"What drives food price volatility? Evidence based on a generalized VAR approach applied to the food, financial and energy markets" submitted to Economics E-Journal

Response to Reviewer.

Thank you very much for a thorough and substantive review of our paper. We have benefited a lot from your comments and suggestions, and we have used them to improve our manuscript.

Below we provide a point-by-point response to the issues raised in the review.

Reviewers' comments:
General comments
Since the financialization of commodity markets, volatility transmission from (conventional) financial markets to commodity markets and within commodity markets is of great interest. Therefore, the paper tackles an important research question that has not been studied in-depth in the existing literature. In this regard, the paper provides some new and interesting insights and could therefore be relevant for the literature on commodity volatility transmission. Therefore, I see the potential for publication. Some detailed comments with questions and suggestions are listed below.

Reviewer
Specific comments
(1) Methodology:
(a) Eq. (1): I was wondering why the price range has been constructed by a double logarithm (i.e. both prices separately and then the difference of prices). What is the rationale behind this procedure?
(b) Why has the price range been taken as a proxy for volatility instead of estimating the time-varying volatility within a GARCH model?
(c) Why has the VAR model given in Eqs. (2) and (3) been estimated without constant terms? This is a restriction that needs to be justified.

Response:

a) As a volatility proxy, in our paper, the logarithm of the difference between the highest and lowest log price is used:

$$range_t = \ln(\ln(\max(y_t) - \ln(\min(y_t)) \ , \qquad (1)$$

where *t* refers to a particular moment (day).

The formula (1) is related to Diebold and Yilmaz (2012) volatility proxy given as:

$$range_t = \ln(0.361[\ln(\max(y_t) - \ln(\min(y_t)]^2) \ . \qquad (2)$$

The last formula can be seen as (logarithm properties):

$$\ln(0.361[\ln(\max(y_t) - \ln(\min(y_t)]^2) = \ln(0.361) + 2\ln[\ln(\max(y_t) - \ln(\min(y_t)]$$

which means, that formula (1) is included as a main component in formula (2). The correlation coefficient between the two formulas is (obviously) one. In fact, our approach is not different from the one proposed in Diebold and Yilmaz (2012).

b) Indeed, the GARCH based, time-varying variance is an alternative measure of volatility. The multivariate GARCH models offer the alternative description of volatility relations. We decided, however, to use Diebold-Yilmaz approach which provides simple, yet extensive description of relations. The range-based volatility proxy is used in Diebold and Yilmaz papers, including theirs seminal papers (Diebold and Yilmaz, 2009, 2012).

c) All the models estimated includ a constant term. The only reason for not including it in formulas is simplicity. It is also a convention proposed in Diebold and Yilmaz (2009, 2012).

Reviewer

(2) Data:

(a) Several other commodity futures prices could be included into the analysis. I was wondering why not e.g. including gold futures prices as an additional (important and often analyzed) financial market and also copper futures prices as an industrial metals market, which is attached to the global business cycle due to its importance for the construction industry. Either include these or justify why omitting.

(b) Why are you accounting for seasonal patterns referring to the month in the year but not for the day-of-the-week effect?

(c) You refer to the normality of most of the volatility measures without explicitly testing. In Table 1 only Skewness and Kurtosis is reported.

Response:

In order to discuss issues raised in point a) and b) additional models are estimated.

First, we included two variables: gold futures prices and copper futures prices. Second, we check the importance of seasonal patterns (both monthly and daily-monthly). In fact, the issue of seasonal effects was already discussed at Energy and Commodity Finance Conference 2017, University of Oxford and The Energy Finance Christmas Workshop, Cracow University of Economics and the approach based on monthly seasonal effect was suggested. Nevertheless, following the comment we check the importance of daily seasonal patterns as well. The additional models (with 9 variables) are estimated for daily data spanning from January 4, 2000 to August 31, 2018. The results presented include: non-seasonally adjusted data and seasonally adjusted (monthly and monthly-daily) data (estimated OLS).

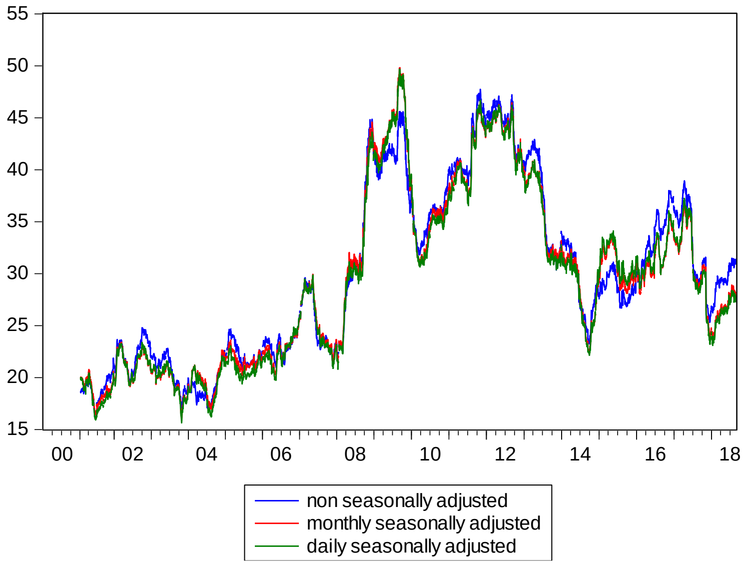

Fig. R1. Dynamic total implied volatility spillover index for nine markets (the OLS method).

Notes: This figure shows the total volatility spillover index over the sample period January 4, 2000 – August 31, 2018 estimated with a rolling window of 250 days and calculated from the forecast error variance decompositions on 10-step-ahead forecasts. The ending date of a window is on the horizontal axis.

No matter which data are used (seasonally adjusted or not seasonally adjusted) the evolution of dynamic total implied volatility spillover index is quite similar. The correlation between all the indices is very high, above 0.95.

The importance of seasonal effects is reported in Table R1a - R1d. The monthly effect is significant for all the markets (tables R1a, R1b). Daily seasonal effects are insignificant for the food markets (Table R1c), with the exception of Rice market on which Monday effect is significant. For non-food markets, except for SP00, the daily seasonal effect is found.

Taking this results into account, the direction of implied volatility spillovers tables were calculated for the cases of nine variables with and without seasonal adjustment (Table R2a - R2c). The overall picture is the same as in the manuscript (see Table 2) that is volatility is transmitted within the group of food markets and within the group of non-food markets, but not between these two groups of markets. The rice market remains detached from both groups, which is consistent with our finding in the manuscript.

Table R1a.

Linear regression for four assets (food markets): January 4, 2000 – August 31, 2018

	CORN	SOYBEAN	WHEAT	RICE
D1	-0.043	-0.028	-0.010	0.005
D2	-0.049	0.036	0.031	0.130***
D3	0.050	0.015	0.088***	0.160***
D4	0.122***	0.072**	0.114***	0.111**
D5	0.203***	0.100***	0.132***	0.130***
D6	0.266***	0.136***	0.145***	0.280***
D7	0.371***	0.322***	0.179***	0.117***
D8	0.233***	0.165***	0.153***	0.193***
D9	0.195***	0.144***	0.129***	0.070
D10	0.172***	0.125***	0.152***	0.103**
D11	0.095***	0.121***	0.047	0.069
C	-4.178***	-4.214***	-3.901***	-4.233***

Notes: ***, ** indicate statistical significance at 1 and 5 per cent level of significance, respectively

Table R1b.

Linear regression for five assets (non-food markets): January 4, 2000 – August 31, 2018

	SP500	USD	WTI	GOLD	COPPER
D1	-0,014	0,061	-0,022	-0,031	0,136***
D2	0,099**	0,061	0,016	0,080**	0,139***
D3	0,123***	0,088**	-0,045	-0,034	0,119***
D4	0,100**	0,036	-0,096***	-0,062	0,143***
D5	0,043	0,083**	-0,063	-0,026	0,150***
D6	0,069	0,081**	-0,069**	-0,031	0,138***
D7	0,044	0,010	-0,105***	-0,077**	0,075**
D8	0,041	0,002	-0,111***	-0,091**	0,088**
D9	0,087	0,050	-0,020	0,020	0,054
D10	0,274***	-0,011	-0,021	-0,004	0,116***
D11	0,130***	0,053	0,021	0,013	0,202***
C	-4,451***	-5,079***	-3,588***	-4,361***	-4,105***

Notes: ***, ** indicate statistical significance at 1 and 5 per cent level of significance, respectively

Table R1c.

Linear regression for four assets (food markets): January 4, 2000 – August 31, 2018

	CORN	SOYBEAN	WHEAT	RICE
D1	-0,043	-0,028	-0,009	0,007
D2	-0,049	0,036	0,032	0,132***
D3	0,050	0,015	0,088***	0,160***
D4	0,121***	0,072**	0,113***	0,110**
D5	0,204***	0,100***	0,133***	0,132***
D6	0,266***	0,136***	0,145***	0,280***
D7	0,371***	0,321***	0,179***	0,117***
D8	0,233***	0,165***	0,153***	0,193***
D9	0,195***	0,144***	0,129***	0,072
D10	0,172***	0,125***	0,152***	0,103**
D11	0,096***	0,122***	0,047	0,068
Monday	0,020	0,003	0,029	0,054**
Tuesday	0,016	0,000	0,005	0,012
Wednesday	0,015	-0,021	0,032	-0,012
Thursday	0,035	0,020	0,029	0,013
C	-4,195***	-4,214***	-3,920***	-4,247***

Notes: ***, ** indicate statistical significance at 1 and 5 per cent level of significance, respectively

Table R1d.

Linear regression for five assets (non-food markets): January 4, 2000 – August 31, 2018

	SP500	USD	WTI	GOLD	COPPER
D1	-0,016	0,054	-0,023	-0,036	0,134***
D2	0,097**	0,054	0,016	0,075	0,137***
D3	0,123***	0,089**	-0,045	-0,034	0,119***
D4	0,101**	0,039	-0,097***	-0,059	0,143***
D5	0,041	0,077**	-0,063	-0,031	0,148***
D6	0,069	0,081**	-0,069**	-0,032	0,138***
D7	0,043	0,009	-0,105***	-0,077**	0,075**
D8	0,041	0,002	-0,111***	-0,092**	0,088**
D9	0,086	0,043	-0,019	0,015	0,052
D10	0,275***	-0,011	-0,021	-0,004	0,117***
D11	0,132***	0,057	0,021	0,016	0,203
Monday	-0,046	-0,220***	0,022	-0,176***	-0,048**
Tuesday	-0,005	-0,093***	0,003	-0,091***	-0,002
Wednesday	0,020	-0,059**	0,104***	-0,065***	0,016
Thursday	0,036	-0,017	0,047**	-0,032	0,017
C	-4,452***	-5,001***	-3,624***	-4,288***	-4,102***

Notes: ***, ** indicate statistical significance at 1 and 5 per cent level of significance, respectively

Table R2a.

The direction of implied volatility spillovers (the OLS method) – (non-seasonally adjusted data).

	SP500	USD	WTI	GOLD	COPPER	CORN	SOYBEAN	WHEAT	RICE	From Others
SP500	81.1	4.7	5.7	3.7	2.6	0.7	0.5	0.6	0.4	18.9
USD	6.4	69.2	5.7	8.3	6.6	0.9	1.2	0.5	1.2	30.8
WTI	8.4	5.1	74.6	2.8	6.6	0.4	0.6	0.6	1.0	25.4
GOLD	4.8	7.3	2.9	70.7	8.9	2.7	1.2	1.5	0.1	29.3
COPPER	3.8	5.2	6.4	8.7	70.9	2.9	1.1	0.9	0.0	29.1
CORN	0.8	0.7	0.6	2.4	2.9	62.7	14.7	14.9	0.3	37.3
SOYBEAN	0.9	1.1	0.9	1.0	1.3	16.9	70.3	7.1	0.4	29.7
WHEAT	1.0	0.7	0.8	1.4	1.2	16.8	7.0	70.0	1.0	30.0
RICE	0.5	1.8	0.8	0.1	0.1	0.5	0.4	0.9	94.9	5.1
To Others	26.7	26.6	23.9	28.2	30.1	41.9	26.7	27.0	4.5	235.7
Net spillovers	7.8	-4.2	-1.5	-1.1	1.0	4.6	-3.0	-3.0	-0.6	

Table R2b.

The direction of implied volatility spillovers (the OLS method) – (monthly seasonally adjusted data).

	SP500	USD	WTI	GOLD	COPPER	CORN	SOYBEAN	WHEAT	RICE	From Others
SP500	80.7	4.9	5.8	3.8	2.6	0.7	0.5	0.5	0.4	19.3
USD	6.5	68.8	5.7	8.3	6.5	1.0	1.4	0.6	1.2	31.2
WTI	8.4	5.1	73.9	2.6	6.7	0.7	0.8	0.8	1.1	26.1
GOLD	4.8	7.2	2.7	69.7	9.0	3.4	1.4	1.8	0.1	30.3
COPPER	3.7	5.2	6.5	8.7	70.5	3.2	1.2	0.9	0.0	29.5
CORN	0.9	0.8	0.9	3.1	3.4	62.5	13.7	14.4	0.3	37.5
SOYBEAN	1.0	1.3	1.2	1.2	1.5	15.6	71.1	6.7	0.4	28.9
WHEAT	1.0	0.7	1.1	1.7	1.3	16.0	6.5	70.9	0.8	29.1
RICE	0.5	1.7	1.0	0.1	0.1	0.6	0.4	0.8	94.8	5.2
To Others	26.8	27.0	24.9	29.5	31.0	41.2	25.9	26.5	4.4	237.1
Net spillovers	7.5	-4.2	-1.2	-0.8	1.5	3.7	-3.0	-2.6	-0.8	

Table R2c.

The direction of implied volatility spillovers (the OLS method) – (daily-monthly seasonally adjusted data).

	SP500	USD	WTI	GOLD	COPPER	CORN	SOYBEAN	WHEAT	RICE	From Others
SP500	80.8	5.1	5.7	3.8	2.4	0.7	0.5	0.5	0.4	19.2
USD	6.3	69.7	5.5	7.9	6.2	1.0	1.4	0.6	1.3	30.3
WTI	8.3	5.6	73.5	2.8	6.5	0.6	0.8	0.7	1.1	26.5
GOLD	4.6	6.7	2.6	70.6	8.8	3.4	1.5	1.8	0.1	29.4
COPPER	3.6	5.3	6.3	8.9	70.5	3.1	1.3	0.9	0.1	29.5
CORN	0.8	0.9	0.9	3.2	3.3	62.5	13.7	14.3	0.3	37.5
SOYBEAN	0.9	1.3	1.2	1.2	1.4	15.6	71.2	6.7	0.4	28.8
WHEAT	1.0	0.8	1.0	1.8	1.3	15.9	6.6	70.9	0.8	29.1
RICE	0.5	1.8	1.0	0.1	0.1	0.6	0.4	0.8	94.7	5.3
To Others	26.0	27.5	24.0	29.7	30.1	41.0	26.2	26.3	4.6	235.5
Net spillovers	6,8	-2,8	-2,5	0,3	0,6	3,5	-2,6	-2,8	-0,7	

c) Table 1 in the manuscript presents descriptive statistics. Indeed, there are no test results. Normality, however, was tested, their detailed results are as follows:

Table R3.

Normality results of log range volatility for seven assets.

	SP500	WTI	USD	CORN	SOYBEAN	WHEAT	RICE
Jarque-Bera	67.88***	42.95***	5270.78***	16.59***	46.98***	32.66***	1431.10***

Notes: ***, ** indicate statistical significance at 1 and 5 per cent level of significance, respectively

As is clear from the results in Table R3., no volatility series met normality assumption. This point will be clarified in the final version of the manuscript.

Reviewer

(3) Conclusion: The paper lacks on policy implications based on the results.

Response:

Indeed, policy implications are not explicitly stated in our manuscript. It is because our objective was to concentrate on economic aspects. We think, however, that there are two potential policy implications of the results obtained. First, financialization seems to have limited impact on food markets volatility. Therefore, the policy-oriented at maintaining low volatility of food markets can potentially be effective and is not undermined by financial volatility (transmission of volatility from financial markets to food markets is negligible). Second, since the corn market seems to be the most important source of volatility in food markets, policy should be focused on this market.

The policy implications presented here will be included in the final version of the manuscript.