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The Evaluation of the Impact of the Stock Exchange-traded Funds Arbitrage Activity on the Co-movement of Equities' Market Values Changes

SUMMARY OF DOCTORAL DISSERTATION

Social Sciences
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SUMMARY OF DOCTORAL DISSERTATION

INTRODUCTION

Relevance of the Issue and the Level of Investigation. Innovation is playing an increasingly important role in a rapidly changing and dynamic financial world. Financial technologies and new emerging products pose challenges for both, market participants and regulators, at the same time expanding the scope of research in new areas. One such new area that attracted researchers' attention after 2007-2009 global financial crisis, was shadow banking (or non-bank financial intermediation)[1] and the risks which it posed (Dičpinigaitienė, Kanapickienė, 2019a; Subramanian, 2013; Pozsar, 2014; Prates, Farhi, 2015; Elliott et al., 2015; Lysandrou, Nesvetailova, 2015; Quinn, Roberds, 2015 and etc.). The tightening of banking regulation and the shift of regulators' focus on non-bank financial intermediation, which is becoming an increasingly important part of the financial system, have led to a number of discussions: what kind of objects or entities are covered by the concept of non-bank financial intermediation; furthermore, the risks involved and the transmission channels through which those risks can be transmitted to the financial system. The researchers have begun to study how to protect financial system from the emerging threats and how to maintain its stability and sustainability.

The exchange traded fund (hereinafter – ETF) is one of the products, classified as non-bank financial intermediation, which has also become the centre of discussions. Although ETFs were established more than thirty years ago, the size of their assets under management and the variety of products started to increase only after

[1] The Financial Stability Board changed the term of "shadow banking" and replaced it with the term "non-bank financial intermediation" for the purpose of clarity and precision.

the global financial crisis. Significantly growing popularity of ETFs among institutional and retail investors has also attracted attention of regulators and researchers. Various theoretical aspects, activity structures, schemes and regulatory issues of ETFs have been studied in scientific literature and in the publications of various institutions and organizations (Hill et al., 2015; Lettau, Madhavan, 2018; Su, 2018; Ramaswamy, 2011; Pagano et al., 2019; Foucher, Gray, 2014; Prieg, Greenham, 2012; Naumenko, Chystiakova, 2015; Autorité des marchés financiers, 2017; Aggarwal, Schofield, 2012; IIAC, 2019; Goodcare UK Research Team, 2018); the problems of different ETFs, such as currency ETFs, leveraged ETFs, and so on, have gained more attention and have been analysed (Ivanov, 2015; Nargunam, Anuradha, 2017; Guo et al., 2019; Mallika, Sulphey, 2018; Zhang, 2015; Avellaneda, Zhang, 2010; Charupat, Miu, 2011; Tang, Xu, 2013b; Tang, Xu, 2013a; Li, Zhao, 2014; Fang, Perng, 2014; Leung, Ward, 2015; Bansal, Marshall, 2015b; Bansal, Marshall, 2015a; Trainor, Gregory, 2016; Giannetti, 2017; Jiang, Peterburgsky, 2017; March-Dallas et al., 2018; Lee, Kim, 2018; Ivanov, Lenkey, 2018; Bahadar et al., 2019). The researchers started to assess the benefits of ETFs for investors (Wong, Shum, 2010; Blitz et al., 2012; Blitz, Huij, 2012; Gastineau, 2004; Alexopoulos, 2018; Stankevičienė, Petronienė, 2019; Rompotis, 2019; Wallace, McIver, 2019; Pandya, 2016; Da Dalt et al., 2019; Chovancová et al., 2019; Milonas, Rompotis, 2015), to analyse the ETFs' impact on the financial market (Hasbrouck, 2003; Buckle et al., 2018; Wallace et al., 2019; McCullough, 2017; Hendershott, Jones, 2005; Chen et al., 2016), Hegde, McDermott, 2004); finally, to go deeper into the risks posed by ETFs activities (Dičpinigaitienė, Kanapickienė, 2019b; Sethi, Tripathi, 2019; Chandrasekaran, Acharya, 2019; Wang, Xu, 2019; Chan et al., 2018; Ben-David et al., 2018; Hurlin et al., 2019; Jarrow, Protter, 2019; Staer, Sottile, 2018; Da, Shive, 2018; Dunham et al., 2016; Morris, 2011; Amenc et al., 2012; Ramaswamy, 2011; Crisóstomo, Medina, 2018; Pagano et al., 2019; Bhattacharya, O'Hara, 2020; Clements, 2020).

In order to substantiate the reasons for the growing popularity of ETFs, the researchers emphasize small deductions, possibilities to acquire a widely diversified portfolio in one transaction and the high liquidity of ETFs (Madhavan, Sobczyk, 2016; Ivanov, 2015; KPMG, Citywire, 2019; Lettau, Madhavan, 2018; Sethi, Tripathi, 2019). Additionally, the ETFs could be used as a product to invest in a sustainable and socially responsible way (Miralles-Quirós et al., 2019; Miralles-Quirós, Miralles-Quirós, 2019; La Monaca et al., 2018; Chen, Scholtens, 2018; Chakrabarty et al., 2017; Milani, Soares, 2015); furthermore, they provide new opportunities for the retail investors, for example, investing in asset classes which for a long time have been only available for certain institutional investors, such as real estate or private equity investments, and so on. Finally, the important role of the ETFs is also reflected in the actions of central banks in conducting monetary policy (Bhattacharya, O'Hara, 2020; Petrov, 2017; Chen et al., 2019; Riquier, 2020).

Rapidly growing popularity and the applicability of ETFs also induce the interest in the risks posed by ETFs activities. ETFs pay special attention to the impact on their underlying securities due to unique structure of ETFs (located in both, primary and secondary markets) and the exclusive arbitrage mechanism, which helps to maintain a similar market value and the net asset value (hereinafter – NAV) of ETF. Empirical studies suggest that ETFs might increase the volatility of the market values changes of the underlying securities (Sethi, Tripathi, 2019; Chandrasekaran, Acharya, 2019; Wang, Xu, 2019; Chan et al., 2018; Ben-David et al., 2018); affect the liquidity of these underlying securities in the event when the gap between the NAV and market value of ETF starts to increase (Atanasova, Weisskopf, 2020); or make an impact on market value discovery mechanisms (Liebi, 2020).

Another impact of ETFs on the underlying securities is a possible increase in the co-movement of securities' market values changes. The analysis of this co-movement is important, because when the underlying securities' market values changes start to move together

more, it reduces the benefits of diversification for investors (Staer, Sottile, 2018). The co-movement of securities' market values changes is not a new issue in scientific literature (it has been analysed by various researchers: Froot, Dabora, 1999; Fama, French, 1995; Hardouvelis et al., 1994; Bodurtha et al., 1995; Chen et al., 2016; Barberis et al., 2005; von Drathen, 2014; Coakley et al., 2008; Antón, Polk, 2014 and etc.), however, the co-movement of securities' market values changes due to ETFs arbitrage activity is still a relatively new topic among the researchers: only a few authors have analysed this issue (Leippold et al., 2016; Glosten et al., 2016; Shim, 2019; Staer, Sottile, 2018; Da, Shive, 2013; Da, Shive, 2018).

Almost all research analysing the impact of ETFs arbitrage activity on the co-movement of securities' market values changes, examine the US ETFs market (Leippold et al., 2016; Glosten et al., 2016; Shim, 2019; Staer, Sottile, 2018; Da, Shive, 2013; Da, Shive, 2018), while the European ETFs market has been only studied by one author (Sakss, 2019). Extremely fast-growing ETFs volume and asset under management in Europe presupposes the need for a broader analysis of the impact of the ETFs arbitrage activity on the co-movement of securities' market values changes (Morningstar's European ETFs market review (Bioy et al., 2019) predicts that the European ETFs market will have reached 2 trillion Eur in assets under management by 2024).

The attention must be also drawn to the quantitative measurement of ETFs arbitrage activity because of the identified lack of research in this area (Brown et al., 2016; Pan, Zeng, 2017; Ivanov, 2016b; Staer, Sottile, 2018). Brown et al. (2016) point out that arbitrage activity is not easy to identify and measure. Although it can be measured both directly and indirectly, there are only a few of those indicators. This situation opens the possibility to propose new indicators to measure this ETFs arbitrage activity. Finally, Pan and Zeng (2017) emphasize that even though ETF is a favourable product for measuring arbitrage activity, there is still a lack of appropriate database in addition to the

fact that, the collected data is not detailed enough to accurately measure the ETFs arbitrage activity.

In Lithuania, despite the fact that there is no established ETFs, the analysis of this product is relevant for the investors. According to Pagano et al. (2019), the largest investors in ETFs are pension funds in Lithuania. The asset of pension funds reaches more than 4 billion Eur (Lietuvos bankas, 2020), and more than a half of it is invested into ETFs. It is important to note that since more than 1.3 million participants accumulate in these pension funds, a comprehensive analysis of the risks posed by ETFs activities is also important for each of them (Dičpinigaitienė, 2020). This argument is supported by researchers Da and Shive (2013), who add and argue that the increased co-movement of securities' market values changes does not only affect the investors in ETFs, but also the investors who seem to invest in traditional instruments, like pension funds or mutual funds (i.e., these financial instruments might also be affected by the risks posed by ETFs activities).

Finally, emphasizing the periods of market stress, Bradley and Litan (2011) claim that while the high co-movement of securities' market values changes during the periods of market stress is not a new issue, special attention should be given to linking it to ETFs activities: ETFs might reduce the benefits of diversification, especially during periods even when there is no panic or stress. Bradley and Litan (2011) add that the equities' market values changes are co-moving together more than ever before in a modern financial history. Therefore, this dissertation also focuses on the analysis of market fluctuations due to the COVID-19 pandemic.

Scientific Problem of the Research. The uniqueness of ETFs' structure and the rapid growth of assets under management presuppose the need for a more thorough investigation of the risks posed by ETFs activities that still lack studies in scientific literature. The lack of the research analysing one of the risks posed by ETFs activities (the impact of ETFs arbitrage activity on the co-movement of securities' market values changes) encourages to fill this gap in scientific

literature. It also opens a way for new research, that would not only solve scientific but also practical problems. It should be added that there is a noticeable lack of research of this risk when European ETFs market is analysed, or the appropriate methodology is sought to be adapted. Moreover, there is also a significant lack of data to measure ETFs arbitrage activity which provides opportunities to propose new indicators to measure it. Thus, the scientific problem of the dissertation is not only to evaluate the impact of the European stock ETFs arbitrage activity on the co-movement of European equities' market values changes, but also to propose new methodology for this empirical research. Finally, it should be added that, the ETFs' activity has been studied very little during periods of market stress, because the assets under management of ETFs significantly increased only after the global financial crisis. The opportunity to analyse this important scientific problem arose due to market fluctuations during the COVID-19 pandemic in February–March 2020.

The Object of the Research. The evaluation of the impact of the European stock ETFs arbitrage activity on the co-movement of European equities' market values changes.

The Aim of the Research is to investigate the impact of stock ETFs arbitrage activity on the co-movement of equities' market values changes, in addition, it aims at developing methodology to evaluate the impact of European stock ETFs arbitrage activity on the co-movement of European equities' market values changes.

The Objectives of the Research. To achieve the intended purpose, the following objectives are to be performed:

1. To perform a theoretical analysis of the ETFs conceptual problems, to distinguish the essential features of the ETFs activity and the classifications, which are used; also, to emphasize the uniqueness of the ETFs arbitrage activity and the importance of wider analysis and research of this arbitrage mechanism.

2. To make a complex evaluation of the level of scientific research of ETFs aspects by performing a meta-analysis of the literature, and

to propose the classification of research areas in which ETFs are analysed, as well as to assess the relevance of these areas.

3. To single out the main risks posed by ETFs activities and to classify them; furthermore, to emphasize the importance of the analysis of one of those risks which is the impact of ETFs arbitrage activity on the co-movement of securities' market values changes.

4. To develop a methodology for an empirical research in order to assess the impact of stock ETFs arbitrage activity on the co-movement of equities' market values changes, and to propose a new indicator, which measures the indirect ETFs arbitrage activity.

5. Based on the methodology developed in the dissertation, to evaluate the impact of the European stock ETFs arbitrage activity on the co-movement of European equities' market values changes.

6. To evaluate the impact of the European stock ETFs arbitrage activity on the co-movement of European equities' market values changes during the period of market stress and to compare this impact of stock ETFs arbitrage activity in different periods of market movements based on the methodology developed in the dissertation.

Research Methods and Sources. Both qualitative and quantitative research methods are applied to study the impact of the stock ETFs arbitrage activity on the co-movement of equities' market values changes since employing them together helps to analyse the problem holistically. First, logical, comparative analysis and synthesis of the scientific literature is used. When analysing the scientific literature, a meta-analysis of the literature is also performed: bibliometric and network analysis methods are used, as well as graphical and cluster analysis.

One of the largest bibliographic databases "Web of Science Clarivate Analytics", as well as "Scopus" and other databases of scientific literature are used for the analysis. Publications of various national and international institutions, associations and organizations are used. Based on the collected data, networks and maps are created using "VOSviewer" software (version 1.6.13).

For the empirical research, the original research methodology is created; this methodology does not only allow to conduct the research and formulate reasonable conclusions in the dissertation, but also to create opportunities to expand this research in the future by applying this methodology to another data sample. The methodology includes the Generalized Autoregressive Conditional Heteroskedasticity – Dynamic Conditional Correlation (hereinafter – GARCH-DCC) model; the indicators that measure indirect ETFs arbitrage activity: the equivalent volume (hereinafter – EPK) proposed by Staer and Sottile (2018) and the equivalent turnover (hereinafter – EA) proposed in this dissertation; finally, the indicator that measures direct ETFs arbitrage activity is used: primary market fund flows (hereinafter – PS). All these indicators and GARCH-DCC model are combined into one common methodological framework which allows to perform empirical research and evaluate the analysed problem applying an autoregressive panel data model: by testing the raised hypotheses and by applying the qualitative analysis. It is worth mentioning that in order to assess the reliability of the model, the parameters of the autoregressive panel data model are additionally evaluated both ways: by changing the covariates of the model and by using the methods of robust statistics for calculations.

The data for the study are collected from the "Bloomberg" database, which is one of the largest financial reporting systems in the world (KTU, 2021). The "ETFGI.com" and "Statista" databases are also used to collect statistical data. Finally, the "Microsoft Office Excel" electronic spreadsheet and "R" software packages are used to perform calculations.

Defending Dissertation Statements:

1. The abundance of research analysing ETFs and the variety of its topics in literature hinder the overall picture of the current level of research. Thus, for the first time a detailed meta-analysis of the literature is accomplished, as well as the classification of research areas are proposed. The evaluation of the relevance of these research

areas contributes to the development of ETFs research in the least investigated areas.

2. The proposed classification of the risks posed by ETFs activities helps to distinguish those risks according to their sources: risks arising from the ETFs structural features and independent from them.

3. The methodology for assessing the impact of the stock ETFs arbitrage activity on the co-movement of equities' market values changes must consist of two stages: analysis and evaluation. The first one, the analysis stage, is important for the selection of data and the selection of appropriate variables that would comprehensively quantify the problem; the second one, the evaluation stage, is necessary for the application of different methods in order to calculate estimates of model parameters and to formulate reasonable conclusions.

4. The proposed new indicator of equivalent turnover (EA) with a clear and reasonable economic interpretation, may be used to measure indirect ETFs arbitrage activity.

5. There is a co-movement between the European equities' market values changes and European ETFs NAVs' changes, which is independent from fundamental factors. There is an impact of the stock ETFs arbitrage activity on the co-movement of equities' market values changes.

6. During the periods of market stress, an additional co-movement of equities' market values changes is formed in the markets. The non-fundamental factors also contribute to this co-movement, such as the influence of stock ETFs arbitrage activity.

Scientific Novelty and Theoretical Value. The problems that are analysed in this dissertation create added value for economics:

1. The dissertation does not only analyse and classify the concept of ETFs and its diversity, but also proposes a new classification of the risks posed by ETFs activities, which helps to distinguish those risks according to their sources.

2. The developed new research methodology which assesses the impact of the stock ETFs arbitrage activity on the co-movement of

equities' market values changes, can be used in further research to analyse other data samples.

3. A new equivalent turnover (EA) indicator is developed and proposed in the dissertation: it measures the indirect ETFs arbitrage activity.

4. A great amount of data (more than 10 million observations) is used in the panel data model; it allows to strengthen the conclusions of the empirical study.

5. For the first time in the scientific literature the impact of the European stock ETFs arbitrage activity on the co-movement of equities' market values changes is measured directly and indirectly. It lets to fill the research gap identified in the scientific literature.

Practical Value of the Dissertation. The problems analysed and researched in the dissertation also have practical significance:

1. The methodology presented in the dissertation may be useful for: (1) the regulator in order to protect the market from emerging risks and to supervise it properly, especially because of the rapid growth of ETFs' asset under management, and (2) the investors choosing this product.

2. The findings of this dissertation are useful for: (1) retail investors to ensure proper diversification of their investment portfolio and (2) institutional investors to incorporate these risks posed by ETFs activities into risk management processes.

3. The dissertation will contribute to the financial education of the public about the ETFs whose popularity is constantly growing.

4. The research conducted in the dissertation will contribute to the development of Lithuania's scientific potential and to the benefit of the academic community.

5. The impact of the European stock ETFs arbitrage activity on the co-movement of European equities' market values changes is evaluated applying newly proposed original methodology that can be used in the study process.

The Structure and Scope of the Dissertation. The dissertation consists of three chapters: theoretical analysis, formation of the

methodology and presentation, and analysis of the analytical research, as well as an introduction, conclusions and bibliography and appendices (see Figure 1). The volume of the dissertation is p. 171, counting with the appendices – p. 188. The text of the dissertation used: 26 tables, 34 figures, as well as 7 appendices, 320 sources of literature.

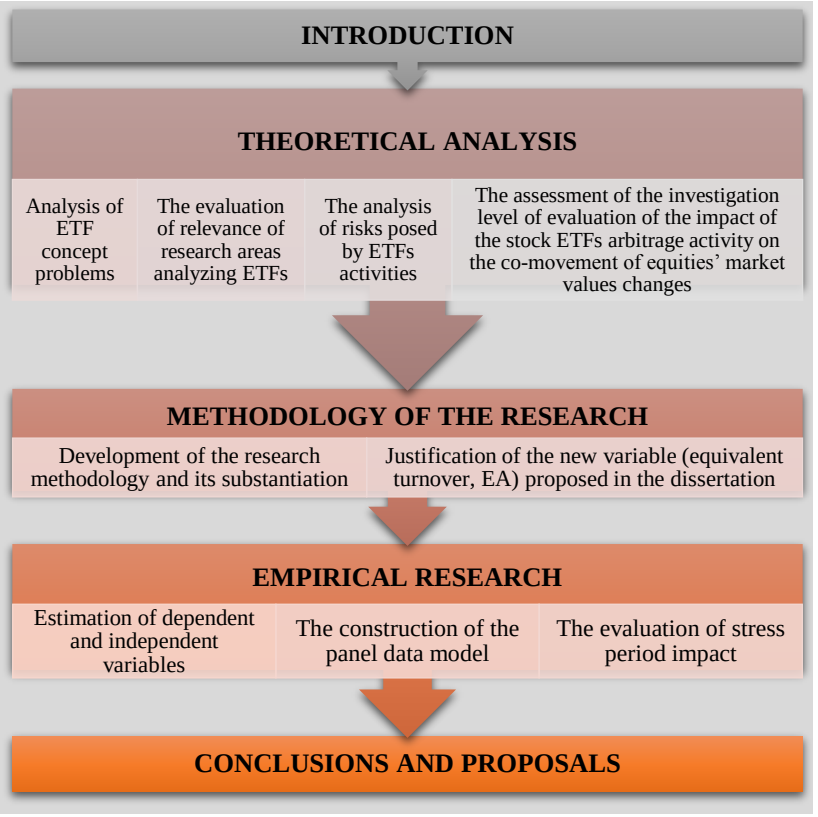


Fig. 1 Logical Structure of the Dissertation

The first theoretical part of the dissertation analyses the problems of the concept of ETFs, it also distinguishes the essential features of ETFs activity as well as discusses the ETFs classifications, that is used in practice and in scientific literature. Special attention is paid to

discuss the structure of the ETFs and to highlight the uniqueness of the ETFs arbitrage mechanism. In addition, the need for more extensive research about this arbitrage mechanism is emphasized. The level of scientific literature on ETFs is also assessed using a meta-analysis of the literature (bibliometric, network and cluster analysis), as well as the classification of research areas is proposed. Furthermore, the relevance of these research areas is evaluated, and the risks posed by ETFs activities are analysed. Finally, it is delved deeper into one of the risks posed by ETFs activities which is he impact of the ETFs arbitrage activity on the co-movement of underlying securities' market values changes as well as the importance of empirical examination of this risk is emphasized.

The second part of the dissertation is intended to substantiate the methodology of the empirical research: the course of the empirical research is detailed, in addition, the data used, and the choice of the analysed period are substantiated. The analysed variables and their calculation methodologies are presented as well. Finally, the choice of the panel data model is substantiated, and the results are used to prove or disprove the raised hypotheses.

The results and conclusions of the empirical research are presented in the third part of the dissertation: the data used in the research is analysed. Additionally, the calculated variables such as Dynamic Conditional Correlation (hereinafter – DCC), EA, EPK and PS are analysed. The descriptive statistics and data visualizations of those variables are also presented. Finally, the results of the panel data regressions using three indicators measuring ETFs arbitrage activity are given. The last part of the empirical study is devoted to additional analysis of the panel data: additional regressions are calculated by including a time-fixed effect and dividing the panel data into different periods of time. When presenting and discussing the research results, the hypotheses (raised in the second part of the dissertation) are proved or disproved.

Approbation and Dissemination of the Scientific Research Results. Scientific articles on the issue presented in the dissertation

have been published in peer-reviewed scientific publications as well as one practical analysis has been prepared. The results of authors' research have been presented at two international scientific conferences (for details, see the section "List of Publications").

REVIEW OF THE CONTENT OF THE DOCTORAL DISSERTATION

Problems of the Concept of Exchange Traded Funds. An increasing number of reports and research papers from various institutions are devoted to the analysis of ETFs (Ramaswamy, 2011; Prieg, Greenham, 2012; Antoniewicz, Heinrichs, 2014; Hill et al., 2015; Lin, 2017; Su, 2018; Lettau, Madhavan, 2018 ; SEC, 2019a; IIAC, 2019 and etc.): to present the concept, to define operational structure or to analyse certain characteristics. However, the ETF remains a new and dynamic product (in regulatory aspect) that raises many debates about its specificities. One such discussion relates to the exceptional structure of the ETFs creating the for ETFs arbitrage activity.

There are various definitions of ETFs in the scientific literature but it is agreed that ETF is an investment vehicle that typically tracks an index or a specific set of assets, combines the characteristics of open-ended and closed-ended investment funds[2], and its investment units are traded continuously on stock exchanges (Pagano et al., 2019; Su, 2018; Deutsche Bundesbank, 2018; Foucher, Gray, 2014; IOCSO, 2013; Neves et al., 2019).

ETFs can be classified in different ways: according to the geographical region of the investments, asset class, strategy, etc. However, the exclusive classification of ETFs is based on the

[2] Like open-ended investment funds, ETFs investment units can be redeemed or acquired at the end of the day for net asset value (NAV). While like closed-end investment funds, ETFs investment units can be traded in the secondary market at the market price (Aquilina et al., 2020).

benchmark replication method. This classification is important because according to this benchmark tracking methodology, the scheme of ETFs operation is constructed differently. This classification is also considered to be a unique feature of ETFs activity in the scientific literature. Two types of benchmark replication methods are distinguished: physical and synthetic replication (Bioy et al., 2019). Physical replication is divided into three groups: full replication, sampling, and optimization. Meanwhile, the synthetic replication is divided into two: unfunded swap model and fully funded swap model. The operation schemes of these different ETFs structures are illustrated and discussed in many scientific articles or various reviews (Ramaswamy, 2011; Prieg, Greenham, 2012; Aggarwal, Schofield, 2012; Foucher, Gray, 2014; Naumenko, Chystiakova, 2015; Hill et al., 2015; Autorité des marchés financiers, 2017; Lettau, Madhavan, 2018; Su, 2018; Goodcare UK Research Team, 2018; IIAC, 2019; Pagano et al., 2019 and etc.).

The structure of ETFs is special because it is located in both, primary and secondary markets. In the primary market, the transactions take place on a daily basis between the ETFs and the authorized participants (hereinafter – APs)[3] for the NAV, while in the secondary market (i.e., at bourse, Over-The-Counter, etc.) the trades are continuous through the day and settled at the market value. Naturally, under the law of demand and supply, the market value and NAV of a ETFs start to distinguish. Accordingly, these differences in values allow to form the possibility for arbitrage (Charteris, 2013), i.e., investors can earn additional returns by taking advantage of these value differences.

Ben-David et al. (2017) argue that this opportunity of arbitrage can be used by APs or investors, who trading in the secondary market.

[3] Authorized participants (APs) are the financial institutions with which the ETF sponsor enters into agreement to distribute the ETF's investment units on the secondary market after acquiring them in the primary market.

With the exclusive ability to trade in the primary market, the AP can not only earn from these transactions, but also eliminate the following differences of values: by buying cheaper assets and selling more expensive ones. When the market value of ETFs is lower than the NAV, the AP may purchase investment units of ETFs in the secondary market and exchange them into the basket of securities (in the primary market). Meanwhile, when the NAV is lower than the market value of the ETFs, the AP can purchase basket of securities in the secondary market and acquire the creation units of ETF in the primary market, thus earning by selling these ETF units in the secondary market. Accordingly, as a result of these AP actions (i.e., the transactions of ETF in primary and secondary markets), the demand or supply of ETF investment units increases, thus the market value of the ETF equals to the NAV. Those actions of the AP are called primary market arbitrage. Secondary market arbitrage, on the other hand, refers to actions when investors take long and short positions in ETFs and their underlying securities (Sethi, Tripathi, 2019): by taking advantage of the difference between the NAV and the value of a basket of securities.

Hu, Morley (2018) defines the arbitrage mechanism as the main criteria to ensure that the market value and the NAV of ETFs would be approximately the same. Fulkerson et al. (2018) add that the arbitrage mechanism is the key component of the structure of ETFs, in order for the market value and the NAV of ETF not to differ, as well as stating that the main player in this arbitrage mechanism is the AP.

However, researchers also find negative effects of the ETFs arbitrage activity. For example, Brown et al. (2016) state that due to the ETFs arbitrage activity, when the AP trades both, investment units of ETFs and the basket of underlying securities of that ETFs, these underlying securities may be negatively affected. The value of those underlying securities starts to co-move or the volatility of changes in their market values start to increase. Also, because of this AP activity, shocks from the ETFs market may spill over to the underlying securities markets. To show that, Malamud (2016) applied a dynamic general equilibrium model and concluded that the buy or redeem

mechanism in the primary market, acts as a shock transmission mechanism, due to which temporary demand shocks may have a long-term effect on future values of securities. Finally, Hu, Morley (2018) summarizes that the effectiveness of the arbitrage mechanism is vital to ETFs market values, and the disruptions of this mechanism can have catastrophic consequences, especially during the periods of market stress.

The Areas of Research Analysing Exchange Traded Funds. The exceptional structure, arbitrage mechanism, and other features of ETFs are getting more and more attention from scholars. Various characteristics of this product and ETFs' impact are now being investigated in the scientific literature. The dissertation includes a meta-analysis of the scientific literature, where 290[4] articles are selected from one of the largest bibliographic citation information databases "Web of Science Clarivate Analytics" (Chadegani et al., 2013; Trumpienė, Šegždienė, 2011). These articles are used to perform the bibliometric, network and cluster analysis, as well as to propose the classification of the main research areas. In addition, the evaluation of the relevance of these research areas are done.

Firstly, the bibliometric analysis is done. After the research papers are evaluated according to various criteria (i.e., research directions, country, author, journals, etc.) it is found, that the US and European researchers show the greatest interest in various ETFs topics, also the increase in scientific articles on ETFs took place and started to increase after the global financial crisis. The issues in the analysed research papers cover a wide range of scientific fields and there is no single exceptionally dominant subject, or a specific issue related to ETFs. The structure of ETFs, the characteristics of different ETFs, the returns of investors or optimization of the taxes are analysed in the scientific literature. The topics of the ETFs impact on the other market

[4] No open access was received for 53 articles, so only 237 articles were analysed in detail.

participants or the whole financial system, the aspects of risks are analysed as well. Finally, despite the growing volume of the research, the level of research on ETFs is still at an early stage.

Three maps are constructed during the network analysis: first one is based on the natural language algorithm, the second one is based on keywords selected by researchers, finally the third one is based on article citations. This analysis is done in order to describe the main areas of the research and the relations between them. It is found that using the natural language algorithm, the constructed map is less accurate than the map which is created using keywords suggested by researchers themselves (in their articles). Moreover, although cluster analysis allows to group the individual words or phrases into clusters, the qualitative classification of the research areas is not ensured. Therefore, it has been decided to conduct an additional evaluation of the topics based on the expert opinion of the dissertation author. Finally, it should be noted that the third map (which has been compiled based on the list of cited articles) reveals that some of the analysed articles are not among the cited articles, i.e., they are not included in the map. That leads to the conclusion that the topic of ETFs is still relatively new in the scientific field. Moreover, the conclusion could be made, that researchers are interested in various aspects of this product, which are not necessarily related to each other.

After a meta-analysis of the literature was done and the evaluation of the topics based on the expert opinion of the dissertation author was performed, it is important to present this classification of the main research areas. The first area includes the papers where the ETFs as an innovative product is analysed: the theoretical, regulatory, etc. aspects are investigated (Hall, 2004; Ben-David et al., 2017; Lettau, Madhavan, 2018; Hu, Morley, 2018). The second area that has received special attention is the evaluation of ETFs' activity and its results. The scientific articles analyse the taxes and diversification aspects of ETFs, raise portfolio optimization issues, analyse the returns earned by investors, finally, the special focus on sustainable and socially responsible investments is dedicated (Poterba, Shoven,

2002; Box et al., 2020; Baule, 2010; Ma et al., 2011; O'Sullivan, Edelman, 2015; Karathanasopoulos et al., 2017; Thanakijsombat, Kongtoranin, 2018; Neves et al., 2019; O'Hagan-Luff, Berrill, 2019; Gad, Andrikopoulos, 2019; Gastineau, 2004; Wong, Shum, 2010; Blitz et al., 2012; Blitz, Huij, 2012; Milonas, Rompotis, 2015; Pandya, 2016; Alexopoulos, 2018; Stankevičienė, Petronienė, 2019; Rompotis, 2019; Wallace, McIver, 2019; Da Dalt et al., 2019; Chovancová et al., 2019; Milani, Soares, 2015; Chakrabarty et al., 2017; La Monaca et al., 2018; Chen, Scholtens, 2018; Miralles-Quirós et al., 2019; Miralles-Quirós, Miralles-Quirós, 2019).

The third area of the research is to analyse different ETFs products and various problems associated with them. For example, the researchers analyse gold ETFs, currency ETFs, commodities ETFs, the leverage ETFs receives a lot of attention (Ivanov, 2015; Nargunam, Anuradha, 2017; Guo et al., 2019; Mallika, Sulphey, 2018; Zhang, 2015; Avellaneda, Zhang, 2010; Charupat, Miu, 2011; Tang, Xu, 2013b; Tang, Xu, 2013a; Li, Zhao, 2014; Fang, Perng, 2014; Leung, Ward, 2015; Bansal, Marshall, 2015b; Bansal, Marshall, 2015a; Trainor, Gregory, 2016; Giannetti, 2017; Jiang, Peterburgsky, 2017; March-Dallas et al., 2018; Lee, Kim, 2018; Ivanov, Lenkey, 2018; Bahadar et al., 2019; Tee, Ting, 2017; Ohana, Huang, 2018).

It is also important to mention the impact of ETFs on the financial market as a whole: the fourth area of research highlighted in the dissertation includes the price formation mechanisms and the role of ETFs in it. Researchers study the impact of ETFs on market liquidity, they also analyse the link between penetration of information and communication technologies and financial innovation (i.e. ETFs), finally, ETF is used as a product to research and compare passive and active investment (Hasbrouck, 2003; Buckle et al., 2018; Wallace et al., 2019; McCullough, 2017; Hendershott, Jones, 2005; Chen et al., 2016; Hasbrouck, 2003; Buckle et al., 2018; Wallace et al., 2019; McCullough, 2017; Hendershott, Jones, 2005; Chen et al., 2016; Hegde, McDermott, 2004; Cremers et al., 2016; Miralles-Quiros et al., 2018; Elton et al., 2019a).

The fifth one, particularly important area is the risk posed by ETFs activities (Sethi, Tripathi, 2019; Chandrasekaran, Acharya, 2019; Wang, Xu, 2019; Chan et al., 2018; Ben-David et al., 2018; Hurlin et al., 2019; Jarrow, Protter, 2019; Staer, Sottile, 2018; Da, Shive, 2018; Dunham et al., 2016). Recently those risks have become the subject of a wider analysis by regulators and scientists. Unfortunately, the empirical research that tries to prove them is not unequivocal, that is why deeper analysis is needed to refine the conclusions.

After assessing the relevance of these five areas of research, it has been found that two areas of research are the most relevant: analysing different ETFs products and their problems, as well as analysing various risks arising from ETFs activities. The latter area, the risks posed by ETFs activities, is quite new as well.

Based on the performed meta-analysis of the scientific literature and the evaluation of ETF scientific research, conclusions can be drawn that this product is analysed in a very versatile way investigating different problems and topics. At the same time, it should be noted that scientific literature analysing ETFs is still in its primary stages, so there is ample space for new research. Finally, it is worth noting that one of the most sensitive and exciting topics is the risks posed by ETFs activities and the uncertainty surrounding them, which is prompting more and more researchers to undertake the analysis of this issue.

The Aspects of Exchange Traded Funds Risks. Although there has been an increasing focus in on analysing the risks of ETFs in the recent years, the views of researchers are not unequivocal. Regulators emphasize threats, while financial market participants[5] argue the opposite: they claim that ETF is an innovative product that helps markets to remain stable and efficient and supports a well-functioning price discovery mechanism and helps to maintain market liquidity.

[5] ETFs sponsors are particularly active in their statements.

The aspects of the risks posed by ETFs activities are analysed in different perspectives in scientific literature (Ramaswamy, 2011; Morris, 2011; Amenc et al., 2012; Crisóstomo, Medina, 2018; Pagano et al., 2019; Liebi, 2020; Bhattacharya, O'Hara, 2020; Clements, 2020): for example, naming the risks arising from the ETFs activities, emphasizing the transmission channels through those risks, making impact on the whole financial system or distinguishing sources of risks. Unfortunately, those transmission channels, sources of risks or risks itself are intertwined in the scientific research. That is why the risks posed by ETFs activities are classified in the dissertation. The following risks are distinguished: operational risk, legal risk, counterparty risk, collateral risk, tracking error risk, liquidity risk, product complexity and complexity of mechanisms (e.g. leveraged ETFs), concentration of managers and APs and reputation risk, as well as the impact of ETFs on their underlying securities (i.e. the co-movement of securities' market values changes; volatility of market value changes; the separation of ETFs market values and NAV during stress periods; market value discovery mechanisms; information quality and efficiency).

Moreover, it is useful to divide these risks into two groups proposed in the dissertation. The first group is the risks arising from the ETFs structural features. Although some of these risks are appropriate for the investment funds too, they arise because of the specific features of the ETFs structure. These include: the impact of ETFs on the underlying securities, counterparty risk (in the case of synthetic replication ETFs, as well as physical replication ETFs, when the securities lending operations are carried out), tracking error risk, collateral issues, etc., i.e., it includes everything that is used in the development and operation cycle of ETFs. The second group of those risks are independent from the ETFs structural features. These are risks that are not directly affected by the peculiarities of the ETF structure: such as product diversity and holder issues, concentration risks of sponsors and APs, operational risks, etc., i.e., this group

includes those risks, which does not arise directly from the peculiarities of the ETFs structure.

However, when analysing empirical studies in which the various risks posed by ETFs activities are examined, it should be noted that such studies are not yet sufficiently numerous, and the conclusions drawn from them are not unambiguous. Researchers analyse counterparty risk (Hurlin et al., 2019), the impact on the volatility of underlying securities market values changes (Ben-David et al., 2018; Wang, Xu, 2019; Sethi, Tripathi, 2019), the co-movement of underlying securities' market values changes (Da, Shive, 2018; Staer, Sottile, 2018) and they also investigate the liquidity aspects (Pan, Zeng, 2017).

Finally, it is important to emphasize that ETFs is an exceptional product because of its structural peculiarities, therefore the dissertation chooses to analyse one of the risks of this group that could have a significant impact on the financial system as a whole. That is, the question arises as to whether ETFs, due to its exceptional structure and the existence of an arbitrage mechanism, influences the co-movement of underlying securities' market values changes.

The Analysis of the Level of Scientific Research on the Evaluation of the Impact of the ETFs Arbitrage Activity on the Co-movement of Underlying Securities' Market Values Changes. Both empirical studies and various theoretical models show that ETFs has a significant impact on their underlying securities and one of the possible channels the co-movement of those underlying securities' market values changes. Liebi (2020) claims that in the context of ETFs, this topic is still analysed narrowly in scientific literature, and the main conclusions of those research are based on the US stock ETFs market. Leippold et al. (2016) agree that the impact of ETFs trading, which has gained great popularity in the recent years, on the co-movement of underlying securities' market values changes has not yet been fully explored, neither theoretically nor empirically. Finally, Pagano et al. (2019) emphasize that one of the directions for further research in order to understand the impact of ETFs activities on

systemic risk should be related to ETFs arbitrage activities and ETFs impact on their underlying securities: their volatility, liquidity and co-movement. The importance of these analysis during periods of market stress is also emphasized (Su, 2018).

Scientific literature (Barberis et al., 2002; Barberis et al., 2005; Antón, Polk, 2014) distinguishes two main approaches the co-movement of underlying securities' market values changes: traditional and alternative. Traditional approach is based on the assumption that the co-movement of securities' market values changes is determined by fundamental factors. Those factors are usually related to the common characteristics of these securities that affect their market values. Nevertheless, scientific literature concludes (Froot, Dabora, 1999; Fama, French, 1995; Hardouvelis et al., 1994; Bodurtha et al., 1995 and etc.), that the traditional approach is not sufficient to fully explain the co-movement of securities' market values changes.

Meanwhile, the second one, the alternative approach of Barberis et al. (2005) and Barberis et al. (2002) is divided into three approaches that are formed on the assumption that investors are not rational. The first of these approaches is defined as "Category-based" co-movement: it means, that these securities are assigned to certain categories, such as an asset class, sector, etc. The second approach is defined as "habitat" view of co-movement. It is explained in the way, that when a group of investors simultaneously buys or sells a certain basket of securities, this behavioural trading results the co-movement of that basket of securities' market values changes. The third approach is defined as information diffusion view. The co-movement of the securities' market values changes based on this approach is formed due to certain market deviations, during which information about different securities is reflected in their market values at different times, i.e., in some securities the information is reflected faster in the market values, in others - with a time lag. Finally, Antón and Polk (2014) propose another alternative approach to the co-movement of securities' market values changes: the institutional-based co-movement. Researchers argue that there is a causal link between the

impact of investment funds on their underlying securities and the co-movement of those underlying securities' market values changes, i.e., changes in the market value of securities which are owned by investment funds are more likely to fluctuate together than those which are not included in those funds.

The latter one, the institutional-based approach of co-movement presupposes the need to pay attention to ETFs. In the scientific literature, the ETFs' impact on the co-movement of underlying securities' market values changes are empirically investigated in only a few articles (Leippold et al., 2016; Glosten et al., 2016; Shim, 2019; Staer, Sottile, 2018; Da, Shive, 2013; Da, Shive, 2018). After analysing the scientific literature, Liebi (2020) suggests that this topic is still examined rather narrowly in the context of ETFs. Moreover, most of the scientific research is based on the US ETFs market analysis, although the European ETFs market is analysed much less. Only one article that analyses the European ETFs arbitrage activity on the co-movement of underlying securities' market values changes is found (Sakss, 2019). This presupposes the need for further research analysing the European ETFs market, because it is the second largest ETFs market in the world (Brown Brothers Harriman, 2020).

Due to poorly researched relationship between ETFs arbitrage activity and the co-movement of underlying securities' market values changes in the scientific literature, the conceptual theoretical research model (to measure the ETFs arbitrage activity on the co-movement of underlying securities' market values changes) is suggested in the dissertation, as well as the empirical application of this model to the European stock ETFs market are proposed. Fig. 2 shows that in order to earn money, the AP and other investors buy or sell both the investment units of stock ETFs and the underlying equities of those stock ETFs. By doing this trading they engage in stock ETFs arbitrage activity of secondary market. The APs, with the exclusive right, also trades on the primary stock ETFs market by buying or selling creation units of ETFs. In the stock market (i.e., in the secondary market for ETFs shares), because of the existence of the stock ETFs, the baskets

of equities are formed, which are traded together because of their belonging to those ETFs. It can be assumed that these trades also affect the co-movement of underlying equities' market values changes. It is important to note that because of the belonging to the group of equities to the same ETFs, the benefits of diversification may be reduced for investors who own those equities, i.e., the co-movement of underlying equities' market values changes is formed because of these equities belongs to the same ETF. Fig. 2 shows, that the investor "A" acquires four equities and wants to ensure the diversification of his portfolio. Unfortunately, the diversification benefit could be reduced, because all these four equities belong to the same "Stock ETF 1". That is why the co-movement of equities' market values changes could increase, and this increase could be not related to the fundamental factors.

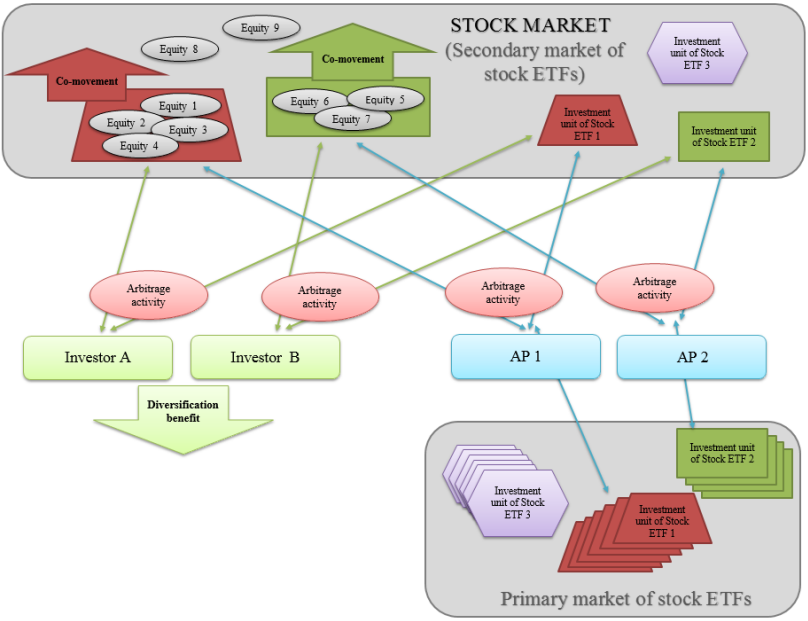


Fig. 2 The conceptual research model of the impact of the stock ETFs arbitrage activity on the co-movement of equities' market values changes

Source: Compiled by the author.

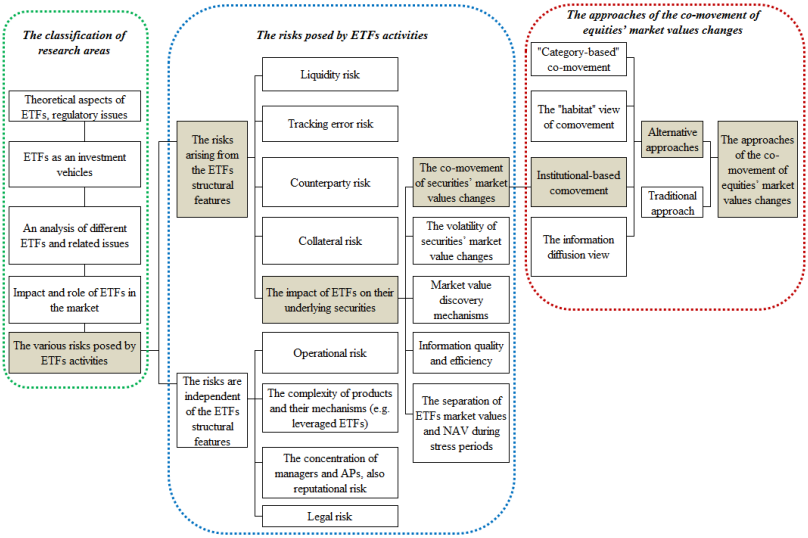
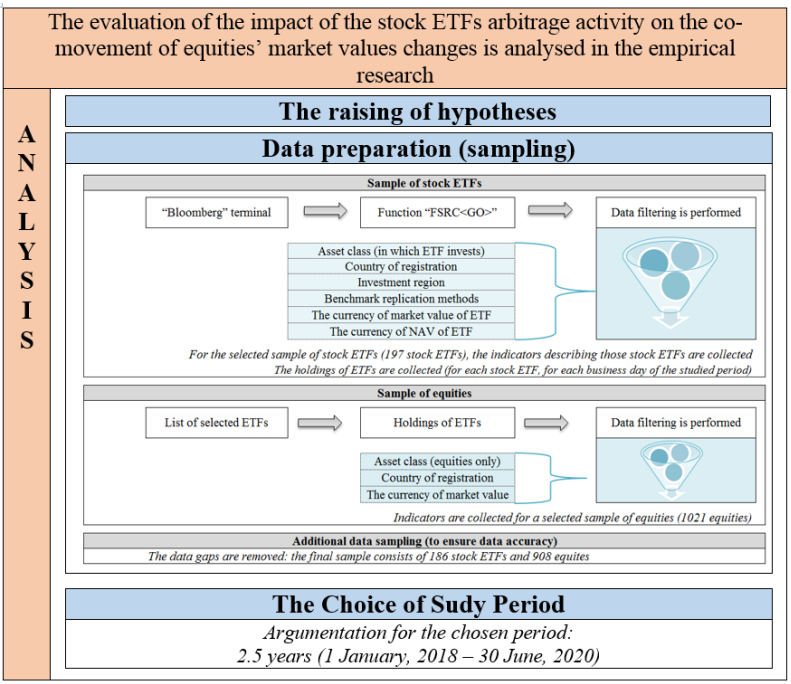


Fig. 3 The model of connections between the importance of ETFs and the co-movement of securities' market values changes

Source: Compiled by the author.

Summarizing the topics discussed in the theoretical part of the dissertation, it is worth combining them into one scheme (see Figure 3), which links the lack of risk analysis of ETFs activities in the scientific literature with the co-movement of equities' market values changes. The theoretical analysis reveals that the link between the co-movement of securities' market values changes, and the ETFs arbitrage activities is a relevant issue both among researchers and regulators despite the fact that it has been studied relatively little. Deeper knowledge of this issue is also relevant for investors seeking to ensure the diversification of their portfolio. Finally, the importance of this issue in the context of the whole financial system as well as in the context of the potential systemic risk is highlighted. It is important because the asset under management of ETFs is rapidly growing, and the peculiarities of this product have been analysed for little time. Thus, the further analysis and research are not only important from the academic but also from the practical side.

Research Methodology. The research methodology is shown in Figure 4. It consists of 2 stages: analysis and evaluation. In the first part of the analysis, the hypotheses of the research are raised, the data are prepared, and the research period is chosen. In addition, the indicators for the evaluation of dependent and independent variables are selected: the co-movement of equities' market values changes, the ETFs arbitrage activity, control variables and fixed effects are defined, and a panel data model is constructed. In the second stage of the research, the evaluation is carried out: the estimates of the parameters of the selected panel data model are calculated, additionally, appropriate methods and techniques for the calculations are selected. Finally, after evaluating the parameters of the selected models and their significance, the reliability of the model is assessed, the hypotheses are proved or disproved, and the conclusions of the research are formulated.



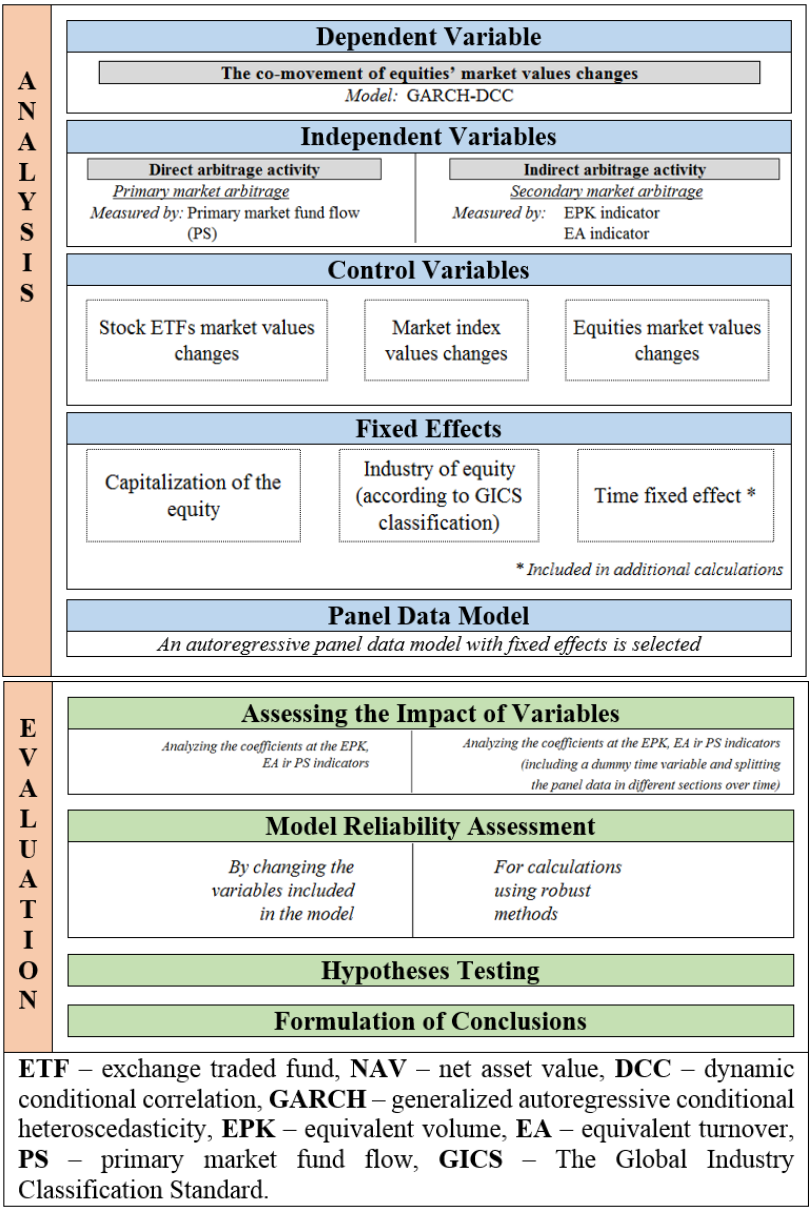


Fig. 4 Author's research methodology

Source: Compiled by the author.

It is important to emphasize that the ETFs arbitrage activity is measured both directly and indirectly in the empirical research. The primary market fund flow ratio (PS) is directive indicator of the ETFs arbitrage activity, while the equivalent volume (EPK) proposed by Staer and Sottile (2018) and the equivalent turnover (EA) proposed in this dissertation are indicators to measure indirectly ETFs arbitrage activity. The latter one, the EA indicator, helps to assess indirect ETFs arbitrage activity more accurately compared to the EPK, due to a clearer economic interpretation as based in the dissertation.

It was decided to conduct the empirical research using European ETFs market data: the theoretical part of the dissertation emphasizes that most studies, which analysing ETFs activities are performed using US ETFs market data (Leippold et al., 2016; Glosten et al., 2016; Shim, 2019; Staer, Sottile, 2018; Da, Shive, 2013; Da, Shive, 2018), while the European ETF market is analysed much less (Sakss, 2019). Thus, in order to expand research analysing the activities of European ETFs and to reduce the research gap between analysis of US and European ETFs, the European stock ETFs are chosen to investigate in the empirical research.

Finally, it is important to mention that the panel database is consisted of more than 10 million observations. This suggests that the conclusions obtained are based on sufficient sample of data to be considered as valid.

Analysis of Indicators Assessing the European Stock ETFs Arbitrage Activity and the Co-movement of European Equities' Market Values Changes. The values of the DCC indicator are calculated according to the GARCH-DCC model (this indicator is used as dependent variable of the panel data regression model). The calculations show that there is a co-movement between the equities' market values changes and the ETF NAV, which is not related to the fundamental factors. Evaluating the values of the calculated DCC indicator, the volatility (measured by standard deviation) is important to discuss. The dynamics of DCC values' standard deviation showed

that during market stress (when markets fall, i.e., for the period 19 February – 18 March 2020) the volatility of DCC values increased significantly. This confirms the statement that during market instability an additional co-movement of equities' market values changes forms, which reduces the benefits of diversification for investors.

Two indicators were calculated to measure indirect ETFs arbitrage activity: the EPK indicator proposed by Staer and Sottile (2018) and the new EA indicator proposed in the dissertation. Qualitative analysis of these two indicators showed that the average of the EA indicator is higher compared to the EPK (0.21 and 0.16, respectively). However, although the values of EA fluctuated slightly more than the EPK, the difference of the EA and EPK standard deviations is relatively small (0.26 and 0.24, respectively). It should also be mentioned that the averages of the values of the EA indicator have a larger amplitude than the EPK indicator. Finally, the EA indicator is more responsive to various changes in the market, such as market fluctuations during the COVID-19 pandemic. EA values' moving averages have increased more, than EPK indicator's. In conclusion, it cannot be ruled out that the EA indicator's values are more sensitive to various changes in market or trading volume.

The primary market fund flow indicator (PS) was chosen to measure direct ETFs arbitrage activity. This indicator is included in the panel data model as an independent variable in three ways: (1) using the nominal value of this indicator (EUR million); (2) using a dummy variable: "1" – when fund flows are and "0", when there are no fund flows; (3) using a dummy variable depending on whether the primary market fund flows are positive, negative or zero. During the analysed period, there was not any single day that the nominal value of the PS indicator for all stock ETFs was non-zero, but there were several days when none of the stock ETFs had either negative or positive primary market fund flows. It is worth mentioning the day when the most stock ETFs had movements: 17 March 2020, 67 of 196 stock ETFs had movements, while 129 stock ETFs had no movements

on that day. Finally, during the COVID-19 pandemic, i.e., chosen period of market stress (when markets fall, i.e., for the period 19 February – 18 March 2020), these primary market fund flows increased: more stock ETFs having positive or negative PS.

All three analysed independent variables are used to directly (PS) and indirectly (EPK and EA) measure the ETFs arbitrage activity in order to investigate the impact of the stock ETFs arbitrage activity on the co-movement of equities' market values changes.

The Evaluation of the Impact of the Direct and Indirect Stock ETFs Arbitrage Activity on the Co-movement of Equities' Market Values Changes. After analysing the variables, an autoregressive (first-order) panel data model with fixed effects is constructed in the methodological part. This model is designed to assess the stock ETFs arbitrage activity on the co-movement of equities' market values changes. Models are constructed with each indicator measuring ETFs arbitrage activity: indirectly measuring EPK and EA, directly – PS. Finally, the obtained results are evaluated.

First of all, the purpose of the investigation is to determine whether the evaluation of the impact of the European stock ETFs arbitrage activity on the co-movement of European equities' market values changes. When evaluating indirect ETFs arbitrage activity, the results show that there is a significant positive impact. The model estimates of the parameters calculated by both the EPK and EA indicators show similar results: in the current period, the 100% shock of the value of EPK or EA indicator could increase the co-movement of European equities' market values changes at 0.09% point (i.e., to lead an increase of 0.09% point in the change in DCC), if all the other factors are constant. Moreover, the changes in EPK and EA indicators have an impact with one and two time lags: the biggest impact on the co-movement of European equities' market values changes is made the next day: with the 99.9% the confidence level, the previous day 100% shock of the EPK or EA indicators increases the change in the value of the DCC indicator by 0.1% point. Meanwhile, the impact of the EPK or EA indicators shock two days ago is smaller: with the 99.9%

confidence level, the 100% shock of the EPK or EA indicators increases the change in the co-movement of European equities' market values changes by 0.05% point. Based on the obtained results, it can be stated that indirect ETFs arbitrage activity increases the co-movement of European equities' market values changes.

When assessing the impact of direct ETFs arbitrage activity, a statistically insignificant or close to zero influence is observed in all the developed models. These results also confirm the doubts raised in the scientific literature (Ivanov, 2016b; Pan, Zeng, 2017). The scientists state, that the PS indicator is still not detailed enough to make reasonable conclusions about ETFs arbitrage activity and more detailed data still needs to be collected.

In order to assess whether estimates of the parameters of the calculated models are correct and the conclusions are reasonable, additional calculations are performed by including and subtracting different independent variables from the regressions, as well as by changing the time lags. In summary, after calculating the estimates of the parameter of the variables in different ways, they were similar and did not differ significantly. So, it can be concluded that the chosen autoregressive panel data model with fixed effects is suitable for analysing the issue studied in the dissertation.

The second stage of model testing was performed by testing the robustness of it, i.e., calculating already constructed models by other, robust, calculation methods. Assessing the indirect ETFs arbitrage activity (measured by the EPK and EA indicators), it is concluded that the impact on the stock ETFs arbitrage activity on the co-movement of equities' market values changes is still positive and significant, although smaller. In the current period, the 100% shock of the value of EPK or EA indicator could increase the co-movement of European equities' market values changes at 0.026% point (i.e., to lead an increase of 0.026% points in the change in DCC), if all the other factors are constant. Regarding the calculation methodologies of these models (described in the methodological part of the dissertation), it can be concluded that the results obtained using robust calculation

methods, more accurately and precisely assess the impact of the analysed factors.

When assessing direct ETFs arbitrage activity, which is measured by the PS indicator, an almost zero or insignificant influence of the arbitrage activity the co-movement of European equities' market values changes is observed. In cases where this influence is significant, it is negative, which does not allow to confirm the presumption of a positive impact of ETFs arbitrage activity.

Assessing the Impact of Market Stress on Co-movement of Equities' Market Values Changes. After developing the main research model, the dissertation additionally aims at assessing whether during the COVID-19 pandemic the additional co-movement of equities' market values changes was formed. It first examined whether equities experience a greater co-movement of equities' market values changes during market stress[6]: thus, two additional fixed time variables are included in the equations of the main regression, during and after the fall of the markets.

The calculations show that during times of stress, the change in the co-movement of European equities' market values changes increases and becomes smaller at the end of this period. Assessing the fixed time effects (when the EPK or EA indicators are included in the models), it can be concluded that the co-movement of European equities' market values changes during market stress to experience an additional increase of 0.012% point (at the 99.9% confidence level), while using the PS indicator, it is around 0.011% point.

Additional calculations were also performed by a robust calculation method. These results did not negate previously obtained results but confirmed them only partially: when control variables are included in the model, the additional time effect becomes insignificant. Despite that, the significant positive additional change

[6] In this doctoral dissertation, the period of stress refers to the fall of the markets on 19 February – 18 March 2020.

in the co-movement of European equities' market values changes increases by about 0.005% point (with a 99.9% confidence level). A similar situation can be seen in the assessment of direct arbitrage activities. The change in the co-movement of European equities' market values changes during the stress period increased by about 0.005% point, but only if control variables and fixed effects are not included in the model.

The dissertation does not only analyse whether there is the impact of the stock ETFs arbitrage activity on the co-movement of equities' market values changes, but also assesses whether different periods in the markets affect the magnitude of the impact of that arbitrage activities. For this purpose, the analysed 2.5 years period is divided into three parts: (1) pre-stress (until 19 February 2020); (2) stress (19 February 2020 – 18 March 2020); and (3) after the fall of the markets (after 18 March 2020). Analogous to the previous algorithm, with each of the stock ETFs arbitrage performance indicators (EPK, EA and PS), the estimates of the regression parameters are calculated using both: the least squares and the robust calculation, methods. The calculated model parameter estimates are compared with each other. In addition, due to the extremely short duration of the market downturn (compared to the whole analysis period), another additional regression is calculated for the whole period, from the beginning of the market downturn to the end of the analysis period (30 June 2020) – this period is named as the whole period of market instability.

Using a robust calculation method and using all the analysed period in the current time, the 100% shock of the value of EPK or EA indicator could increase the co-movement of European equities' market values changes at 0.026% point (i.e., to lead an increase of 0.026% point in the change in DCC), if all the other factors are constant. The next day this impact is the same (0.026% point), while two days later it starts to decrease (the increase would be 0.011% point). Meanwhile, when assessing the period before the markets fall, the impact becomes slightly smaller: at 0.025% point in the current period. Furthermore, the following day and the two days after current

day the impact would be respectively 0.028% and 0.011% points. In times of market stress – insignificant. However, combining the periods of decline and recovery, the impact in the current period is very similar – 0.024% point, but the next day this influence doubles to 0.0411% point. Therefore, using a robust methodology, both the EPK and EA indicators have shown that the greater impact of indirect arbitrage occurs during periods of market instability, with the largest impact occurring the next day. Finally, the direct ETFs arbitrage activity (measured by PS indicator) did not allow to confirm the hypothesis about the positive impact, because the parameter estimates were not unambiguous.

In summary, it can be concluded that during periods of market stress the additional co-movement of equities' market values changes are formed. Furthermore, although the impact of ETFs arbitrage (measured indirectly) is slightly higher than in normal market periods, the parameters estimates were insignificant during periods of stress, so they could not be interpreted.

CONCLUSIONS AND PROPOSALS

Based on the theoretical and empirical research performed in the dissertation, the main conclusions are formed:

1. The analysis of scientific literature in the dissertation is aimed at: examining the problems of the concept of exchange traded funds (ETFs), discussing the exclusive structure of ETFs and classifications used in both practice and scientific literature, and finally emphasizing the importance of arbitrage mechanism. It presupposes several main conclusions:

    1.1. Based on the analysis of scientific literature, it has been established that several aspects need to be included in the definition of ETF. First, ETF is an investment vehicle that normally tracks a chosen benchmark or set of assets, it combines the characteristics of open-ended and closed-ended investment funds, furthermore, is continuously traded on stock exchanges.

Secondly, the definition of ETF must also cover ETF arbitrage activity which is considered as exclusive property of ETF. This arbitrage possibility may be used by authorized participants (APs) or investors, who trade in the secondary market. By having the exclusive ability to trade in the primary market, the AP can not only earn from these transactions, but also eliminate the differences between the market value of the ETFs and the net asset value (NAV) of it: by buying cheaper assets and selling more expensive ones. Moreover, because of this APs activity, the correlation and the volatility of securities market values changes start to increase. Finally, as a result of the APs' trading activity, shocks from the ETFs market may move into the markets of the underlying securities.

1.2. Various classifications of ETFs are identified in the dissertation: geographical region, investment asset class, strategy, etc. However, the ETFs separates with its structure and the benchmark replication methods. In scientific literature this classification (according to the benchmark replication methods) is important because it is considered as a unique feature of ETFs activity.

1.3. The analysis of scientific literature presupposes the need for a more detailed study of ETFs arbitrage activity because this activity creates benefits for APs and other investors, at the same time posing new risks that have not been studied in the scientific literature.

2. The meta-analysis of the literature was dedicated to comprehensively assess the level of the research on ETFs' aspects, to propose the classification of research areas analysing ETFs and to assess the relevance of those areas. The results show that there is ample scope for new research as ETF is a complex and diverse product, and the more detailed empirical analysis and research are needed to study their activities:

2.1. The bibliometric analysis reveals that the researchers from the USA and European countries show the greatest interest

in the topic of ETFs; furthermore, the growth of scientific articles on this issue has taken place after the global financial crisis. After evaluating scientific research according to various criteria (i.e., research directions, countries, authors, journals, etc.), it is concluded that these research cover a wide range of scientific fields and there is not one that is dominant. Finally, despite the growing volume of the research, the level of research on ETFs is still at an early stage.

2.2. In the second part of the theoretical research of the scientific literature, network analysis was performed, furthermore, cluster analysis was used. Three maps describing and connecting the main topics related to ETFs were constructed. It was found that the maps did not ensure a qualitative grouping of the research areas, so it was decided to carry out an additional evaluation of the topics based on the dissertation's expert opinion. Finally, it is concluded that the topics related to ETFs are still relatively new in the scientific field, and that researchers are interested in various aspects of this product, which are not necessarily interrelated.

2.3. The third part of the meta-analysis of the literature reveals the added value of it for science. According to dissertation's author expert evaluation, the existing scientific literature has been classified into the main areas of the research, which interests the scientists and researchers. These five main areas are: (1) the analysis of ETF itself as an innovative product; (2) the evaluation of ETFs activities and its results; (3) the analysis of different ETFs products and various problems associated with them; (4) the impact of ETFs on the financial market as a whole; (5) the analysis of various risks posed by ETFs activities. After assessing the relevance of these five areas of the research, it has been found that two areas are the most relevant: analysing different ETFs products and their problems, as well as analysing various risks arising from ETFs activities. The latter area, the risks posed by ETFs activities, is quite new as well.

3. The aspects of the risks posed by ETFs activities are analysed from different perspectives in scientific literature, for example, naming the risks arising from the ETFs activities, emphasizing the transmission channels through those risks, making impact on the whole financial system or distinguishing sources of the risks. Unfortunately, those transmission channels, sources of risks or risks itself are intertwined in the scientific research. This is why the risks posed by ETFs activities are classified in the dissertation, highlighting the most important ones. In addition, a classification of these risks dividing them into two groups is proposed: (1) the risks arising from the ETFs structural features, such as, the impact of ETFs on their underlying securities, counterparty risk, tracking error risk, etc.; (2) the risks that are independent from the ETFs structural features, such as, product diversity, managers and APs concentration risks, operational risk, etc. Finally, the analysis of scientific literature has shown that more detailed empirical studies are needed to refine the effects of these risks.

4. Both, empirical research and various theoretical models show that ETFs has a significant impact on their underlying securities. One of the possible channels, how ETFs make impact on their underlying securities, is the co-movement of securities' market values changes:

4.1. The issue of the risks posed by ETFs activities is still examined rather narrowly, and the main conclusions are based on studies performed in the analysis of the US ETF market (for this reason it has been decided to analyse the European ETFs market in this dissertation). Moreover, it is important to emphasize the importance of examining this risk during the periods of market stress, as the activities of ETFs during such periods have not yet been analysed in detail. It is worth noting that the analysis of scientific literature reveals that there are two main approaches of the co-movement of underlying securities' market values changes: traditional and alternative. The co-movement of underlying securities' market values changes should be classified as an alternative approach.

4.2. After assessing the level of scientific research on the impact of ETFs arbitrage activity on co-movement of underlying securities' market values changes, it was found that this topic is relevant both among researchers and among regulators, although it has been relatively little studied. Due to poorly researched relationship between ETFs arbitrage activity and the co-movement of underlying securities' market values changes in the scientific literature, the conceptual theoretical research model (to measure the ETFs arbitrage activity on the co-movement of underlying securities' market values changes) is suggested in the dissertation, furthermore, the empirical application of this model to the European stock ETFs market is proposed.

5. The dissertation proposes a new research methodology to assess the ETFs arbitrage activity on the co-movement of underlying securities' market values changes:

5.1. The co-movement of underlying securities' market values changes has been chosen to be measured using the GARCH-DCC model, which estimates the co-movement of underlying securities' market values changes and eliminates co-movement of fundamental factors (i.e., whole market, measured by whole market index).

5.2. The dissertation proposes to measure the activity of arbitrage in two aspects: direct and indirect. To measure direct ETFs arbitrage activity, the equivalent volume (EPK) proposed by Staer and Sottile (2018) and the equivalent turnover (EA) proposed in this dissertation. Finally, the indicator that measures direct ETFs arbitrage activity is used: primary market fund flows (PS). It should be noted that the proposed new EA indicator to measure indirect arbitrage activities is important because it has a more meaningful economic interpretation compared to the EPK indicator. This EA indicator creates added value to scientific literature, by expanding the level of the research on stock ETFs risks.

5.3. Autoregressive panel data model with fixed effects was chosen to measure the impact of the stock ETFs arbitrage activity on the co-movement of equities' market values changes. To ensure the accuracy of the results, calculations are performed not only by using the least squares method, but also by using robust calculation methods.

5.4. By combining all the methods necessary for the implementation of the conceptual model, a common research methodology is constructed: this allows to measure the impact of stock ETFs arbitrage activity on the co-movement of underlying securities' market values changes directly and indirectly.

6. After the assessment of the impact of the European stock ETFs arbitrage activity on the co-movement of European equities' market values changes, the main conclusions are drawn:

6.1. The calculation of co-movement of equities' market values changes, measured by the DCC indicator, shows that this co-movement exists (the values of the DCC indicator were not zero) and is not determined solely by fundamental factors.

6.2. Autoregressive panel data model with fixed effects was used to evaluate the parameters estimates. The ETFs arbitrage activity, measured indirectly by EPK or EA indicators, allowed to confirm the positive significant impact on the co-movement of equities' market values changes: in the current period, the 100% shock of the value of EPK or EA indicator could increase the co-movement of European equities' market values changes at 0.09% point (i.e., to lead an increase of 0.09% point in the change in DCC), if all the other factors are constant. Meanwhile, the indicator measuring direct ETFs arbitrage activity, PS, did not allow to confirm this hypothesis, because the results were not unambiguous: statistically insignificant or close to zero influence was observed in the regression models. In addition, using robust methods for parameters estimate in the current period, the 100% shock of the value of EPK or EA indicator could increase the co-movement of European equities' market values changes at

0.026% point (i.e., to lead an increase of 0.026% point in the change in DCC), if all the other factors are constant. Meanwhile, the PS indicator measuring direct arbitration did not allow to confirm the following: using robust calculation methods, the effect of ETFs arbitrage activity on o-movement of European equities' market values changes was almost zero or insignificant.

6.3. It is concluded that the use of robust methods to calculate parameter estimates of regressions results in a slightly smaller impact of ETFs arbitrage activity than when using the least squares method. Due to the accuracy of the robust calculation methodology, it can be concluded that these estimates of the impact of ETFs arbitrage activity should be considered as more accurate ones.

6.4. The calculations and the comparison of the EPK and EA indicators have showed that although they are calculated according to different methodologies and have different economic interpretations, they show very similar results, i.e., a similar effect of the impact of the stock ETFs arbitrage activity on the co-movement of equities' market values changes. Based on the fact that the EA indicator has a reasonable economic interpretation, in the dissertation's author's opinion, it is the latter indicator, EA, which should be used to measure indirect arbitrage activities.

7. After assessing the additional impact of the European stock ETFs arbitrage activity on the co-movement of European equities' market values changes, during period of market stress and comparing the impact of arbitrage activities in different periods of market movements, it was determined:

7.1. After assessing the time fixed effects (when in the models are included the EPK or EA indicators), it can be concluded that the co-movement of European equities' market values changes during market stress to experience an additional increase of 0.012% point (at the 99.9% confidence level), while using the PS indicator, it is around 0.011% point. Additional calculations were

also performed by using robust calculation method. These results did not negate previously obtained results but confirmed them only partially: when control variables are included in the model, the additional time effect becomes insignificant. Despite that, the significant positive additional change in the co-movement of European equities' market values changes increases by about 0.005% point (with a 99.9% confidence level).

7.2. After calculating the estimates of the parameters of the panel data model to the indicators assessing ETFs arbitrage activity, it was found that it was not possible to draw unambiguous conclusions for different data samples by time: during periods of market instability the coefficients during the stress period were insignificant and therefore could not be interpreted.

8. In addition, it should be noted that the research conducted in the dissertation is distinguished by a very large sample: although the analysed ETFs market share is about 10%, the panel data model used a data block consisting of more than 10 million observations. This suggests that the conclusions obtained are based on a sufficient sample of data to be considered valid.

Further research directions, suggestions and recommendations are formed on the basis of the performed research:

1. Because the issue analysed in the dissertation is quite narrowly covered in the scientific literature, it is proposed to expand those research, emphasizing not only the European or US stock ETFs markets, but also expanding research in other markets.

2. It is proposed to apply the research methodology developed in the dissertation to other data samples in order to evaluate the impact of the ETFs arbitrage activity on the co-movement of underlying securities' market values changes. This would not only help to calibrate the proposed methodology, but also help to purify the impact of analysed risk, i.e., the impact of ETFs arbitrage activity on the co-movement of underlying securities' market values changes.

3. Given the shortcomings of the PS indicator, which did not provide confirmatory conclusions on the stock ETFs arbitrage activity on the co-movement of equities' market values changes, it is recommended to collect more information on APs activities, transactions, etc., which would be valuable, especially if collected centrally at European level. This would pave the way for in-depth investigations and informed conclusions about the direct ETFs arbitrage activity and their impact. Furthermore, it would help to the regulator to making decisions as the stock ETF market grows and to protect the financial system from potential sources of threats and risks.

4. It is important to emphasize the importance of a holistic approach. This dissertation analyses only one structure-related equity ETFs risk for their underlying equities. Despite this fact, in order to ensure a sufficient level of analysis of stock ETFs risks, a conceptual approach is needed to combine more different risks. This combination would help to assess the overall systemic impact on financial market, because the risks of ETFs are intertwined.

LIST OF PUBLICATIONS

List of scientific publications:

1. Novickytė, L., Rabikauskaitė, V. (2017). The evaluation of the II pillar pension's funds: an integrated approach using multi-criteria decision methods. *Business: Theory and Practice* 18: 109-127. doi: https://doi.org/10.3846/btp.2017.012.
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3. Dičpinigaitienė, V., Kanapickienė., R., Shadow banking issues: meta-analysis using a network approach, *Conference Proceedings of SGEM International Multidisciplinary Scientific Conference on Social Sciences and Arts*, 2019, p. 353-360.
4. Dičpinigaitienė, V., Kanapickienė., R., The risks of investment in ETF: the case of Lithuanian pension funds, *Conference Proceedings of 47th International Scientific Conference on Economic and Social Development*, 2019, p. 391-400.

List of other publications:

1. Dičpinigaitienė, V. (2020). Lietuvos pensijų fondų investicijų į biržoje prekiaujamus fondus analizė. *Lietuvos bankas, serija „Analizė ir tyrimai"*, Nr. 8, ISSN 2538-9386 (online).

Presentations at international scientific conferences:

1. „Shadow banking issues: meta-analysis using a network approach" (co-author Kanapickienė, R.). Presentation at an international conference „SGEM International Multidisciplinary Scientific Conference on Social Sciences and Arts", Vienna, Austria, 11–14 April, 2019.

2. „The risks of investment in ETF: the case of Lithuanian pension funds“ (co-author Kanapickienė, R.). Presentation at an international conference „47th International Scientific Conference on Economic and Social Development“, Prague, Czech, 14–15 November, 2019.

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