRFs to export and stocks shocks in the Black Sea model

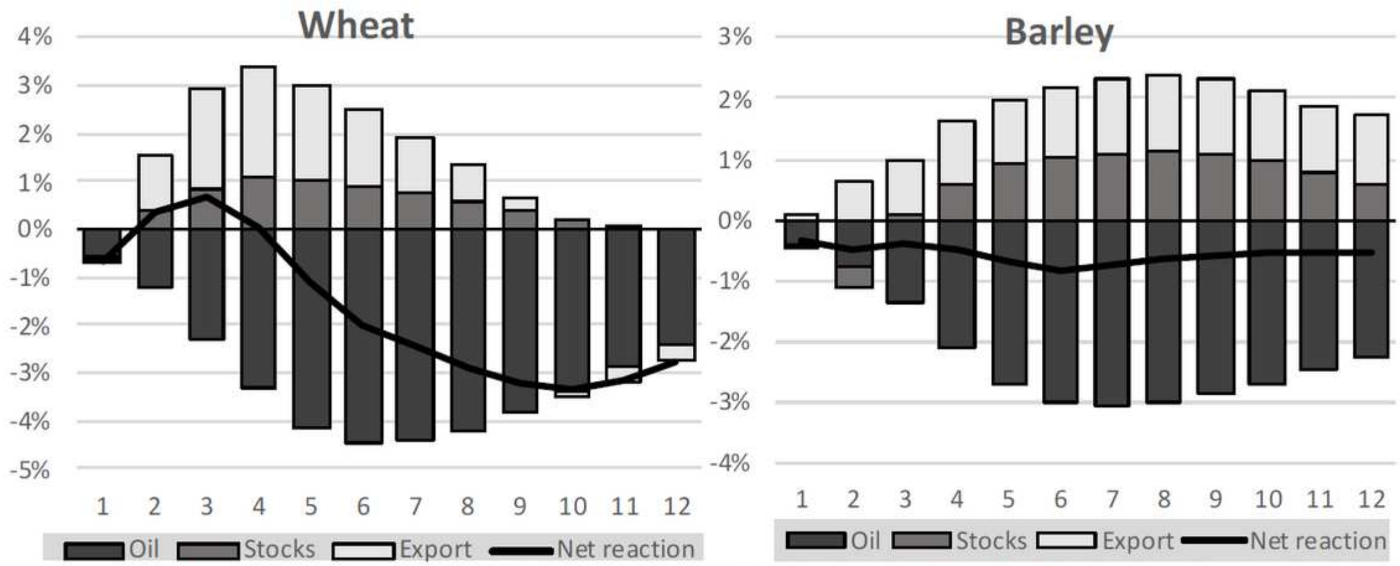


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Figure 4

Global market reactions to Black Sea shocks and low oil prices