

# Model of the Relationship Between ETFs of Individual European Countries: Austria, Belgium, Denmark, Croatia, Hungary

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**Abstract:** *The development of the economy is associated with the continuity of the investment process on an ongoing basis. Raising funds is possible through bank lending or through the securities market. We consider investments that are received in the stock market. For these purposes, as a rule, ETF funds are used. This allows you to diversify the source of borrowing and reduce risks. But at the same time, one should pay attention to the markets where such funds operate. Each regional market has its own specifics, factors that determine the characteristics of securities trading. You should also take into account the relationship between such structural units of the overall investment process. For the analysis, we use descriptive statistics that help to understand the current trends for investing in the market. We also use wavelet coherence, which is the basis for modeling relationships. This is necessary in order to assess the impact of different segments of the ETF market. The paper considers such countries as Austria, Belgium, Denmark, Croatia, Hungary. The results obtained allow: to evaluate investment decisions, choosing an effective strategy. Many figures and diagrams are presented in the work to understand the results.*

**Keywords—**model; analysis; relationship; ratio; investments; time series; ETF funds; stock market; wavelet methodology; statistical characteristics

## 1. INTRODUCTION

Investing is a source of raising funds, a way to preserve savings and increase the capital of investors [1], [2]. Investing allows you to attract the necessary financial resources that are used to finance various projects. Investment is a competitive source of funds compared to bank loans.

To implement the investment process, you can use the tools of the stock market. Various securities are traded on the stock market. Stock market assets are available to all categories of investors: from individuals to institutional representatives. This allows you to optimize fundraising, diversify sources and reduce risks for potential investors and stakeholders [3]-[5].

Among the financial obligations and rights to attract investment resources, ETF funds should be singled out [6], [7]. Such funds make it possible to invest money simultaneously in different assets. This is due to the fact that the corresponding instrument is formed from shares and bonds of individual business entities.

There are many ETF funds (or exchange-traded, investment, index funds), each of which has its own specifics of attracting assets, its own market of investors and clients. Therefore, it is important to know the features of the functioning of such a tool, its capabilities and implementation specifics. To do this, use all sorts of methods, ideas, theories, approaches [8]-[15]. Also important is given to models that allow you to evaluate relationships, understand the influence of various factors, and make it possible to build forecasts [16]-[21]. Therefore, the subject of this study is important, practical

orientation. First of all, it concerns the study of the relationship between individual ETF funds.

Thus, the main goal of this work is the analysis of ETFs of individual European countries, the implementation of a general model for such a study, a series of experimental calculations and the construction of appropriate estimates.

## 2. RELATED WORKS

The particular interest in the topic of this work is confirmed by the variety of relevant studies by different authors.

I. Ben-David, F. Franzoni and R. Moussawi pay attention to the study of investment funds [22]. The paper notes that exchange-traded funds are an important tool for passive investment among potential investors. This is due to low costs, acceptable liquidity and relatively low risks. The authors highlight the role of ETFs in market capitalization and market trading. It was also concluded that such funds led to the redistribution of funds in the securities market, increasing the efficiency of interaction with various assets. To ensure the turnover of the ETF, parity management of the underlying instruments is used. However, ETF securities introduce non-fundamental volatility and affect the structure of market returns as a whole. This makes it necessary to consider the mutual dynamics of such instruments and conduct an appropriate analysis.

G. L. Gastineau considers investment funds as a phenomenon that has changed the way of raising funds for the necessary projects and directions [23]. The author cites statistics that show that the assets of such funds almost double every year. This growth is based on: low cost, low risk, high

liquidity. Understanding index funds requires an analysis of their mutual influence, an understanding of how they function over time. This distinguishes this study from other similar works.

The article by M. Lettau and A. Madhavan discusses the functioning of exchange-traded funds [24]. At the same time, the emphasis is placed on the fact that these are important financial innovations in the stock market. Such tools have their own architecture and rules for their circulation. This allows these securities to be interesting for the market and investors. The authors note that the diversity and market value of asset ETFs have made them a sought-after and desirable instrument. A feature of such exchange-traded funds is the ability to choose a specific investment strategy. It is also possible to regulate this strategy over time under the influence of certain factors. To do this, it is necessary to operate with a change in the structure of the ETF portfolio, to know the interaction of its individual elements. Knowledge of financial stability, their margin of safety and the impact on various market risks play an important role in such an analysis. All of this highlights the importance of analyzing ETFs.

M. Sharifzadeh and S. Hojat in their work compare the development of exchange-traded investment funds [25]. This study covers the period from 2002 to 2010. The paper notes the popularity of ETF funds from the demand, which is reflected in the volumes and capitalization of this sector of the stock market. An important aspect of this analysis is the consideration of the mutual dynamics of various instruments of exchange-traded funds. For research, the authors consider the Sharpe theory, Sharpe ratios and total returns [25]. To substantiate the results obtained, the Wilcoxon test is used. All data are divided into separate groups, which are combined according to different criteria. This allows you to get meaningful results.

Z. Da and S. Shive explore the issues of security returns that determine various ETF instruments [26]. For such an analysis, correlation estimates of the relationship between the various components of exchange-traded investment funds were used. The paper shows that ETF funds are a good tool for returning capital through arbitrage. This is confirmed by the fact that the authors analyze both the correlations of various stock ETFs and their instruments at the level of individual stocks. The paper also examines the effects of beta coefficients, which help to understand the formation of prices and changes in the yield of the studied securities. In general, this study justifies the need for a mutual analysis of the individual components of the ETF.

The work of the authors G. W. Buetow and B. J. Henderson analyzes the development of investment funds [27]. The peculiarity of such funds is that a single security contains various instruments. This allows you to access the index on different commitments. Close attention is also paid to the formation of profitability of exchange-traded funds. The relationship between the overall return of the index and the components that form it is investigated. G. W. Buetow and B.

J. Henderson come up with interesting insights into index ETF replication. The basis of such conclusions is the assessment of mutual relations between the components of stock indices.

D. Blitz, J. Huij and L. Swinkels consider the functioning of exchange-traded funds [28]. Such an analysis is carried out for European ETF funds. The authors study the impact of taxes as a factor in the formation of the return on assets of various investment funds. The paper also shows the impact of the tax on dividends on the overall performance of the funds that are considered. In this case, the time factor is important. This confirms the need for a comparative analysis.

J. T. Harper, J. Madura and O. Schnusenbergl compare the effectiveness of investment funds from the point of view of individual countries [29]. The authors consider risk and return indicators for exchange-traded funds. The study evaluates data from 14 countries. For the study, Sharpe's portfolio theory is used. The main hypothesis is the possibility of applying a passive or active investment strategy for each country. The result is a conclusion about the possibilities and advantages of each type of strategy. This allows you to justify the profitability of securities, taking into account the risk, which can be diversified.

C. D. Dannhauser analyzes the impact of funds raised through exchange-traded funds [30]. At the same time, the innovative effect of such investments is considered. This study is based on the differentiating features of various ETFs. The author points out that such innovation have a positive effect on the value of the underlying securities that are components of the respective investment funds. C. D. Dannhauser is considering possible changes to ETF rights. Thus, this work also uses cross-analysis to obtain the final results.

N. T. Milonas and G. G. Rompotis explore investment European funds that are quoted on the securities market [31]. The authors consider the Swiss stock market. The paper emphasizes that the corresponding ETFs can cause a lot of investment risk. This is due to the fact that ETF indices lag behind the main market indicators. In this case, there is also no full replication. For the analysis, regression analysis methods and basic statistical parameters are used.

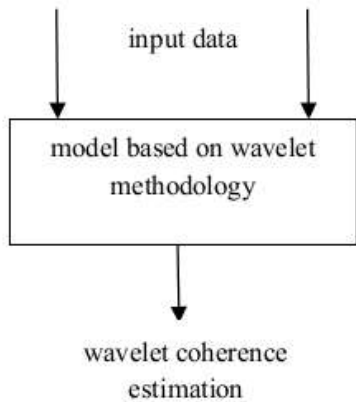
It should be noted different directions in the study of the ETF market. At the same time, the basis of such an analysis is the classical methods of statistical inference. Nevertheless, the issues of analyzing the mutual dynamics of exchange-traded funds indices remain insufficiently studied.

### 3. WAVELET COHERENCE AS THE BASIS OF A DATA RELATIONSHIP ANALYSIS MODEL

Simulation allows you to analyze the behavior of the parameters that are being investigated. Such a study is possible both in the retrospective and prospective time horizon. Here, special attention should be paid to retrospective modeling, which allows you to change the impact on the influencing factors or take into account such an impact in the future. We

can also model the behavior of the mutual dynamics between the data being studied.

One of the methods of mutual data analysis is the wavelet methodology, where wavelet coherence should be distinguished. Then two sets of data are fed to the input of the model, and at the output it is possible to obtain an appropriate estimate of such mutual behavior of the data (fig. 1).



**Figure 1:** Generalized model based on wavelet coherence

If we have two data sets, then in a formalized form, the model based on wavelet coherence can be represented as follows:

$$f(t),g(t) \rightarrow W(f,g) \rightarrow EW,$$

where

$f(t),g(t)$  – datasets that are being investigated,

$t$  – time parameter,

$W(\dots)$  – wavelet coherence function,

$EW$  – wavelet coherence estimate.

The choice of wavelet coherence for the corresponding study is justified by the fact that this approach has found wide application for the analysis of economic data [32]-[36]. For this, special software is also used [37].

#### 4. DATA FOR ANALYSIS AND THEIR MAIN CHARACTERISTICS

In this paper, we analyze ETFs from selected European countries. Among such countries are selected: Austria, Belgium, Denmark, Croatia, Hungary. These countries can be characterized as subjects with developed, but medium-sized economies. At the same time, we take into account the spatial component of the sources of attracting investment resources. It should also be noted that different exchange-traded investment funds can be distinguished in the markets of these countries. Therefore, we chose for the study the funds that have the

largest volumes of asset placement on the stock market. These are the following tools:

Austria – Lyxor Core DAX (DR) UCITS ETF (C001);

Belgium – Lyxor S&P 500 VIX Futures Enhanced Roll UCITS ETF – C-EUR (LVX);

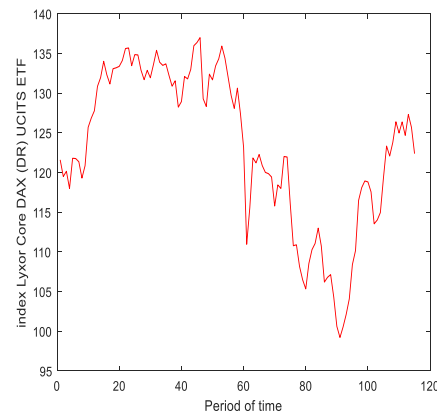
Denmark – Danske Invest Global (DKIGI);

Croatia – InterCapital SBI TOP UCITS ETF (7SLO);

Hungary – iShares Core S&P 500 UCITS ETF USD (Acc) (IEB5BMR087).

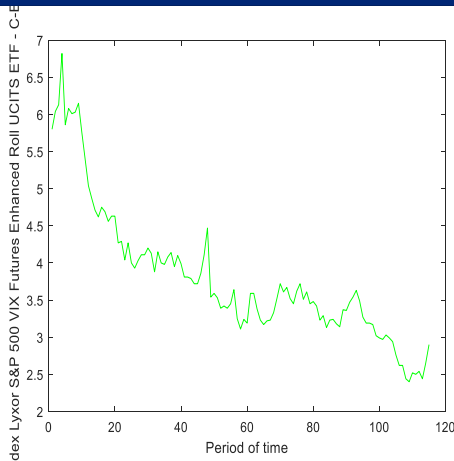
All data from the site <https://investing.com/>. These data are for the period from 03.01.2021 to 12.03.2023 in the weekly calculation of the respective indices.

The figures below show the dynamics of the indexes of the ETF funds that we are considering.



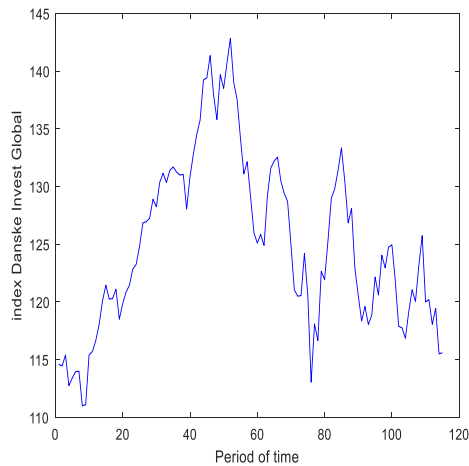
**Figure 2:** Austria investment fund index

Between 03.01.2021 and 12.03.2023, the indicator values for the Lyxor Core DAX (DR) UCITS ETF (C001) change significantly. From 03.01.2021 to 06.06.2021, there is an increase in the index. Then it is necessary to note the period of stabilization of this indicator. From 06.02.2022 there is a sharp drop in the index, and from 25.09.2022 there is a new increase. At the same time, the variability of Lyxor Core DAX (DR) UCITS ETF (C001) is moderate.



**Figure 3:** Lyxor S&P 500 VIX Futures Enhanced Roll UCITS ETF - C-EUR (LVX)

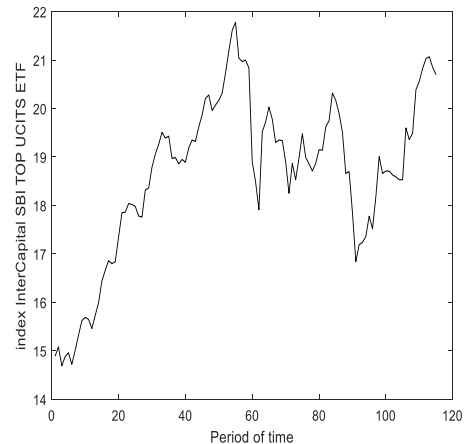
It should be noted that the Belgian stock index is constantly decreasing over the entire interval that we are studying. Such dynamics is also characterized by moderate local volatility of investment fund indicators.



**Figure 4:** Meaning of Denmark ETF

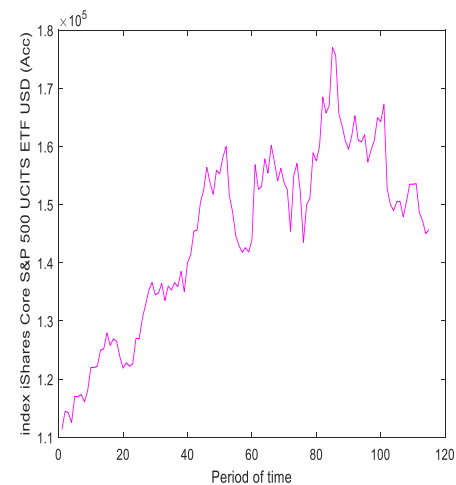
We can see that the Danish ETF index has different values between 03.01.2021 and 12.03.2023. The highest value falls on 26.12.2021. Further, the value of the indicator for Danske Invest Global (DKIGI) decreases significantly. The lowest value falls on 12.06.2022. At the end of the study period, the index value also decreases.

The figure below shows the index values for the InterCapital SBI TOP UCITS ETF (7SLO) (Croatia).



**Figure 5:** Croatian investment fund index

In general, the dynamics of the index, which is shown in fig. 5 is increasing. At the same time, we see that the maximum value of this indicator falls on 16.01.2022. After the specified date, the value of the specified index decreases. Such a decrease is not sharp and its dynamics varies over time. The variability of the 7SLO indicator is moderate.



**Figure 6:** Hungarian ETF performance

iShares Core S&P 500 UCITS ETF USD (Acc) values are rising. The highest value of the index was observed on 14.08.2022. Next, we see a sharp decline in the performance of the Hungarian investment fund. In the last period of time, the index values also decrease.

We can also note that all the graphs presented above are different from each other. This is also confirmed by the data presented on fig. 7.

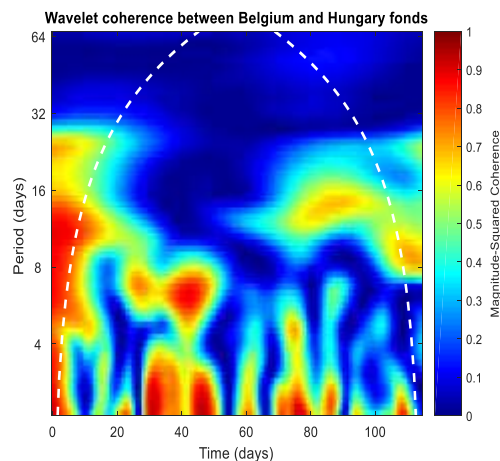
	Kurtosis	Skewness	Median
Austria	-0,69	-0,55	123,34
Belgium	1,38	1,22	3,59
Denmark	-0,59	0,34	124,2
Croatia	-0,04	-0,67	18,9
Hungary	-0,76	-0,41	148990

**Figure 7:** Statistical characteristics of funds

Thus, we can talk about the expediency of using wavelet coherence as an element of the corresponding modeling.

### 5. RESULTS AND DISCUSSION

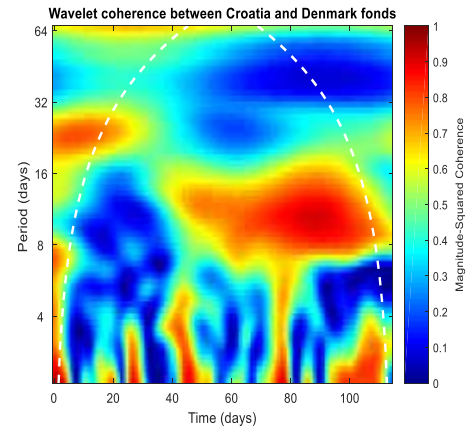
As noted earlier, for a retrospective analysis of the relationships between different investment funds, we will use a model based on building wavelet coherence estimates. The results of such modeling are presented in the figures below. Here we consider not all models, but only the most characteristic and significant.



**Figure 8:** Relationship model between Belgian and Hungarian investment fund

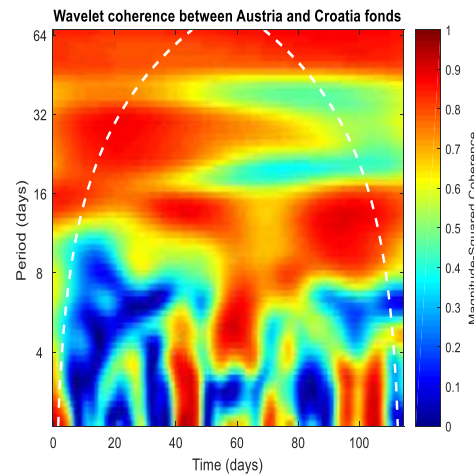
The relationship assessment presented in figure 8 is fragmentary. This means that there is no stable relationship between the data we are exploring. The highest values are observed in the period from 01.08.2021 to 19.12.2021. The depth of such an assessment is insignificant. This does not allow long-term forecasts to be made. Nevertheless, the resulting model will be useful when choosing a strategy for simultaneously investing in both types of exchange-traded funds.

Now consider the relationship between the data that have the most similar trends. This data is for exchange-traded funds in Croatia and Denmark.



**Figure 9:** Assessing the relationship between Croatian and Danish ETF

In this example, we also see the fragmentation of relationships between the studied types of exchange-traded funds. The highest values of the presented estimates fall on the period from February 27, 2022 to January 8, 2023. The depth of such relationships is significant, which makes it possible to build more accurate forecasts.



**Figure 10:** Relationship between Austrian and Croatian exchange-traded funds

The connection between the Austrian and Croatian ETFs is also volatile, as it was for other data. But in this case, a more significant depth of the relationship should be noted. We also see that the depth of the relationship between the investment funds of Austria and Croatia extends over almost the entire period of time that we study.



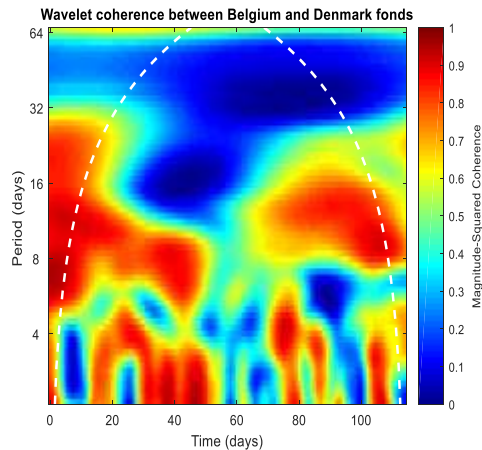


Figure 11: Assessing the relationship between Belgian and Danish exchange-traded funds

In this case, we observe a more stable relationship between investment funds. The significance of the depth of such a relationship is determined by the period from 03.01.2021 to 21.11.2021 and from 03.07.2022 to 19.02.2023.

In general, everything presented above allows you to choose the necessary investment strategy for entering the stock market. At the same time, we can combine various exchange-traded funds and achieve the most acceptable result.

## 6. CONCLUSION

The paper considers the features of investing through ETF funds. Particular attention is paid to the spatial organization of such funds. Therefore, we consider exchange-traded funds of different countries. We make such a comparison based on the construction of a model, which is based on wavelet coherence estimates.

The article analyzes the dynamics of exchange-traded funds in such countries as Austria, Belgium, Denmark, Croatia, Hungary. The results of estimates of wavelet coherence are presented. The results obtained can be used to develop and select appropriate investment strategies.

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