The impact of COVID-induced shock on the risk-return correspondence of agricultural ETFs

Andrii Kaminskyi[1[0000-0002-6574-8138]], Maryna Nehrey[2[0000-0001-9243-1534]] and Nina Rizun[3[0000-0002-4343-9713]]

[1] Taras Shevchenko National University of Kyiv, 64 Volodymyrska Str., Kyiv, 01026, Ukraine
kaminskyi.andrey@gmail.com

[2] National University of Life and Environment Science of Ukraine, 15 Heroyiv Oborony Str., Kyiv, 03041, Ukraine
marina.nehrey@gmail.com

[3] Gdańsk University of Technology, 11/12 Gabriela Narutowicza Str., Gdańsk, 80-233, Poland
nina.rizun@pg.edu.pl

Abstract. Risk-return correspondence for different investment asset classes forms one of the pillars of modern portfolio management. This correspondence together with interdependency analysis allows us to create portfolios that are adequate to given goals and constraints. COVID-induced shock unexpectedly generated high uncertainty and turmoil. Our paper is devoted to the investigation path through shock by agricultural assets (presented by ETFs) in comparison with traditional assets. There were identified three time periods: before the shock, explicitly shock, and post-shock. At the explicit shock period was suggested estimation risk frameworks on the pair indicators: falling depth and recovery ratio. Basic attention focuses on comparison risk-return estimations prior to shock and post-shock. To this end was considered four approaches to risk measurement and were applied to the sample of agricultural ETFs. The results indicated differences in risk changing by the path from before shock to post-shock. Differences arise from choosing the approach of risk measuring. The variability approach reveals much growth of risk of traditional assets, but the Value-at-Risk approach indicates higher risk growth for agricultural ETFs. Combine together with relatively low correlation these estimations provide a clear vision of risk-return frameworks.

Keywords: exchange traded funds, risk measurement, COVID, shock, portfolio management, agriculture, investment.

1 Introduction

The COVID-19 pandemic has a strong influence on the prices of all financial instruments [29]. Financial markets had shivered at the end of January 2020 and crashed in the middle of March 2020. The shock was extremely forceful. COVID-induced shock hit almost all assets: as traditional assets as alternative assets (including cryptocurrencies). Correspondingly, the shock had an effect on investment portfolio management which led to decreasing portfolio value. Meanwhile, different assets have different dynamics of passing such a turbulent period. Does it necessary to change the asset allocation design of investment portfolios? This question became an actual one for individual and institutional investors. The aim of this paper is to investigate risk-return correspondence "transmission" through the COVID-induced shock for agricultural Exchange Trade Funds (ETFs) and ETN.

Two hypotheses were put forward in our research. First hypothesis conjectures differences of shock parameters for agricultural ETFs and two traditional asset classes such as stocks and bonds (presented in our research by key stock indices). Especially, it was supposed differences in the renewal level. Second, our hypothesis focuses on verification of the assumption that risk is higher aftershock then before the shock. In general, this is a typical effect and we have tried to estimate the level of such risk increasing.

Class of agricultural ETFs one of the significant parts of the commodities ETFs and has its own distinctive features. The first distinctive aspect is that the prices of agricultural production are determined both by market factors (demand in the first place) and the crop yield (production) of a particular agricultural product. The dependence on the yield generates an additional level of lack of correlation of such ETFs with other investment assets, which can be used in investment portfolio forming procedures. The second distinctive feature of the agricultural ETFs is their structuring into ETFs associated with one agricultural product (for example, wheat, rice, livestock, sugar, and others), and associated with a specific fund diversified through different agricultural products. One of the interesting points for analysis concerns the meaningfulness of such features at the time of shock and renewal. Understanding the difference in "risk-return correspondence" in this context will allow a better justification for their using in the portfolio structure.

Our approach involves ETF using. The emergence of ETFs in the early 1990s and their intensive development expanded the portfolio management tools in two ways. First, the essence of the ETF design has allowed expanding the asset classes that can be used in the portfolios. In this regard, it is possible to use ETF connected with non-traditional investments (commodities, gold, private equity, and many others). Such possibilities essentially expand the diversification effect through portfolio construction. As a rule, alternative investments indicate a lower correlation level with others. Secondly, ETFs make it easy to assess the risk and return of the entire portfolio based on their characteristics. In addition, to some extent, with this approach, the task of filling the class with assets can be removed, because ETF diversified funds can be used. The task of portfolio investment, in fact, is more reduced to a strategic allocation. So, we used ETFs for analysis risk-return correspondence for agricultural assets.

It should be noted that we applied a complex view of the notion of "risk measurement". Modern financial risk theory considers different approaches to measure risk. Each approach reflects one or another property of the many-sided notion of "risk". We used three approaches to risk measurement. A first approach based on the classical view for risk measurement at the frameworks of variability. The second approach considers risk from point of view losses in a negative situation. The importance of such an approach is explained by using the regulative risk measure Value-at-Risk (VaR) and coherent risk measure Conditional Value-at-Risk (CVaR). The third approach is based on conception sensitivity. It is logically to use sensitivity analysis in concern both types of traditional assets – stocks and bonds. The results of using such a complex approach are a generalized estimation of risk characteristics changing. Such an approach provides a deeper understanding of investment risk frameworks.

2 Materials and methods

2.1 Risk measurement conception

Risk measurement in the frameworks of portfolio investment can be structured into two blocks. The first block is a risk assessment of an investment asset, considered separately. The second block focuses on assessing the relationship between asset returns and risk through diversification.

The first block of risk assessment supposes to introduce mapping μ which each return of investment asset R (interpreting as random variable) correspond some non-negative number $\mu(R) \subset [0;+\infty]$. The return of investment asset (in this paper – ETF) over a period of time $[t; t+1]$ will be expressed through the formula:

$$R_{t,\, t+1} = (P_{t+1} - P_t) \,/\, P_t \tag{1}$$

where P_t and P_{t+1} prices of ETF in USD at times t and t+1 correspondingly. $R_{t,\, t+1}$ will be a random variable, because the future price P_{t+1} is unknown. Thereafter R which reflect return through the time is also random variable. Mapping μ which corresponds to some rules interpret as risk measuring.

2.2 Investment risk measures approaches

There are many measures of investment risk present which formalise in mapping μ different logic of risk interpreting [33]. In our research, we have divided risk measuring into three conceptual approaches:

- Variability approach. Such an approach is based on the measurement of return`s variability (volatility). This approach goes back to the papers of H. Markowitz [21] and underlies the models of modern portfolio theory. Critiques of it using in the non-transparency connection between variability indicators and real losses.
- Losses in a negative situation. This more practical and regulative approach. It focuses on measuring possible losses and fulfill capital requirements.
- Sensitivity approach. According to such an approach, the risk is measured as the rate of response for occurring some factors.

Each of the abovementioned approaches had their pros and cons. Our point of that investment risk should be estimated by all these conceptual approaches. It provides multifaceted understanding of investment risk.

The logic of risk measuring leads to properties which reflect "natural properties" of risk. Trying to understand the essence of properties which should be represented in risk measure was formulated in [3]. Authors created the notion of coherent risk measure. Risk measure is coherent if satisfying following properties (axioms):

Axiom 1. Sub-additivity. For all random values presenting asset`s returns R_1 and R_2 we have

$$\mu\ (R_1 + R_2) \leq \mu(R_1) + \mu(R_2) \tag{2}$$

Axiom 2. Positive Homogeneity. For all R and for all $\lambda \geq 0$, we have

$$\mu(\lambda R) = \lambda\mu(R) \tag{3}$$

Axiom 3. Monotonicity: If $R_1 \geq R_2$ for all possible cases then

$$\mu(R_1) \leq \mu(R_2). \tag{4}$$

Axiom 4. Translation Invariance. For all R and for all $\alpha \geq 0$ which interpret as risk-free asset, we have

$$\mu(R+\alpha) = \mu(R)-\alpha. \tag{5}$$

Examples of coherent risk measures are Conditional Value-at-Risk (considered introduced below) [28] and T. Fischer measure [8]. It is necessary to note, that presented approach for coherency is not unique. Other approaches of coherency are considered in [18].

The second block of risk measurement in the portfolio aspect corresponds to estimate interrelations of returns of different asset classes. It can be estimated as average correlation, reducing the value of chosen risk measure for a naïve diversified portfolio or risk value for the portfolio with minimum risk.

Below we try to realize these ideas for agricultural ETFs.

2.3 Risk measurement throughout the period of shock

A financial shock is an exceptionally extraordinary event that affects the entire market. Therefore, the classical approaches to measuring risk may be ineffective and we used the following approach. Based on the analysis of the manifestation of COVID-induced shock, we divided the time interval into three periods. The first period is the "calm" period before the onset of the shock. The shock-related asset price changes began to show in the second half of January 2020. Therefore, we had to take 08/28/2019 to 01/15/2020 as the first period. The role of measuring risk in a given period serves as a benchmark for further changes.

As the second period, we have identified the period 01/16/2020 – 03/31/2020 – the direct manifestation of shock. The manifestation of COVID-induced shock was, in a sense, a classic manifestation of shock. Namely, it had the form Sign of "tick". At first, the onset of a shock is a gradual fall in asset prices, and then a sharp and deep fall. The shock drop was on 03/17/2020 for the studied assets. After that, a gradual slow price recovery begins. Moreover, at first, after the maximum fall, there is a "rollback", and then the dynamics stabilize. Thus, as the post-shock period, we have defined the period 04/01/2020 to 08/14/2020.

The use of classical risk measures is not correct due to a sharp fall in a short period. To display risk during a shock period, we have proposed an approach based on two parameters. The first parameter characterizes the depth of the fall, and the second – the level of recovery over a certain period. The parameter that characterizes the depth of the fall is calculated by us as the ratio of the lowest price to the average price for 1,5 months before the start of the shock period. And the second parameter is calculated based on the average stabilization price after the maximum decline. In our case, for calculating average prices, we took the periods 12/01/2019–01/15/2020 and 05/01/2020–06/15/2020.

The logic for calculating the parameters is shown in the fig. 1 for SPY (ETF which correspond to leading stock index S&P500).

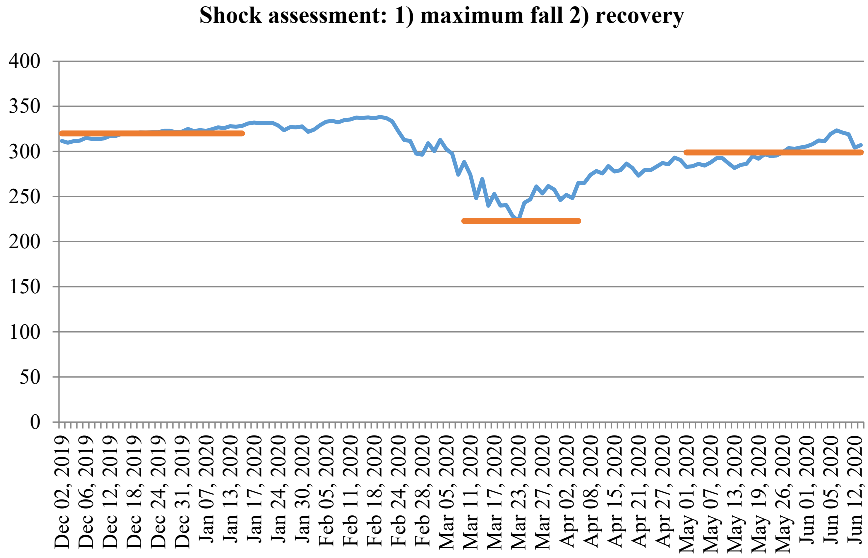


Fig. 1. Parameters of risk during shock period for SPY.

As the third, for this period, we have applied standard approaches to measuring risk. They are compared with the values of these parameters in the first period. The economic sense of the study is in assessing the risk changes as a result of shock.

3 Results and discussion

3.1 Literature review

There has been a lot of academic studies that have addressed agricultural investment and agriculture assets. The last of them are [2; 5; 6; 7; 15; 16; 27; 36].

Martin and Clapp [22] investigated the relationship between agriculture, finance, and the state. In [10] the authors analyzed the relation between the notional value of commodity futures contracts and expected returns on futures contracts.

ETFs as financial instruments investigated in [14] and [32]. Petajisto proposed a method for ETFs mispricings detection [25].

The global challenges caused by COVID have updated crisis and shock research. The analysis of the impact of macroeconomic changes on the financial market was conducted in [1; 11; 17; 19; 24; 26; 30]. Financial security level analysis in order to timely detect and neutralize possible crisis phenomena presents in [9; 13; 20].

Forecasting the dynamics of financial markets during the crisis is studied in [23; 31; 34; 35].

In spite of shortness time after COVID-induced shock, there are a lot of papers described this phenomenon. The uncertainty which have raised from this shock is analyzed in [4].

In new European Banking Study 2020, was quantified COVID induced effects on balance sheets and P&Ls of Europe's 50 largest banks and set out the implications for bank management, governments, and regulators [12].

3.2 Sample of agricultural ETFs

Our sample of agricultural ETFs was created on the base of capitalization level of such financial instrument which traded in the USA which are currently tagged by ETF Database. It is necessary to note that we use term ETF in extend sense which include both instruments which tracking indices: ETF and ETN. Of course, we pay attention for the differences between these instruments, but our main focus for the conceptual essence of tracking indices, after that we did not differentiate ETF and ETN in our paper and use one term ETF.

Agriculture ETFs invest in agriculture commodities including sugar, corn, soybeans, coffee, wheat and other. It can be single commodity fund or diversified fund. We have formed sample (11 components) based on total assets volume by following ETFs (ETN).

CORN. This ETF corresponds to Teucrium Corn Fund which tracks an index of corn futures contracts.

COW. This ETN offers an opportunity for investors to gain exposure to hogs and cattle iShares Global Agriculture Index ETF.

DBA. This ETF corresponds to diversified basket of various agricultural natural resources.

FUD. This is ETN, associated with futures-based index that measures the collateralized returns from a basket of 11 futures contracts from the agricultural and livestock sectors.

JJSF. This is ETN which connected with sugar futures.

NIB. This ETN offers exposure to cocoa futures.

RJA. RJA ETN tracks Rogers International Commodity Index-Agriculture which is consumption-based index of agricultural commodities.

UAG. Exchange-traded note which offers exposure to a number of agricultural commodities, including corn, soybeans, wheat, coffee, cocoa, and other natural resources.

CANE. This ETF offering exposure to the commodity of sugar.

SOYB. This ETF invests in soybean futures contracts.

WEAT. This ETF offers exposure to wheat futures contracts.

The following ETFs were chosen for comparison agricultural ETFs with traditional assets ETFs.

SPDR's **SPY** to model the large-cap public equities, it tracks the Standard & Poor's 500 and is the oldest and largest of all ETFs.

SPDR's **MDY** that tracks the Standard & Poor's 400 to model the mid-cap equities, while being smaller than iShares IJH it has about the same turnover but offers a longer time series.

iShares **IJR** to model the small-cap companies, it tracks the Standard & Poor's 600 index and is much larger and liquid than the corresponding SPDR fund SLY.

iShares **IEF** to model a balanced portfolio of Treasury bonds, the choice of this particular government bond fund is motivated by its duration 7,6 years that is comparable to the duration of other bond funds analyzed in this paper.

iShares **LQD** to model a balanced portfolio of investment-grade corporate bonds, it's one of the oldest bond ETFs and its duration (8,5 years) is approximately the same as for the IEF fund mentioned above, so we can contrast government and corporate bonds.

iShares **TIP** to model inflation-linked bonds, an asset class that should have quite a distinct characteristic, however its duration (7,6 years) aligned to LQD and IEF.

3.3 Measurement of shock characteristics

The measurement of the characteristics of the shock was carried out, as noted above, within the framework of 01/16/2020–03/31/2020 based on two indicators. The first indicator is the depth of the fall (fig. 2). In the context of our work, it can be interpreted as a "measure of risk in shock conditions". The second indicator, the percentage of recovery after a fall, can be interpreted as "profitability in a shock". The economic meaning of this parameter can be interpreted in two directions. First, this is a formal interpretation of the situation to buy assets at a low point and receive income in the recovery process. The second direction concerns the comparison of the falling percentage and the recovery percentage.

Two observations are interesting. The first is that ETFs that match stock indices (especially MDY and IJR) have a deeper fall than most agricultural ETFs. However, the recovery rate is higher. The second observation is that ETFs of bonds did not have a great dip and a recovery rate of about 100%, or even more. The first indicates a high sensitivity of stocks to shock, while bonds are in high demand. Agricultural ETFs are in the middle.

3.4 The variability approach to risk measurement

Table 1 present the comparative analysis which was realized twofold. One side characterizes differences in risk measures prior to and post-shock. The other side characterizes differences of risk measures for alternative and traditional assets. Prior to the shock agricultural ETFs indicate higher values of range than traditional assets (on average close to two times more). After the shock, the widening of the range had concerned both types of assets, but growth of range for traditional assets was essentially more. So, post-shock average ranges for traditional and agricultural ETFs approximately equal. The average growth of ranges in returns was 4% for agricultural ETFs and 5,8% for traditional assets.

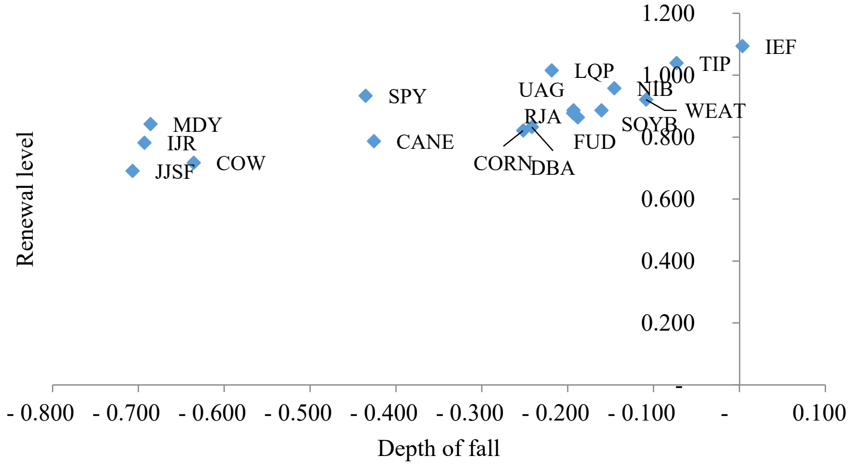


Fig. 2. Depth of fall via renewal level.

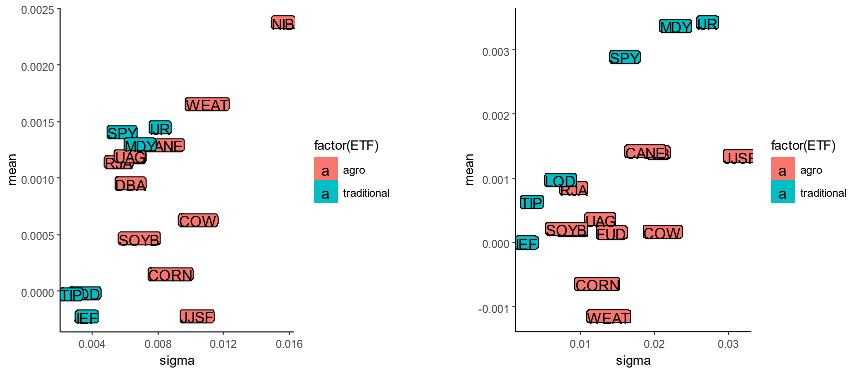
Table 1. Statistical analysis for risk measures. Agricultural ETF.

ETF	min		max		mean		std		skewness		kurtosis	
	Before shock	Post-shock	Befo-re shock	Post-shock	Befo-re shock	Post-shock	Before shock	Post-shock	Before shock	Post-shock	Before shock	Post-shock
Agricultural ETF												
CORN	**-0,025**	-0,031	0,031	**0,037**	0,000	-0,001	0,009	**0,012**	**0,650**	0,142	1,942	**0,948**
COW	**-0,030**	-0,062	0,040	**0,065**	0,001	0,000	0,010	**0,021**	**0,444**	0,289	1,973	**2,048**
DBA	**-0,022**	-0,027	**0,026**	0,024	0,001	0,000	0,006	**0,009**	**0,382**	0,053	**2,925**	0,531
FUD	**-0,020**	-0,051	0,017	**0,044**	0,001	0,000	0,006	**0,014**	**0,006**	-0,185	0,691	**1,729**
JJSF	**-0,051**	-0,073	0,018	**0,085**	0,000	**0,001**	0,010	**0,032**	-1,260	**0,154**	**4,694**	0,342
NIB	**-0,030**	-0,058	0,051	**0,065**	**0,002**	0,001	0,016	**0,020**	**0,262**	0,185	-0,124	**0,642**
RJA	**-0,009**	-0,028	0,021	**0,025**	**0,001**	0,001	0,006	**0,009**	**0,882**	-0,424	**1,525**	0,961
UAG	**-0,012**	-0,052	0,022	**0,056**	**0,001**	0,000	0,006	**0,013**	**0,561**	0,065	0,589	**5,571**
CANE	**-0,015**	-0,052	0,021	**0,041**	0,001	**0,001**	0,008	**0,019**	**0,151**	-0,172	-0,314	**0,401**
SOYB	**-0,014**	-0,025	**0,031**	0,022	**0,000**	0,000	0,007	**0,008**	**0,826**	-0,069	**3,581**	0,765
WEAT	**-0,020**	-0,031	0,030	**0,044**	**0,002**	-0,001	0,011	**0,014**	0,412	**0,498**	-0,365	**0,363**
ETF of traditional assets												
SPY	**-0,018**	-0,046	0,014	**0,067**	0,001	**0,003**	0,006	**0,016**	-0,482	**0,034**	0,840	**2,870**
MDY	**-0,019**	-0,060	0,017	**0,081**	0,001	**0,003**	0,007	**0,023**	-0,188	**0,127**	0,581	**1,219**
IJR	**-0,020**	-0,070	0,025	**0,082**	0,001	**0,003**	0,008	**0,027**	**0,282**	0,092	**0,500**	0,367
IEF	-0,009	**-0,006**	0,009	**0,009**	0,000	**0,000**	**0,004**	0,003	-0,268	**-0,236**	-0,113	**0,707**
LQD	**-0,009**	-0,017	0,008	**0,047**	0,000	**0,001**	0,004	**0,007**	-0,384	**-0,085**	-0,013	**0,244**
TIP	**-0,006**	-0,009	0,006	**0,015**	0,000	**0,001**	0,003	**0,003**	-0,086	**0,434**	-0,263	**0,198**

The situation with standard deviation (std) is similar by essence. Growth of std was for both types of assets, but std for traditional assets demonstrated a faster pace. Average growth of std in returns was 0,68% for agricultural ETFs and 8,1% for traditional assets.

A very interesting difference between agricultural ETFs and traditional assets for average return before and post-shock. They have equal average returns before shock but traditional assets post-shock demonstrated triple higher average returns. At the same time agricultural ETFs shown changing positive returns for negative.

The changing of risk-return correspondence prior to and post-shock is illustrated by Fig. 3. It is very interesting that post-shock traditional assets form exactly efficient frontier at the Markowitz sense.



a) 08/28/2019 – 01/15/2020 b) 04/01/2020 – 08/14/2020

Fig. 3. ETFs risk-return correspondence.

It is interesting results we can identify by analysis of skewness, which indicates divergence from symmetry. Negative skewness indicates a long-left tail of the distribution or the possibility of larger losses than profits. Positive skewness is a desirable characteristic for risk-averse investors. The motivation of that is based on the expected utility theory.

From this point of view, agricultural ETFs have demonstrated higher positive skewness before shock than after. Traditional assets quite the contrary was demonstrated better skewness post-shock. Kurtosis indicators were growth post-shock for traditional assets and were multidirectional for agricultural ETFs.

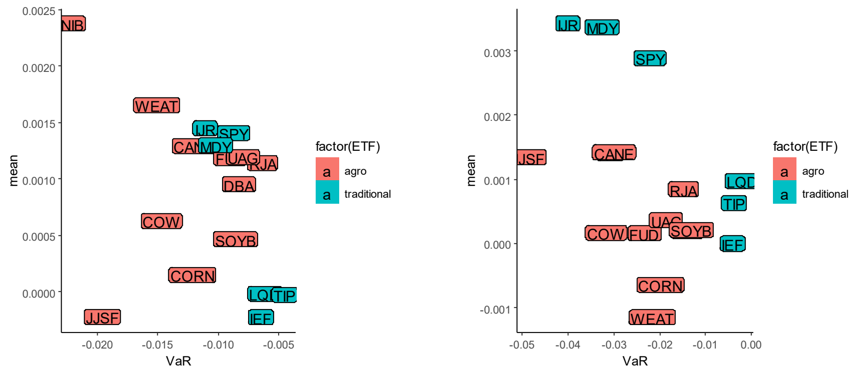
3.5 Risk measurement as losses in a negative situation

This conceptual approach is based on considering measures relating to the interpretation of "negative situation" for the investor. The most popular in this group is Value-at-Risk (VaR), which presents a quantile of the probability distribution function. This quantile corresponding to some level of safety (it maybe 95%, 99%, or 99,9%). The logic of VaR is based on risk covering. If, for example, VaR orients for 95%, then 5% biggest losses will throw off. VaR will cover maximum losses at the framework of 95% possibilities. Risk measure Conditional Value-at-Risk (CVaR) is based on a generalization of VaR. This is the conditional mathematical expectation of losses which higher than VaR (table 2).

Table 2. Risk measurement of ETFs by VaR and CVaR.

ETFs	VaR		CVaR	
	Before shock	Post-shock	Before shock	Post-shock
Agricultural ETFs				
CORN	**-0,012**	-0,020	**-0,017**	-0,028
COW	**-0,015**	-0,032	**-0,020**	-0,049
DBA	**-0,008**	-0,014	**-0,012**	-0,019
FUD	**-0,009**	-0,023	**-0,012**	-0,033
JJSF	**-0,020**	-0,049	**-0,026**	-0,065
NIB	**-0,022**	-0,031	**-0,027**	-0,039
RJA	**-0,006**	-0,015	**-0,008**	-0,022
UAG	**-0,008**	-0,019	**-0,010**	-0,028
CANE	**-0,012**	-0,030	**-0,014**	-0,043
SOYB	**-0,009**	-0,013	**-0,013**	-0,018
WEAT	**-0,015**	-0,022	**-0,018**	-0,024
ETFs of traditional assets				
SPY	**-0,009**	-0,022	-0,013	-0,035
MDY	**-0,010**	-0,033	-0,015	-0,045
IJR	**-0,011**	-0,040	-0,0**16**	-0,051
IEF	-0,006	**-0,004**	-0,008	**-0,005**
LQD	-0,006	**-0,002**	**-0,008**	-0,011
TIP	-0,005	**-0,004**	**-0,006**	-0,007

Considering risk measuring for agricultural ETFs we have found that Value-at-Risk and Conditional Value-at-Risk is higher than similar values for traditional assets but not so much. This fact true for both periods prior to and post-shock. Fig. 4 demonstrates the risk-return correspondence between VaR and average returns.



a) 08/28/2019 – 01/15/2020 b) 04/01/2020 – 08/14/2020

Fig. 4. ETFs Value-at-Risk.

Not less excitingly the comparison of changing risk measures values for an approach based on losses in negative situations. In contrast to the results for variability risk measuring here agricultural ETFs indicated higher growth.

It is an interesting conclusion that ratio CVaR/VaR is a good indicator of the distinction of risk. The ratio CVaR/VaR characterizes correspondence between "catastrophic" losses and maximal losses at the frameworks of 95% safety level. This ration became extremely higher for traditional assets than for agricultural ETFs. The changes of CVaR/VaR for agricultural ETFs are negligible in comparison with traditional assets. These values for traditional values had grown 1,6 times on average.

3.6 Risk measurement based on sensitivity approach

Risk measurement at the frameworks of sensitivity analysis provides an opportunity to understand the role of systematic and non-systematic risks. We have chosen for sensitivity analysis SPY as systematic factors. The logic of this choice lies in interpreting the S&P 500 as a leading factor in the stock market. And analysis should provide an answer to the question: How the stock market as a whole affect the return of ETFs? (table 3)

Table 3. Regression analysis.

	SPY beta coefficient		Intercept		R^2		p-value	
	Before shock	Post-shock	Before shock	Post-shock	Before shock	Post-shock	Before shock	Post-shock
Agricultural ETFs								
CORN	0,0214	**0,2134**	0,0014	**0,0030**	0,0010	**0,0266**	**0,7534**	0,1107
COW	**0,0817**	0,0728	0,0014	**0,0029**	**0,0217**	0,0092	0,1498	**0,3487**
DBA	0,0650	**0,6853**	0,0013	**0,0028**	0,0050	**0,1438**	**0,4907**	0,0001
FUD	**0,0718**	0,0045	0,0013	**0,0029**	**0,0061**	0,0000	0,4469	**0,9687**
JJSF	0,0402	**0,3432**	0,0014	**0,0024**	0,0052	**0,4612**	**0,4829**	0,0000
*NIB	-0,0097	**0,2578**	0,0014	**0,0025**	0,0007	**0,1094**	**0,7993**	0,0009
RJA	0,2028	**0,6773**	0,0012	**0,0023**	0,0384	**0,1465**	**0,0545**	0,0001
UAG	0,0138	**0,3302**	0,0014	**0,0028**	0,0002	**0,0682**	**0,8839**	0,0098
CANE	-0,0695	**0,2528**	0,0015	**0,0025**	0,0100	**0,0879**	**0,3295**	0,0032
SOYB	0,0632	**0,8562**	0,0014	**0,0027**	0,0056	**0,1883**	**0,4663**	0,0000
WEAT	0,0866	**0,1820**	0,0013	**0,0031**	**0,0270**	0,0247	0,1075	**0,1242**
ETFs of traditional assets								
MDY	**0,7303**	0,6355	0,0005	**0,0007**	0,7545	**0,8264**	0,0000	0,0000
IJR	**0,5297**	0,5050	0,0006	**0,0012**	0,5524	**0,7376**	0,0000	0,0000
IEF	**-0,6213**	-2,802	0,0013	**0,0029**	0,1538	**0,2170**	**0,0001**	0,0000
LQD	-0,2184	0,9809	0,0014	**0,0019**	0,0176	**0,1990**	**0,1951**	0,0000
TIP	-0,4011	0,**0241**	0,0014	**0,0029**	**0,0348**	0,0000	0,0672	**0,9606**

The main result is very low R-squared indicators. The economic consequence of this is the domination of nonsystematic risks in returns of agro ETFs.

3.7 Correlation analysis

Correlation analysis was provided as inside the sample of agriculture ETF as between traditional assets. It is interesting that agriculture ETFs indicate a very low correlation not only with traditional assets but inside the sample group (table 4). This leads to consideration of portfolio construction directly through agricultural ETFs and through all types of ETFs.

Table 4. Correlation analysis

	Average correlation between sample agriculture ETFs	Average correlation between sample agriculture ETFs and sample of ETFs of traditional assets	Average correlation between sample traditional asset
Before shock	0,31	0,02	0,30
Post-shock	0,33	0,11	0,35

We think that so low correlation can be explained by affecting these ETFs real prices of agricultural products. Not by supply and demand as it appears at the stock market.

4 Conclusion

Risk-return correspondence for different asset classes one of the cornerstones of modern portfolio management. This correspondence together with interdependency analysis allows us to form a portfolio structure that is adequate to given goals and constraints. But "pandemic risk" broke into the investment world and created uncertainty and turmoil. This is a real "black swan" event in terms of Nassim Nicolas Taleb. How much risk investments will involve post-shock? What returns can investors expect? We believe strongly that search answers for these questions will be an actual topic for active research in the nearest future.

Our paper is concentrated on one of such questions. How agricultural commodities expressed by agricultural ETFs pass through COVID-induced shock? How to transform their risk-return correspondence in comparison with traditional assets? The search for the answer was realized through different approaches to risk measurement. First of all was highlighted three time periods: specifically shock period, the quiet period before the shock, and post-shock. It was considered three basic approaches for risk measurement: variability, losses in negative situations, and sensitivity. Correlation analysis also was realized.

Conclusions are the following. Traditional assets (stock indices) demonstrated a higher depth of falling but at the same time higher level of recovery. Indices of bonds not so much falling and then increased in price higher previous level. Agricultural ETFs demonstrated an average level of falling and moderate recovery. The general conclusion lies in increasing risk after shock as for agricultural ETFs as for traditional. It is interesting that risk changing for the first two approaches provides us a discrepancy that is presenting in fig. 5. The variability approach indicated that ranges and standard deviations of traditional asset returns are increased higher. In the meantime, returns of agricultural ETFs demonstrated higher increments in VaR and CVaR. Average returns of agricultural ETFs moved down at the post-shock time but average returns of traditional assets moved up. So, the reaction for shock is different at the frameworks of approaches of risk measuring.

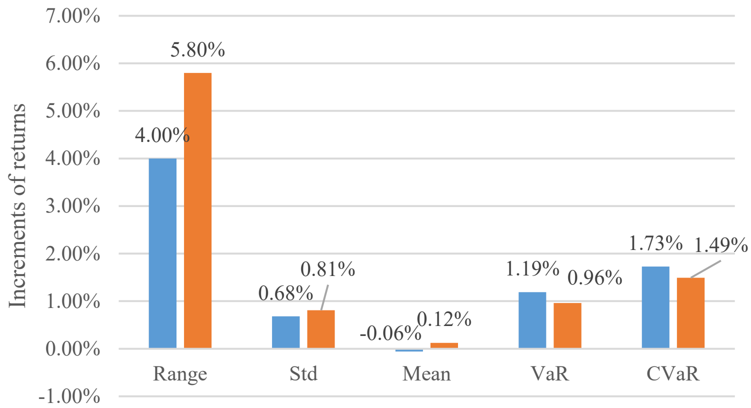


Fig. 5. Growth/falling of risk measures values in absolute increments of returns.

The results of applying sensitivity risk measuring illustrate increasing beta-values to returns of SPY, but R-squared is essentially low as before as after crises. These are confirmed by correlation analysis which shows low correlations. These estimations confirm facts effective diversification between traditional asset classes and alternatives which involved agricultural ETFs.

Summarizing results, it is possible to note differences path of shock and post-shock period for agricultural ETFs and traditional assets.

References

1. Aikman, D., Lehnert, A., Liang, N., Modugno, M.: Financial vulnerabilities, macroeconomic dynamics, and monetary policy. Finance and Economics Discussion Series 2016-055. Board of Governors of the Federal Reserve System, Washington (2016). doi:10.17016/FEDS.2016.055
2. Andreasson, P., Bekiros, S., Nguyen, D.K., Uddin, G.S.: Impact of speculation and economic uncertainty on commodity markets. International review of financial analysis **43**, 115–127 (2016)
3. Artzner, P., Delbaen, F., Eber, J.M., Heath, D.: Coherent measures of risk. Mathematical finance **9**(3), 203–228 (1999)
4. Baker, S., Bloom, N., Davis, S., Terry, S.: COVID-induced economic uncertainty. NBER Working Paper No. 26983. National Bureau of Economic Research, Cambridge (2020). doi:10.3386/w26983
5. Chen, S., Wilson, W., Larsen R., Dahl, B.: Investing in Agriculture as an Asset Class. Agribusiness **31**, 353–371 (2015)

6. Clapp, J.: Responsibility to the rescue? Governing private financial investment in global agriculture. Agriculture and human values **34**(1), 223–235 (2017)
7. Clark, B., Detre, J., D'Antoni, J., Zapata, H.: The role of an agribusiness index in a modern portfolio. Agricultural Finance Review **72**(3), 362–380 (2012)
8. Fischer T.: Risk capital allocation by coherent risk measures based on one-sided moments. Insurance: Mathematics and Economics **32**, 135–146 (2003)
9. Fischer, T., Krauss, C.: Deep learning with long short-term memory networks for financial market predictions. European Journal of Operational Research **270**(2), 654–669 (2018)
10. Hamilton, J., Wu, J.: Effects of index-fund investing on commodity futures prices. International economic review **56**(1), 187–205 (2015)
11. Hau, H., Lai, S.: The role of equity funds in the financial crisis propagation. Review of Finance **21**(1), 77–108 (2017)
12. Holländer, D., Bauer, E., Mrusek, F., Rotermann, B.: European Banking Study 2020: How COVID might affect Europe's banks. https://www.bankinghub.eu/banking/research-markets/european-banking-study-COVID (2020). Accessed 17 Aug 2020
13. Hryhoruk, P., Khrushch, N., Grygoruk, S.: An approach to design a composite index of economic development and identifying the bounds of its levels. Paper presented at the 9th International Conference on Advanced Computer Information Technologies (ACIT), pp. 48–51. IEEE, June 2019. doi:10.1109/ACITT.2019.8779918
14. Jensen, G.R., Mercer, J. M.: Commodities as an Investment. The Research Foundation of CFA Institute Literature Review **6**(2), 1–33 (2011)
15. Johnson, M., Malcolm, B., O'Connor, I.: The Role of Agribusiness Assets in Investment Portfolios. Australasian Agribusiness Review **14**, 11 (2006)
16. Kaminskyi, A., Nehrey, M.: Investment Risk Measurement for Agricultural ETF. Advances in Economics, Business and Management Research **95**, 325–329 (2019)
17. Kaminskyi, A., Versal, N.: Risk management of dollarization in banking: case of post-soviet countries. Montenegrin Journal of Economics **14**(3), 21–40 (2018)
18. Kaminskyi, A.: Financial Risk Modeling. National Taras Shevchenko University, Kyiv (2007)
19. Kuzheliev, M., Zherlitsyn, D., Rekunenko, I., Nechyporenko, A., Nemsadze, F.: The Impact of Inflation Targeting on Macroeconomic Indicators in Ukraine. Banks and Bank Systems **15**(2), 94–104 (2020)
20. Liu, C., Arunkumar, N.: Risk prediction and evaluation of transnational transmission of financial crisis based on complex network. Cluster Computing **22**(2), 4307–4313 (2019)
21. Markowitz, H.: Portfolio Selection: Efficient Diversification of Investment. John Wiley & Sons Ltd, New York (1959)
22. Martin, S., Clapp, J.: Finance for agriculture or agriculture for finance? Journal of Agrarian Change **15**(4), 549–559 (2015)
23. Matviychuk, A.: Fuzzy logic approach to identification and forecasting of financial time series using Elliott wave theory. Fuzzy economic review **11**(2), 51 (2006)
24. Paul, P.: A macroeconomic model with occasional financial crises. Journal of Economic Dynamics and Control **112**, 103830 (2020)
25. Petajisto, A.: Inefficiencies in the pricing of exchange-traded funds. Financial Analysts Journal **73**(1), 24–54 (2017)
26. Racicot, F.É., Théoret, R.: Macroeconomic shocks, forward-looking dynamics, and the behavior of hedge funds. Journal of Banking & Finance **62**, 41–61 (2016)
27. Rasool, A.: Investing in Agribusiness Stocks and Farmland: A Boom or Bust Analysis. Dissertation, Utah State University (2018)

28. Rockafellar, R., Uryasev, S.: Optimization of conditional Value-At-Risk. The Journal of Risk **2**(3), 21–41 (2000)
29. Semerikov, S., Chukharev, S., Sakhno, S., Striuk, A., Osadchyi, V., Solovieva, V., Vakaliuk, T., Nechypurenko, P., Bondarenko, O., Danylchuk, H.: Our sustainable coronavirus future. E3S Web of Conferences **166**, 00001 (2020). doi:10.1051/e3sconf/202016600001
30. Skrypnyk, A., Nehrey, M.: The Formation of the Deposit Portfolio in Macroeconomic Instability. CEUR Workshop Proceedings **1356**, 225–235 (2015)
31. Spelta, A., Flori, A., Pecora, N., Pammolli, F.: Financial crises: uncovering self-organized patterns and predicting stock markets instability. Journal of Business Research (2019, in press). doi:10.1016/j.jbusres.2019.10.043
32. Stoll, H., Whaley, R.: Commodity index investing and commodity futures prices. Journal of Applied Finance **20**(1) (2010)
33. Szegö, G.P.: Risk measures for the 21st century, vol. 1. Wiley, New York (2004)
34. Tiwari, A.K., Albulescu, C.T., Yoon, S.M.: A multifractal detrended fluctuation analysis of financial market efficiency: Comparison using Dow Jones sector ETF indices. Physica A: Statistical Mechanics and its Applications **483**, 182–192 (2017)
35. Uthayakumar, J., Metawa, N., Shankar, K., Lakshmanaprabu, S.K.: Financial crisis prediction model using ant colony optimization. International Journal of Information Management **50**, 538–556 (2020)
36. Valdes, R.: What drives the regional integration of agribusiness stocks? Evidence in worldwide perspective. Paper presented at the 2017 Annual Meeting, Agricultural and Applied Economics Association, Chicago, Illinois, July 30-August 1 (2017). doi:10.22004/ag.econ.258265