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ARE AGRICULTURAL COMMODITY PRICES AFFECTED BY COVID-19? A STRUCTURAL BREAK IDENTIFICATION

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ABSTRACT

The paper aims to identify the COVID-19-driven structural break in agricultural commodity prices time series. We assume the official outbreak of the COVID-19 pandemic, i.e., 11 March 2020, as the breaking point. We use data on the S&P GSCI Agriculture and Livestock Index and the S&P 500 from Refinitiv Datastream. The structural break is identified based on the Chow test. We prove the existence of structural break in both the S&P 500 and the S&P GSCI Agriculture and Livestock Index triggered by the official outbreak of the COVID-19 pandemic. Moreover, to assess the causality between the analysed series, we apply the Granger causality test. We reveal a unidirectional causal relationship from the stock market to the agricultural commodity market.

Key words: agricultural commodities, stock market, COVID-19, structural breaks
JEL codes: Q02, G12, G01, E44

INTRODUCTION

COVID-19 belongs to the group of infectious diseases and is caused by the severe acute respiratory syndrome coronavirus 2 – SARS-CoV-2 (Andersen et al., 2020). The World Health Organization (WHO) officially classified COVID-19 as a global pandemic on 11 March 2020 (Maier and Brockmann, 2020). The novel coronavirus has shaken the global economy on an unprecedented scale (Barro, Ursúa and Weng, 2020). The recent outbreak of the COVID-19 pandemic has significantly affected the global financial markets (Czech et al., 2020; Goodell, 2020). It is worth mentioning that the financial markets often label COVID-19 as an enormous black swan event (Nicola et al., 2020).

Our paper is focused on the agricultural commodity markets. Since the beginning of the 21st century, the financialization process of commodity markets arises (Domanski and Heath, 2007). The existence of links between stock and agricultural commodity markets is broadly known and proven. To our knowledge, there are numerous studies on the COVID-19 pandemic impact on stock markets (Ashraf, 2020; Zhang, Hu and Ji, 2020) and foreign exchange markets (Benzid and Chebbi, 2020; Gunay, 2020) while the agricultural commodity markets' reaction on the novel coronavirus has not been thoroughly explored. Our contribution is that by applying the Chow test, we proved that the COVID-19 pandemic outbreak triggered structural changes in both stock and agricultural commodity markets.

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The outline of the paper is as follows. The next section presents the literature review. Section 3 describes the material and research methods used. The posterior section includes empirical findings and discussion. The final section offers our conclusions.

THEORETICAL BACKGROUND

In the 21st century, commodity markets have experienced rapid liquidity growth, and an influx of investors attracted to commodities purely as investment products rather than as a means to support real economic activity via the hedging of risks (Vivian and Wohar, 2012; Silvennoinen and Thorp, 2013). Domanski and Heath (2007) state that commodity markets have adopted more and more features of traditional financial markets. Consequently, commodities have turned out to be an attractive investment alternative (Irwin and Sanders, 2012). Creti, Joëts and Mignon (2013) show that the links between stock and commodity markets evolve through time and are highly volatile, particularly since the global financial crisis. As a result, the phenomenon of commodity markets' financialization arises.

The commodity market could be characterised by large price changes, particularly during unexpected events and high uncertainty times (Kamdem, Essomba and Berinyuy, 2020). Baffes and Haniotis (2010) show that speculation is a key factor affecting commodity prices during a crisis. Creti, Joëts and Mignon (2013) observe that financial markets consider agricultural commodities, including coffee and cocoa, as speculative assets. According to Zhang and Broadstock (2018), food became the most influential commodity class in the market after the global financial crisis.

Shalini and Prasanna (2016) indicate that the transmission of the shocks across the financial markets during the financial crisis results in structural changes in commodity volatility. Structural breaks in the time series of food prices interest research studies (Jin and Kim, 2012). Vivian and Wohar (2012), studying all classes of commodities, found structural breaks in the volatility during the crisis period only in agricultural grain commodities. Nazlioglu, Erdem and Soytas (2013) show that the dynamics of volatility transmission changes significantly following the food price crisis, particularly interrelationships between energy and agricultural markets. In the paper, we investigate whether the COVID-19 pandemic triggered the structural breaks, similarly to the recent global financial crisis.

Salisu, Akanni, and Raheem (2020) show the existence of a positive relationship between commodity price returns and the COVID-19 global fear index, confirming that commodity returns increase as COVID-19 related fear rises. Rajput et al. (2020) observe a sudden drop in the demand and supply of all commodities, including agricultural ones, due to the novel coronavirus outbreak. Barichello (2020), based on the UNCTAD Report Update, showed that in the first quarter of 2020, the average price decline was 6.8% for all agricultural commodities.

MATERIALS AND METHODS

The paper aims to identify COVID-19 driven structural break in agricultural commodity prices time series. Knowing the impact of COVID-19 on the stock markets and the links between the stock and agricultural commodity markets, we build three research hypotheses to achieve the main aim of the study.

– H1: There is a causal relationship between stock and agricultural commodity markets.
– H2: The outbreak of the COVID-19 pandemic has triggered a structural break in the S&P 500 index series.
– H3: The outbreak of the COVID-19 pandemic has triggered a structural break in the S&P GSCI Agriculture and Livestock Index series.

The S&P GSCI Agriculture and Livestock Index belongs to the S&P Dow Jones Indices group and measures agricultural commodity market performance. It is considered a benchmark for investment in agricultural commodities and is designed to be a tradable index accessible to financial market participants. Moreover, the S&P GSCI Agriculture and Livestock Index reflects price movements and inflation in the global economy, enhancing its suitability as a benchmark. The index includes prices of the main agricultural commodities, i.e. wheat, corn, soybeans, coffee, sugar, cocoa, cotton, lean hogs, live cattle, and feeder cattle (S&P GSCI, 2020).

The S&P 500 is an iconic financial market indicator and is recognized worldwide as one of the premier benchmarks for stock markets. The S&P 500 is the world's most-followed stock market index (Revenue, 2016). The index comprises 500 constituent companies and measures the performance of the large-cap segment of the market (S&P U.S., 2020a, b).

Daily data on the S&P GSCI Agriculture and Livestock Index and the S&P 500 come from the Refinitiv Datastream. The research covers the period from the beginning of 2000 till 2 September 2020.

To assess the causality between the S&P 500 and the S&P GSCI Agriculture and Livestock Index, we apply the Granger causality test (Granger, 1969). X is said to Granger-cause Y if Y can be better predicted using the lagged values of both X and Y than by using the history of Y alone. The null hypothesis states that X ddoes not Granger-cause Y. The Granger causality test is sensitive to the stationary of variables series. The series stationarity is checked based on the augmented Dickey-Fuller (ADF) test (Dickey and Fuller, 1979). The ADF null hypothesis assumes that the time series is integrated of order 1 (I(1)), implying that the process contains a unit root and is therefore non-stationary.

We investigate the impact of the official announcement of the COVID-19 pandemic on agricultural commodity markets, searching for a structural break in the analysed time series. Structural breaks identification is the way to measure price-variation, including commodity markets (Jin and Kim, 2012). Structural change is identified based on the first-order autoregressive model (1):

$$y_t = \alpha + \beta y_{t-1} + \varepsilon_t, \tag{1}$$

where ε_t is a time series of serially uncorrelated shocks, α, β are the model parameters and explanatory variables y_{t-1} are lagged values of y_t. The structural break occurs when at least one of the above-mentioned parameters is changed in the sample period at some date. In other words, it is called a structural break when a time series abruptly changes at a certain point in time.

The classical test for structural change is introduced by Chow (1960). Hansen (2001) provides the main disadvantages of applying the Chow breakpoint test and stresses that the test's main limitation is that researcher needs to know about the structural break date in advance. More advanced tests detecting structural breaks in time series are, e.g. Andrews (1993) or Bai and Perron (1998, 2003). However, in the paper, we would like to check if there is a structural break in the time series for a specific date, i.e. the announcement of the COVID-19 pandemic by the World Health Organization. Therefore, we apply the Chow test, which allows us to identify the structural change within the specific expected date. We assume that the official outbreak of the COVID-19 pandemic, i.e. 11 March 2020, brought about structural changes both in stock and agricultural commodity markets' prices.

RESEARCH RESULTS AND DISCUSSION

The Granger causality test is sensitive to the stationary of variables series. Table 1 presents the calculated t-statistic for the ADF unit root test.

The results of ADF tests presented in Table 1 show that the analysed time series are integrated of

Table 1. The ADF test results

Variable	Level		First differences	
	intercept	intercept and trend	intercept	intercept and trend
S&P 500	1.10	–1.41	–22.99***	–23.12***
S&P GSCI Agriculture and Livestock Index	–1.78	–1.54	–70.69***	–70.69

***H_0 is rejected at the 1%, **5%, and *10% significance level.

Source: own calculations based on Refinitiv Datastream.

first-order. We obtain the stationary processes by applying the first differences of the logarithmic values of the original time series.

Researchers emphasize that the stock and agricultural commodity markets are correlated, and their relationship has been significant since the last global financial crisis. The Granger causality test is used to assess the link between stock and agricultural commodity markets. Table 2 depicts the estimated Granger causality F test statistics and the corresponding *p*-values.

Granger causality test results show that we cannot reject the null hypothesis stating that the S&P GSCI Agriculture and Livestock Index does not Granger-cause the S&P 500. However, we prove that the S&P 500 does Granger-cause the S&P GSCI Agriculture and Livestock Index at the significance level below 1%. It implies that the S&P GSCI Agriculture and Livestock Index can be better predicted using the history of the S&P 500 than by applying only its lag values. The Granger causality test reveals a one-side causal relationship from the S&P 500 to the S&P GSCI Agriculture and Livestock Index.

Structural change is identified based on the first-order autoregressive model (1) for the S&P 500 and the S&P GSCI Agriculture and Livestock Index series. The model is built for the first differences of the logarithmic values of the analysed time series. Table 3 presents the estimated models' coefficients. The obtained results are in line with Creti, Joëts and Mignon (2013).

The results presented in Table 3 show that intercept coefficients are not significant. The null hypothesis that slope coefficients in the S&P 500 and the S&P GSCI Agriculture and Livestock Index models equal zero is rejected at 1% and 5% significance levels, respectively. The estimated models (1) are applied to identify a structural break in the S&P 500 and the S&P GSCI Agriculture and Livestock Index series. The results of the Chow breakpoint test are presented in Table 4.

The null hypothesis in the Chow test assumes that there are no structural breaks at specified dates. In the paper, we assume that the breakpoint is the day of the COVID-19 pandemic announce-

Table 2. Granger causality test results

Dependent variable (*Y*)	Predictor variable (*X*)	Test statistic	*p*-value
S&P 500	S&P GSCI Agriculture and Livestock Index	1.31	0.270
S&P GSCI Agriculture and Livestock Index	S&P 500	6.11	0.001

Source: own calculations based on Refinitiv Datastream.

Table 3. First-order autoregressive models for the S&P 500 and the S&P GSCI Agriculture and Livestock Index series

S&P 500			
Coefficient	estimated parameter	*t*-statistics	*p*-value
Constant	0.01	1.16	0.248
Slope coefficient	–0.11	–8.40	0.000
S&P GSCI Agriculture and Livestock Index			
Coefficient	estimated parameter	*t*-statistics	*p*-value
Constant	0.01	0.70	0.482
Slope coefficient	0.03	1.97	0.049

Source: own calculations based on Refinitiv Datastream.

Table 4. Chow breakpoint test results

Variable	Wald test statistic	*p*-value
S&P 500	61.89	0.000
S&P GSCI Agriculture and Livestock Index	5.86	0.054

Source: own calculations based on Refinitiv Datastream.

ment, i.e. 11 March 2020. The test results presented in Table 4 show a structural break in the S&P 500 and the S&P GSCI Agriculture and Livestock Index series, at 1% and 10% significance levels, respectively. The obtained results suggest that the COVID-19 pandemic has affected not only the stock market but also the agricultural commodity market. Our results are in line with study by Vivian and Wohar (2012), which identified structural breaks in agricultural commodity prices' volatility during times of financial crisis.

CONCLUSIONS

Agricultural commodity markets attract investors since the beginning of the 21st century. Links between the stock market and agricultural commodity market have tightened since the global financial crisis. We reveal a unidirectional Granger causal relationship from the stock market to the agricultural commodity market.

Both stock and commodity markets are substantially volatile since the global financial crisis, particularly in times of huge uncertainty. The COVID-19 pandemic labelled as a black swan event is a perfect example of an overwhelmingly high uncertainty period. In the paper, we assess the reaction of the stock and agricultural commodity markets, in detail the S&P 500 index and the S&P GSCI Agriculture and Livestock Index, to the COVID-19 pandemic outbreak, i.e. 11 March 2020. We prove the existence of structural break in both the S&P 500 and the S&P GSCI Agriculture and Livestock Index triggered by the official outbreak of the COVID-19 pandemic. Our results confirmed all three research hypotheses. Explaining the reaction of specific agricultural commodity groups to the COVID-19 pandemic is a challenge for future research.

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