

# Complex Risk Analysis of Investing in Agriculture ETFs

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Received 10 August 2020; Revised 10 September 2020; Accepted 20 October 2020; Published online 30 October 2020  
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## ABSTRACT

*The aim of the paper is to present a complex risk analysis of investing in agriculture Exchange Trade Funds (ETFs). The specific characteristics of agricultural investments should be taken into account as from the direct financial investments into agricultural ETFs, as for the general portfolio approach applying. To achieve the objectives of the work, the authors structured agriculture ETFs into 6 classes, which represent different types of ETFs. A special sample of 26 agricultural ETFs was formed. A complex risk analysis consisted of applying 5 different conceptual approaches to measuring investment risk. In particular, approaches based on measuring variability, applying the concept of Value-at-Risk are applied. The approach of estimating the shocks of changes in the profitability of the asset class in question is applied. The risk level in the aspect of sensitivity to changes in stock returns, bonds and the uncertainty index EPU is investigated. Built portfolios with minimal risk. Obtained results can be applied for investment decisions.*

**KEYWORDS:** Exchange trade funds; Portfolio management; Agriculture; Investment; Risk measurement.

## 1. Introduction

Investing in agriculture is of interest to investors and is in the focus of attention. This is due to a wide range of investment characteristics of this asset class. So, in the strategic plan there is always a demand for agricultural products, and, therefore, we can expect positive returns in the long term. On the other hand, the risks of such investments are to some extent independent of the risks of investments in other segments (in particular, yield volatility). Therefore, we can expect the manifestation of the diversification effect when combining in the portfolio of investments in agricultural assets with others.

The construction of such portfolios can be implemented on the basis of different approaches and tools representing agricultural assets. In this paper, we use an approach based on investing in agro Exchange Trade Funds (ETFs), which we consider to be the most advanced. The advantage of this approach is that on its basis it is possible to fully use all the tools of modern portfolio

theory. It is this approach that we have chosen as the basis for research in this paper. We have formed a sample of agricultural ETFs, which covers both different segments of this market, and different ETFs by construction. The sample includes 26 ETFs, which are structured into 6 classes.

The main idea of the work is a comprehensive assessment of the risk of investing in agricultural ETFs at the level of these classes (and not individual ETFs). The complexity of the analysis we understand in two aspects. The first aspect is risk analysis and assessment using various approaches, and the second aspect is the consideration of the portfolio approach.

When considering a complex analysis and assessment of investment risks, the following approaches were used. The first approach was to analyze risks in terms of profitability variability. In fact, this goes back to the classical approach of G. Markowitz [1], who used the standard deviation as an indicator of risk. We have applied a set of indicators of variation. The second approach that we use is a risk analysis based on the concept of Value-at-Risk, which is normative for measuring market risks. An important measure of risk, in this case, is the notional value at risk, the advantage of which is the coherence property. This property is associated with the use of the risk-sharing method, which is associated with portfolio investments. The third approach to

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the analysis of investment risk presented to us and the work is based on the concept of sensitivity. We analyzed the extent to which ETF returns respond to three systematic factors: SPDR S & P 500 (SPY) returns, US Aggregate Bond ETFs (AGGs), and relative changes in the EPU. This analysis reflects the correlation between systematic and unsystematic risks. In the fourth approach, we tried to build an indicator of the risk of shock changes in the profitability of the ETFs under consideration.

In terms of the portfolio approach, we conducted a correlation analysis of ETF returns from different classes and created portfolios with minimal risk for several approaches. This provides an understanding of the relationship between profitability and risk for the agricultural investment class as part of a wider investment portfolio.

The structure of the work is as follows. Section 2.1 contains a review of the literature on the issues addressed in the article. Section 2.2 contains the main reasons and forms of agricultural investing. Section 2.3 describes agriculture ETFs and ETNs as investment classes. Section 3.1 includes a description of the analysis and risk assessment approaches that we calculated in this study. Section 3.2 focuses on our sampling approach. The results of our comprehensive risk analysis are presented in Section 3.3 and conclusions in Section 3.4.

## 2. Results and Discussion

### 2.1. Literature review

There has been a lot of academic studies that have addressed agricultural investment and agriculture assets. The last of them are [2] - [9].

Martin and Clapp [10] investigated the relation between agriculture, finance, and the state. In [11] 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 [12], [13]. A. Petajisto proposed a method for ETFs mispricings detection [14].

### 2.2. Reasons and forms of investing in agriculture

There are several basic reasons for investing in agriculture. One of the most basic is that there will always be demand for these products. Its consumption lies in the "basis of the existence of people." Therefore, strategically, this is an area with stable demand. In this case, two factors can be added. The first factor is population growth on earth, which naturally increases the demand for agricultural products. The second factor is the

development of the middle class, which helps to improve the quality of consumer products.

The second reason is the use of agricultural products in industrial production. A typical example is ethanol production. It is used as fuel, in the chemical industry, in the production of perfumes and cosmetics, and in a number of other areas. Its demand in the industry determines the demand for agricultural products: grain (rye, wheat), potatoes, corn, and other apples.

In the investment aspect, several forms of investing in agro-industrial assets can be distinguished. One form is a classical investment in different publicly-traded companies that operate in the farming sector. These companies range from those that directly grow and produce crops to those working in a variety of industries that support farmers. This is a traditional asset and may be considered as a classical investment. Which may direct or portfolio investment.

The other form is mutual funds that invest in the farming and agriculture industries. It may be different in investment strategies. One mutual may be focusing on investment in agriculture-related firms, others include investments in commodities. Other types of mutual funds may follow the diversity strategy. Their funds have exposure to different sectors along with agriculture. When investing in mutual funds, investors need to consider fees.

A common form is investing in farming-focused real estate investment trust (REIT). These REITs typically purchase farmland and then lease it to farmers. Farmland REITs offer many benefits. For one thing, they provide much more diversification than buying a single farm, as they allow an investor to have interests in multiple farms across a wide geographic area. Farmland REITs also offer greater liquidity than does own physical farmland, as shares in most of these REITs can be quickly sold on stock exchanges. And farmland REITs also decrease the amount of capital needed to invest in farmland, as a minimum investment is just the price of one REIT share. Investing in REIT is an example of an alternative investment.

Finally, the form of investing in the use of investing in ETFs and ETNs, which is considered in our work. A description of this form of investment is presented in the following paragraph.

### 2.3. Agriculture ETF as alternative investments

Exchange-traded funds (ETFs) are investment funds that have been created in order to replicate the performance of market indices or sub-indices.

The first ETF was organized in 1989. It went under the name Index Participation Shares (IPS) and was an S&P 500 proxy. The statistic presents the development of assets of Exchange Traded Funds worldwide last decade. In 2018, the assets managed by ETFs globally amounted to approximately 5.02 trillion U.S. dollars and the number of ETFs reached approximately 6500 [15].

The advantages of ETFs over mutual funds are, among other things, lower costs, the possibility of tracking the performance of the whole market rather than investing in single stocks, and potentially better investment results, as active fund managers tend to underperform the market.

One of the parts of today's ETF worldwide is Alternative ETF. Alternatives refer to investments that fall outside of the conventional asset class buckets, which are stocks, bonds, and cash. Alternatives ETFs offer exposure to alternative asset classes. There are various alternative classifications but typically are divided into 5 alternative classes: Private Equity, Venture capital, Real Estate, Commodities, Hedge Funds.

At these frameworks, it is possible to choose agricultural ETF of different approaches. The first approach based on Agricultural commodity ETFs. Agricultural commodity ETFs are funds that invest in companies that produce agricultural products such as grains, dairy, and livestock. These funds can invest in a bundle of commodity types, or focus on one specific commodity. So, here we can form 2 classes: 1) ETFs, corresponding to one specific commodity 2) ETFs, corresponding to a bundle of commodity types.

Another approach involves equity-based exposure to agriculture and natural resources. It is important to note that these ETFs are distinct from exchange-traded products that provide futures-based exposure to commodities. Futures based ETPs have very unique characteristics since they do not track spot prices and are also impacted by futures roll costs. Equity-based commodity ETFs are also not 'pure commodity plays' since they are correlated with the broader equity market and incorporate company-specific management risk. However, they do provide investors with convenient and low-cost access to

agri-commodity and natural resources driven businesses [16].

There is no universally accepted classification scheme for these ETFs, and we have therefore grouped them into four categories for purposes of comparison and analysis:

- Agri-business ETFs;
- Water themed ETFs;
- Timber & Forestry Themed ETFs;
- Diversified Natural Resources ETFs.

We follow the approach which includes 6 abovementioned classes of ETFs.

### 3. Experimental Procedure

#### 3.1. The variability approach for risk measurement

The variability approach is focused on dispersion or deviation from an expected outcome. The most simple risk measure is a range which equals to the difference between the maximum and minimum possible values:

$$L(R) = \max_{[0,T]} R(t) - \min_{[0,T]} R(t).$$

This risk indicator is important for investors from the point of view of receiving a general picture of future possibilities (it is assumed that future distribution will be the same as historical distribution). The shortcoming of this risk indicator is that the maximum and minimum prices were on peak and crisis time. These may be rare events and not relevant for periods of stability. Consequently, it is more efficient to use the interquartile range:

$$Q(R) = Q_{75\%}(R(t)) - Q_{25\%}(R(t)).$$

Of course, the most famous risk measure using in this approach is standard deviation which characterizes deviation from mean value:

$$\sigma(R) = \sqrt{\int_{-\infty}^{+\infty} (R - E(R))^2 dF(R)}.$$

An unbiased estimate of standard deviation is

$$\hat{\sigma}(R) = \sqrt{\frac{1}{T-1} \sum_{t=1}^T (R(t) - E(R))^2}.$$

Tab. 1. ETFs risk (variability approach)

	Specificity	Basket	Agri-business	Water	TFT	DNR
range	0,259	0,232	0,204	0,182	0,282	0,224
mean	0,007	0,000	0,003	0,013	0,008	0,007
std.dev	0,055	0,043	0,042	0,036	0,052	0,050

The other indicators which can be used for risk measurement at the frameworks of the variability approach are skewness and kurtosis.

### 3.2. Risk measurement as Value-at-Risk

This conceptual approach is based on considering different measures relating to the interpretation of “negative situation” for the investor. Among others, it is possible to mark out the downside deviation risk measure. This measure focuses on the returns below MAR (minimum acceptable return). MAR should be considered as a minimum threshold. Another risk measure at analyzing frameworks is TUW (time under the water). This measure calculates how long does the investor wait to recover its money at the start of the down period. But, of course, the most popular in this group is the left-tail risk measures, such as Value-at-Risk (VaR) (Holton 2003). This risk measure presents a quantile corresponding to some level of safety (example 90%, 95%, 99% or 99.9%). The economic 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. VaR is a very efficient measure for market risk. Moreover, it is a regulative risk measure in banking. But together with advantages, this measure has shortcomings, too. The first shortcoming raises from the fact that VaR is really only one point of probability distribution function (pdf). Behaviour of pdf left-side and right-side from VaR is out of consideration. The second gap of VaR is the absence of coherency property. Coherency property of Value-at-Risk occurs only for the elliptical class of distributions.

Risk measure Conditional Value-at-Risk (CVaR) is based on the generalization of VaR. This is conditional mathematical expectation:

$$CVAR(R) = E(R|R < VaR).$$

**Tab. 2. ETFs risk (VaR/CVaR approach)**

	Specificity	Basket	Agri-business	Water	TFT	DNR
VaR	-0,089	-0,061	-0,065	-0,049	-0,080	-0,072
CVaR	-0,102	-0,085	-0,083	-0,071	-0,118	-0,089
CVaR/VaR	1,185	1,367	1,306	1,456	1,474	1,222

### 3.3. Portfolios with minimum risks

Creation portfolios based on correlation analysis. We applied correlation analysis two-fold. The first analysis was devoted to calculating

correlation inside each class. The second analysis includes the results of the average correlation between representatives of pairs of classes. The results are present below.

**Tab. 3. ETFs correlation**

	Specificity	Basket	Agri-business	Water	TFT	DNR
Specificity	0,040	0,210	0,140	0,093	0,113	0,167
Basket		0,327	0,172	0,057	0,096	0,155
Agri-business			0,565	0,571	0,667	0,602
Water				0,871	0,703	0,636
TFT					0,952	0,662
DNR						0,904

Where diagonal is the average value of the correlation coefficient inside the corresponding class. Other cells include the average value between classes.

It is possible to see that ETFs based on futures (Specificity+Basket) essentially low correlate with other and inside classes.

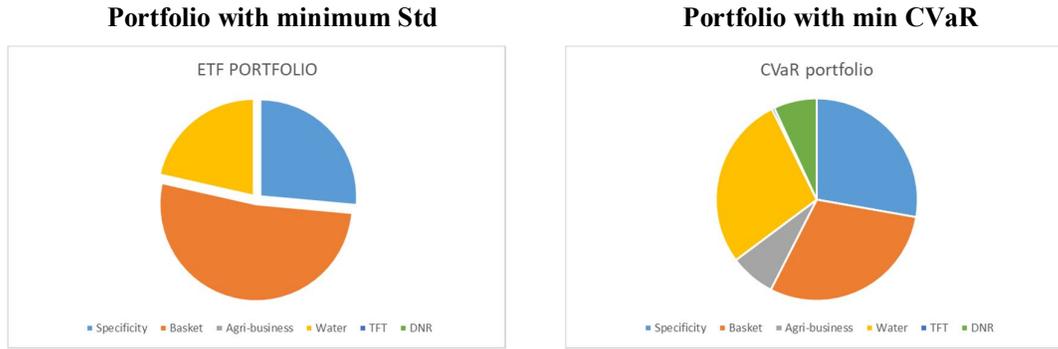


Fig. 1. ETFs portfolios

3.4. Shock-based analysis

One of the important focuses of analysis is the appearance of shocks. According to the approach presented in [17] shocks can be identified as an

intersection line trend plus/minus standard deviation. The illustration of this in our case can be done by graphs.

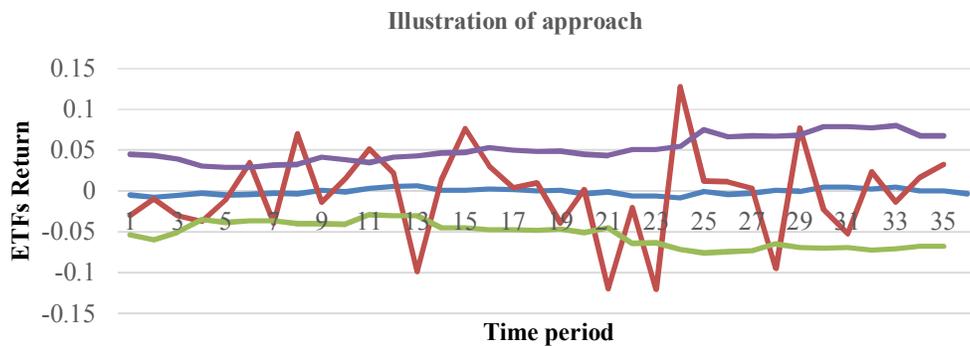


Fig. 2. ETFs shock-based analysis

Peaks which intersect lines with plus/minus standard deviation may be different sharpness and appearance with different frequencies. After that, we introduced two indicators – average quadratic deviation above up-line and the average quadratic deviation below down-line. Their

relations characterize what type of shocks are dominated. We propose indicator as ratio average quadratic deviation above up-line to average quadratic deviation below down-line. The calculation of such value provides us with the following diagram.

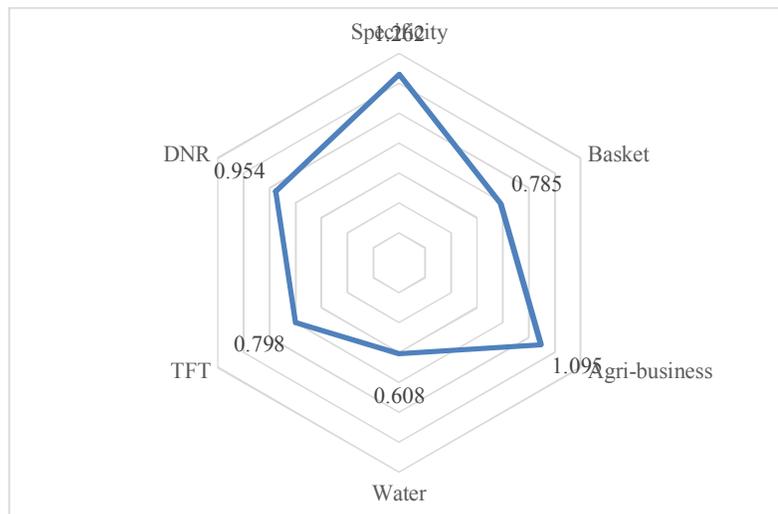


Fig. 3. Shocks indicator for different ETFs classes

We can see the domination of positive shocks only for specificity ETF and Agri-business. Another ETF illustrates the domination of negative shocks.

### 3. 5. Sensitivity analysis

One of the most important approaches for investment risk measurement is based on sensitivity analysis. The importance of this approach is based on the possibility to structure risk into systematic and non-systematic risks. Systematic risk reflects the impact of market changes on to return of an investigated asset. Sensitivity analysis involves procedures for assessment of such impacts. The classical approach consists of using a linear regression model for return:

$$RA = aA + bARI + eA,$$

where

- RI indicates the return of some market index (source of systematic risk);
- RA is the return of investment asset;
- bA – coefficient of sensitivity (more precisely, this coefficient explains the sensitivity numerically);

- aA – coefficient of linear regression;
- eA is a random variable that indicates “own” – non-systematic risk (not caused by index).

One of the crucial suppositions in this model is independence between random variables  $R_t$  and  $eA$ . So, the covariance between those random variables equals 0.

Risk structuring on systematic and non-systematic risk can be obtained after applying operator of the variance to the formula for RA

$$\sigma^2(R_A) = \beta_A^2 \cdot \sigma^2(R_I) + \sigma^2(\varepsilon_A),$$

will be indicators of the significance of systematic risk and non-systematic risk correspondingly.

Ratios are measured as percentages.

$$\sigma^2(R_A) = \left( \frac{\beta_A^2 \cdot \sigma^2(R_I)}{\sigma^2(R_A)}; \frac{\sigma^2(\varepsilon_A)}{\sigma^2(R_A)} \right).$$

As systematic factors that were used in research stock index SPY, Bond index AGG and index Economic Policy Uncertainty. The average values of estimation are presented in the table below.

**Tab. 4. ETFs sensitivity analysis**

	SPY	AGG	EPU
Specificity	0,052	-0,133	-0,049
Basket	0,027	-0,105	0,112
Agri-business	0,620	-0,190	-0,082
Water	0,806	0,046	-0,174
TFT	0,793	-0,201	-0,210
DNR	0,610	-0,153	0,018

### 4. Conclusion

Portfolio management has new tools for strategic allocation investments between classes. This tool arises from essence of Exchange Trade Funds. ETFs can represent different asset classes which previously cannot be included efficiently to the portfolios. One of such class is agriculture ETFs. The results of complex risk measurement indicate some specificities of this class. First of all, risk level higher than risk of traditional assets. But not so much. It is possible to consider this class as moderate level of risk. The characteristic features of risk of this class are: 1) positive skewness. The agro ETFs which linked with single product illustrates higher positive values of skewness return. 2) lower than for traditional assets correspondence CVaR/VaR. The economic explanation is indicates lower left tail of

distribution of return and 3) domination of non-systematic risk. Correlation analysis shows that this class has low correlation inside class and low correlations with classes of traditional asset classes. EPU do not affect for return of agro ETF. The basic economic logic of apply these results in portfolio management is combination traditional investment classes with agriculture ETF. Such combination will rise diversification effect from non-correlation properties.

Further investigation may include analysis differences in types of probability of distribution functions for traditional assets and agro ETF

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