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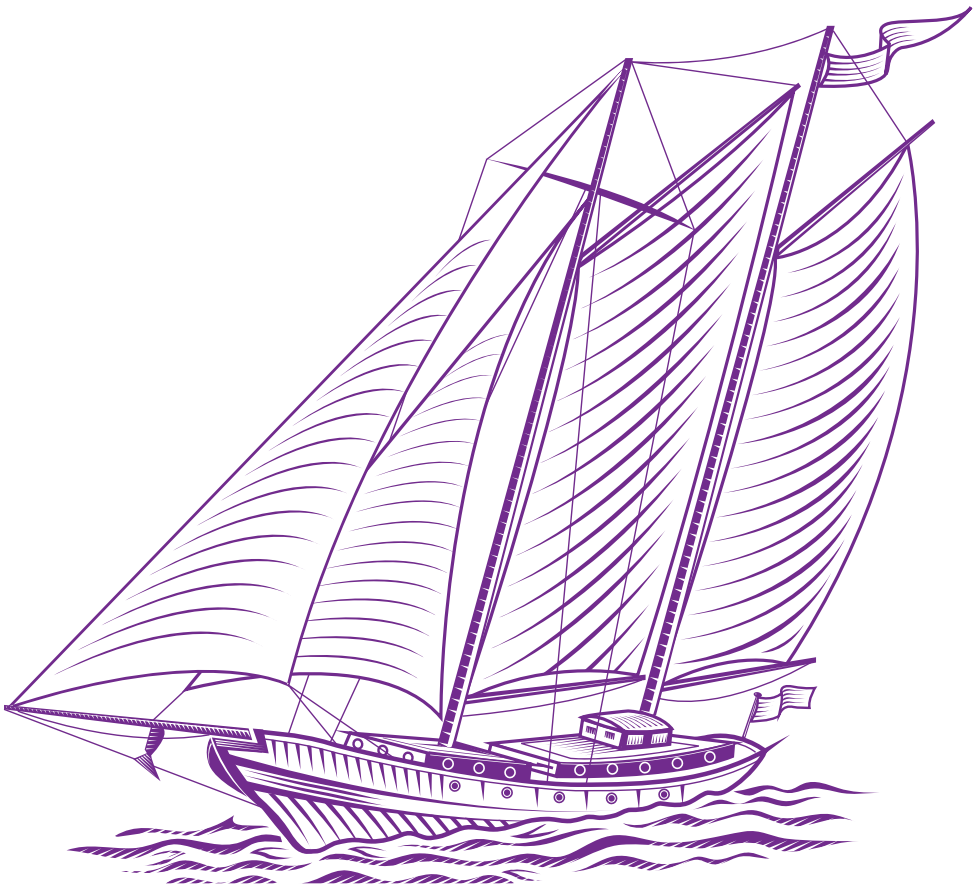

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DEVELOPING AND DEVELOPED MEDITERRANEAN STOCK EXCHANGES: INTERDEPENDENCE IN PERIODS OF CRISIS AND STABILITY

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ABSTRACT. This research aims to explore how the stock exchange indexes of developed and developing Mediterranean countries are interrelated, both during times of crisis and stability. Specifically, it examines the association between Macedonia's MBI10 index and the stock exchange indexes of Serbia (BELEX15), Italy (FTSE MIB), and Spain (IBEX35) from 2005 to 2022 using monthly data. To understand how crises impact the relationships between these markets, the study breaks down the timeframe into four distinct periods: before the Great Financial Crisis (pre-GFC), during the GFC, after the GFC (post-GFC), and during the Covid-19 pandemic and energy crisis. Through Pearson correlation and linear regression analyses, the findings show that the MBI10's correlation with the BELEX15, FTSE MIB, and IBEX35 indexes was strongest during the GFC. However, this correlation dropped significantly during the Covid-19 pandemic and energy crisis.

Keywords: Mediterranean, stock exchange, Great Financial Crisis, interdependence, Covid-19, energy crisis

JEL Classification: F02, F21, G15

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Introduction

The pivotal role of stock exchanges in the global economy cannot be overstated, as they serve as hubs for fostering economic growth and innovation worldwide. Particularly in recent times, stock exchanges have been instrumental in bolstering investment, facilitating capital allocation, and driving economic development. Research has demonstrated their crucial function during financial and economic crises, rendering them susceptible to and influential upon downturns. Their responses to such crises, coupled with governmental interventions and adjustments, play a vital role in stabilizing markets and restoring investor confidence. However, it is evident that the influence of economic crises on stock exchanges can have enduring adverse impacts on the global financial system and economy. In this regard, the Great Financial Crisis of 2008 precipitated significant turbulence in financial markets and widespread economic deceleration (Dhal, 2009). In light of these circumstances, numerous scholars and policymakers have endeavored to assess the extent of the interplay between economic uncertainty and asset yields (Garcia *et al.,* 2014), the impact of financial crises on stock exchanges worldwide, yielding mixed empirical findings that contribute to the literature in this domain. Liu (2013) identified several key factors that drive the interdependence between financial markets in developed and developing countries. These factors include information dissemination quality, industrial structure correspondence, economic and financial consolidation, which tend to be relevant only within the same cluster of either developed or emerging markets. Samadder & Bhunia (2018) conclude that investors can enjoy notable gains from diversifying their portfolios internationally in the short term, but the long-term advantage of such diversification are limited. Recognizing that global macroeconomic and financial crises can cause major changes in the economy, public revenues, and investor risk behavior, numerous studies have explored how stock market correlations behave during such crises (Sharma, 2011; Srikanth & Aparna, 2012; Hwang *et al*., 2013; Yarovaya & Lau, 2016; Jiang *et al*., 2017; Das *et al*., 2019; Ji *et al*., 2020).

Regarding the Macedonian Stock Exchange (MSE), it is noteworthy that it is relatively young and exhibits liquidity deficit and lack of market depth. In the pre-crisis period, foreign investor participation in the exchange reached

40% in 2008, followed by a swift withdrawal post-crisis, which significantly impacted MSE stock prices. Additionally, there was evidence of a remarkable 905% increase in the main stock index MBI10 from 2005 to 2007, followed by a 75% decline in 2011. Furthermore, compared to other developing countries, the recovery period for MSE was notably sluggish. Consequently, this paper aims to explore the nexus between emeging and developed stock exchanges (Macedonian Stock Exchange (MBI10), Belgrade (BELEX15), Italian (FTSE MIB), and Spanish (IBEX35) stock exchange index) by analyzing monthly data from 2005 to 2022. Moreover, this study aims to add to the existing literature by exploring the interrelationships among Mediterranean stock exchanges, emphasizing the importance of time-varying factors in financial market integration.

This paper has the following structure: After the introduction, the Literature Review section examines existing literature pertaining to stock exchanges, with particular emphasis on the great financial crisis of 2008, the Covid-19 pandemic, and the global energy crisis, and their interrelations. The subsequent section, Data and Methodology, delineates the methods employed for data collection, processing, and analysis. The fourth section, Findings and Discussion, offers a detailed analysis of the empirical results. Finally, the Conclusions section synthesizes the findings of the empirical research, providing insights derived from the analysis.

Literature review

The examination of stock exchange markets has been a focal point for numerous researchers and scholars, particularly in assessing their dynamics during periods of crisis and stability. Olbryś & Majewska (2017) suggest that the association between S&P500 and France-CAC, as well as British FTSE and German DAX markets, intensified during the GFC in comparison to the period before the crisis, an assertion confirmed by Slimane *et al*. (2013) in view of the Germany, France, and UK linkage. Meanwhile, Wang (2014) investigated the correlations between six East Asian stock exchanges and their interactions with the US market during the GFC, finding that the crisis bolstered connections between East Asian markets, albeit with reduced responsiveness to US shocks post-crisis. Additionally, Meric *et al*. (2012) studied the relationship among US, European, and Australian stock exchanges during the GFC, concluding an increased integration between them during this period.

Choi (2022) analyzed volatility dynamics in South Korea, China, Japan, and the US during the GFC and the COVID-19 pandemic, aiming to discern how volatility shocks propagate among these nations during regular periods and

crises. The study revealed temporal variations in overall interdependence and net interconnection among the volatilities of the four stock markets, with the GFC demonstrating higher total connectedness in comparison to the COVID-19 period. Basuony *et al.* (2021) examined how the COVID-19 pandemic affected equity returns, conditional fluctuations, probability distribution asymmetry, and the probability of adverse market conditions. They found that major equity markets experienced a negative impact, with a significant surge in conditional volatilities and bad state probabilities across the board. However, the extent of this impact varied by country: China and Germany showed lower conditional volatility, whereas Italy, the United States, and the United Kingdom saw higher volatility and bad state probabilities. The spike in conditional volatility during the pandemic gradually diminished once markets absorbed the initial shock.

Abuzayed et al. (2021) investigated the transmission of systemic distress risk between worldwide and single stock exchanges amidst the COVID-19 pandemic. Utilizing conditional value at risk (CoVaR) and delta conditional VaR (CoVaR) measures alongside the bivariate dynamic conditional correlation (DCC) conditional autoregressive heteroscedastic (GARCH) model, their findings revealed a heightened spread of systemic risk between the worldwide stock market and individual stock markets during the COVID-19 pandemic. North American and European markets were particularly affected, showing higher levels of risk transmission and reception in contrast to Asian markets, indicating a greater integration of ultimate distress risk during the pandemic.

In contrast, Goetzmann *et al.* (2001) examined how major global equity markets correlated over 150 years, highlighting a period of prosperity in the late 1990s. Their findings supported the "U" shaped hypothesis on globalization, indicating that about half of the diversification benefits for international investors during that time came from the increasing number of global markets, while the other half stemmed from lower average correlations among these markets.

Das *et al.* (2019) investigated how global crises affected the relationships between stock markets, specifically focusing on G7 countries and analyzing data dating back to the 1800s. Their research shed light on the varied impacts of global crises on the changing correlations between the US stock market and its counterparts in the G7 nations, indicating strengthened associations between the US market and those of the UK and Canada during crises, with contrasting trends observed concerning European and Japanese markets.

Pagano *et al.* (1999) investigated push factors influencing European companies to exchange abroad, highlighting increased co-integration among European stock exchanges with the EU's growth. Similarly, Syriopoulos & Roumpis (2009) and Kenourgios & Samitas (2011) found that EU accession facilitated the consolidation of Balkan and developed stock markets, particularly

European and US markets. Conversely, Horvath & Petrovski (2012) noted limited connections between stock markets in Central and South Eastern Europe with those in developed Western Europe, except for Croatia, which showed a notably high level of integration.

Recent studies have confirmed the interrelationship between Balkan stock exchanges (Karagoz & Ergun, S, 2009; Gradojević & Dobardžić, 2013; Şahin, 2015; Zdravkovski, 2016; Angelovska, 2017; Srbinoska *et al*., 2021). Notably, Angelovska (2017) suggested bidirectional causality between the Macedonian and Croatian stock markets, while Zdravkovski (2016) observed increased integration among Balkan stock markets during the GFC. Additionally, Srbinoska *et al*. (2021) detected a heightened association between the Macedonian, Belgrade and Euronext Paris equity markets, in conjunction with a diminished association with Six Swiss in periods of financial crises.

Data and methodology

Sample

The analysis utilized secondary data collected from the Internet sites of the selected stock exchanges and stock trading web pages, specifically investing.com and finance.yahoo.com. The dataset comprises four selected stock exchanges: the Macedonian (MBI10) index, the Belgrade (BELEX15) index, the Italian (FTSE MIB) index, and the Spanish (IBEX35) index, spanning from 2005 to 2022. Monthly index values of the stock exchanges are denominated in their respective national currencies. The timeframe is segmented into four sub-periods: pre-GFC, during the GFC, post-GFC, and during the Covid-19 and energy crises.

Table 1 presents a summary of the main stock indices for the countries included in our study. The paper explores how investors react during normal times, crises, and recovery phases by examining the interconnections among two developing and two developed European stock markets. The data is segmented into four periods: pre-GFC spanning from November 2005 to July 2007, GFC from August 2007 to November 2011, post-GFC sub-sample covering December 2011 to January 2020, and the pandemic and energy crisis from February 2020 to October 2022.

Table 1. Stock exchanges and their indices

Country	Stock Exchange	Index	Index date of inception
North Macedonia	Macedonian Stock Exchange	MBI10	November, 2001
Serbia	Belgrade Stock Exchange	BELEX 15	September, 2005
Italy	Italian Stock Exchange	FTSE MIB	September, 2004
Spain	Spanish Stock Exchange	IBEX35	January, 1992

Source: authors' compilation

Hypotheses

The primary goal of this study is to investigate how integrated the Macedonian Stock Exchange (MBI10) is with the Belgrade Stock Exchange (BELEX15), the Italian Stock Exchange (FTSE MIB), and the Spanish Stock Exchange (IBEX35) across different periods: pre-, during, and post-GFC, as well as during the Covid-19 pandemic and energy crisis. To explore the existence of correlations between emerging and developed stock markets during these times, three hypotheses have been formulated:

H1: During crises (GFC and Covid-19 and energy crisis), the correlation between the Macedonian Stock Exchange (MBI10) and the Belgrade Stock Exchange (BELEX15) is greater compared to the pre- and post-crisis periods.

H2: During crises (GFC and Covid-19 and energy crisis), the correlation between the Macedonian Stock Exchange (MBI10) and the Italian Stock Exchange (FTSE MIB) is greater compared to the pre- and post-crisis periods.

H3: During crises (GFC and Covid-19 and energy crisis), the correlation between the Macedonian Stock Exchange (MBI10) and the Spanish Stock Exchange (IBEX35) is greater compared to the pre- and post-crisis periods.

Methodology

To investigate the correlations among developing (Macedonian and Belgrade stock markets) and developed stock markets (Italian and Spanish Stock Exchanges) before the Great Financial Crisis (GFC), during GFC, post-GFC, and during the Covid-19 and energy crisis, the methodology outlined by Srbinoska *et al*. (2021) was followed. Linear regression analysis was employed, along with Pearson correlation and ANOVA tests, to ascertain the interrelationship between these stock exchanges across the four sub-categories of the time period.

Empirical findings and discussion

Descriptive statistics

Table 2 provides a summary of descriptive statistics, including the count of observations, the average, lowest and highest values of the indexes, and their standard deviation.

Table 2. Descriptive statistics

Variable	Number of observations	Minimum value	Maximum value	Mean value	Standard Deviation
Entire period November 2005 to October 2022					
MBI10	204	1581.87	10014.82	3302.856	1711.634
BELEX15	204	380.83	3283.62	865.0996	531.3279
FTSEMIB	204	12873.84	43755	23168.32	7136.371
IBEX35	204	6089.8	15890.5	9941.266	1964.669
Pre-crisis period November 2005 to July 2007					
MBI10	21	2237.32	7046.15	3880.669	1568.34
BELEX15	21	1028.27	3283.62	1720.11	775.4421
FTSEMIB	21	34090	43755	39100.29	2690.436
IBEX35	21	10557.8	15329.4	12964.76	1568.437
Crisis period August 2007 to November 2011					
MBI10	52	1789.33	10014.82	3722.794	2148.691
BELEX15	52	380.83	2869	1002.617	666.503
FTSEMIB	52	14836.33	40512	23783.81	7073.293
IBEX35	52	7620.9	15890.5	10934.04	2011.756
After-crisis period of GFC December 2011 until January 2020					
MBI10	33	3529.17	6265.86	5192.41	747.175
BELEX15	33	636.53	858.86	767.8245	65.01666
FTSEMIB	33	6452.2	9148.9	8062.576	786.0426
IBEX35	33	17050.94	27346.83	22706.01	2988.367
Covid – 19 and energy crisis period February 2020 until October 2022					
MBI10	98	1581.87	4645.17	2319.935	809.2387
BELEX15	98	430.99	808.22	641.6709	99.07123
FTSEMIB	98	6089.8	11521.1	9399.216	1110.856
IBEX35	98	12873.84	23979.37	19583.41	2761.314

Source: authors' analysis

From the above statistics, we can see that MBI10 and BELEX15 are the indexes with the highest percentage of variability and fluctuations. Descriptive statistics are also shown for the pre-GFC period, during GFC and the aftermath, and during Covid-19.

Additionally, Figure 1 depicts the trends of the four indices during the whole time – period by showing the fluctuations of the stock exchange markets before GFC, during GFC, post-GFC and Covid-19 and energy crisis. The sharpest decline took place during the crisis period between 2007 – 2009.

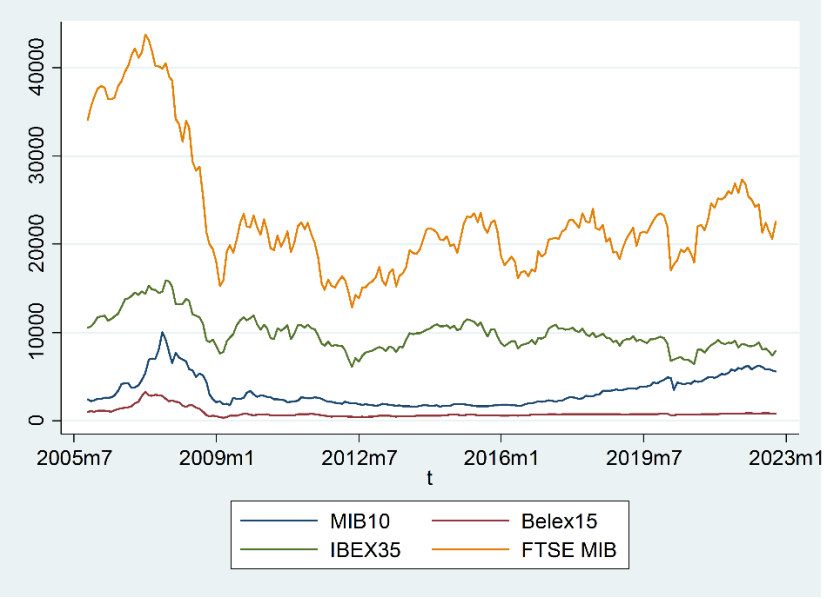

Figure 1. Trends of the Macedonian (MBI10), Belgrade (BELEX15), Italian (FTSE MIB) and Spanish (IBEX35) stock exchange index
Source: authors' analysis

Correlation(s)

H1: During crises (GFC and Covid-19 and energy crisis), the correlation between the Macedonian Stock Exchange (MBI10) and the Belgrade Stock Exchange (BELEX15) is greater compared to the pre- and post-crisis periods.

For our first hypothesis, we aimed to determine whether the association between the Macedonian Stock Exchange (MBI10) and the Belgrade Stock Exchange (BELEX15) is stronger during times of crisis compared to both before and after the crises (Tables 3 and 4). The regression results from our empirical

analysis support the hypothesis during the Great Financial Crisis timespan, but not during the Covid-19 pandemic and energy crisis. Specifically, we found a significant increase in correlation between these exchanges during the GFC, whereas during the Covid-19 and energy crisis, the correlation was observed to be very low.

Conversely, in the GFC aftermath, we observed a diminished correlation between these markets, which may indicate a longer recovery period required for the Macedonian Stock Exchange. Our findings align with prior studies by Zdravkovski (2016) and Srbinoska *et al.* (2021) concerning the GFC period, and with Choi (2022) regarding the Covid-19 pandemic and energy crisis findings.

Table 3. Regression Results: MBI10 and BELEX15

	Pre-crisis (Period before Great Financial Crisis)	**During GFC**	**Post-crisis (Period after the Great Financial Crisis)**	**Covid – 19 and energy crisis**
R Square	0.799	0.927	0.8340	0.4644
Adjusted R Square	0.789	0.926	0.8287	0.4588
Standard Error	390.22	147.23	309.25	595.33
Observations	21	52	33	98

Source: authors' analysis

Table 4. ANOVA: Regression Analysis, MBI10 and BELEX15

Regression analysis MBI10-BELEX15, pre-GFC					
	Df	SS	MS	F	Significance F
Regression	1	39341200.5	39341200.5	75.87	0.000
Residual	19	9852596.92	518557.733		
Total	20	49193797.4	2459689.87		
Regression analysis MBI10-BELEX15, GFC period					
	Df	SS	MS	F	Significance F
Regression	1	218418198	218418198	640.81	0.000
Residual	50	17042223.8	340844.476		
Total	51	235460422	4616871.01		
Regression analysis MBI10-BELEX15, post-GFC					
	Df	SS	MS	F	Significance F
Regression	1	14899858.4	14899858.4	155.79	0.000
Residual	32	2964796.78	95638.6058		
Total	33	17864655.2	558270.474		
Regression analysis MBI10-BELEX15, during Covid-19 and energy crisis					
	Df	SS	MS	F	Significance F
Regression	1	29498257.1	29498257.1	83.23	0.000
Residual	96	34023867.4	354415.285		
Total	97	63522124.5	654867.263		

Source: authors' analysis

H2: During crises (GFC and Covid-19 and energy crisis), the correlation between the Macedonian Stock Exchange (MBI10) and the Italian Stock Exchange (FTSE MIB) is greater compared to the pre- and post-crisis periods.

The second hypothesis explores whether the association between the Macedonian Stock Exchange (MBI10) and the Italian Stock Exchange (FTSE MIB) is higher during the GreatFinancial Crisis (GFC) and Covid-19 crises compared to before and after these crises (Tables 5 and 6). This analysis also aims to assess if the impact of crises affects developing and developed markets similarly.

Table 5. Regression Results: MBI10 and FTSE MIB

	Pre-crisis (Period before Great Financial Crisis)	**During GFC**	**Post-crisis (Period after the Great Financial Crisis)**	**Covid – 19 and energy crisis**
R Square	0.600	0.896	0.4885	0.1649
Adjusted R Square	0.578	0.894	0.4720	0.1562
Standard Error	1016.6	697	542.91	743.34
Observations	21	52	33	98

Source: authors' analysis

Table 6. ANOVA: Regression Analysis, MBI10 and FTSE MIB

Regression analysis MBI10- FTSE MIB, pre-GFC					
	df	SS	MS	F	Significance F
Regression	1	29557340.3	29557340.3	28.60	0.000
Residual	19	19636457.1	1033497.74		
Total	20	49193797.4	2459689.87		
Regression analysis MBI10- FTSE MIB, GFC period					
	df	SS	MS	F	Significance F
Regression	1	211169673	211169673	434.67	0.000
Residual	50	24290748.8	485814.976		
Total	51	2354604422	4616871.01		
Regression analysis MBI10- FTSE MIB, post-GFC					
	df	SS	MS	F	Significance F
Regression	1	8727499.87	8727499.87	29.61	0.000
Residual	31	9137155.29	294746.945		
Total	32	17864655.2	558270.474		
Regression analysis MBI10- FTSE MIB in the period of Covid – 19 and energy crisis					
	df	SS	MS	F	Significance F
Regression	1	10476496.7	10476496.7	18.96	0.000
Residual	96	53045627.8	552558.623		
Total	97	63522124.5	654867.263		

Source: authors' analysis

During the Great Financial Crisis, we observed a slight increase in correlation between these two stock markets, which supports this hypothesis for that period. However, our findings lead us to reject the hypothesis for the Covid-19 pandemic and energy crisis period, consistent with Choi's findings (2022). These observations are consistent with previous studies by Tudor (2011), Nistor *et al.* (2012), and Srbinoska *et al.* (2021).

H3: During crises (GFC and Covid-19 and energy crisis), the correlation between the Macedonian Stock Exchange (MBI10) and the Spanish Stock Exchange (IBEX35) is greater compared to the pre- and post-crisis periods.

The third hypothesis assesses if the association between the Macedonian stock market (MBI10) and the Spanish stock market (IBEX35) is stronger during the Great Financial Crisis (GFC) compared to the periods before the GFC, after the GFC, and during the Covid-19 pandemic. As depicted in Tables 7 and 8, the relationship between MBI10 and IBEX35 is significantly elevated before and during the GFC, suggesting a heightened relationship until January 2020. The correlation between MBI10 and IBEX35 shows a notable decrease in the aftermath of the Great Financial Crisis and during the pandemic and energy crisis, indicating divergent market behaviors between the Macedonian and Spanish stock exchanges, which is consistent with Choi's observations (2022).

Table 7. Regression Results: MBI10 and IBEX35

	Pre-crisis (period before Great Financial Crisis)	**During GFC**	**Post-crisis (Period after the Great Financial Crisis)**	**Covid – 19 and energy crisis**
R Square	0.759	0.743	0.4019	0.0009
Adjusted R Square	0.746	0.738	0.3826	0.0008
Standard Error	1469.97	850.235	587.07	813.09
Observations	21	52	33	98

Source: authors' analysis

Table 8. ANOVA: Regression analysis, MBI10 and IBEX35

Regression analysis MBI10- IBEX35, pre-GFC					
	df	SS	MS	F	Significance F
Regression	1	37341734	37341734	59.86	0.000
Residual	19	11852063.4	623792.811		
Total	20	49193797.4	2459689.87		

Regression analysis MBI10- IBEX35, GFC period					
	df	SS	MS	F	Significance F
Regression	1	175062423	175062423	144.92	0.000
Residual	50	60397998.5	1207959.97		
Total	51	2354604422	4616871.01		
Regression analysis MBI10- IBEX35, post-GFC					
	df	SS	MS	F	Significance F
Regression	1	39777966.5	39777966.5	20.92	0.000
Residual	31	245304128	1901582.38		
Total	32	285082094	2192939.18		
Regression analysis MBI10- IBEX35 during the period of Covid – 19 and energy crisis					
	df	SS	MS	F	Significance F
Regression	1	14899858.4	14899858.4	20.83	0.0001
Residual	87	2964796.78	95638.6058		
Total	88	17864655.2	558270.474		

Source: authors' analysis

Conclusion

The purpose of this study was to examine the correlations between the Macedonian Stock Exchange and the Belgrade Stock Exchange, Italian Stock Exchange, and Spanish Stock Exchange across different periods: before, during, and after the Great Financial Crisis (GFC), as well as during the pandemic and energy crises. Using monthly data spanning from November 2005 to October 2022, the study segmented the timeframe into four sub-periods: pre-crisis (Nov 2005 – July 2007), GFC crisis (Aug 2007 – Nov 2011), post-GFC (Dec 2011 – Jan 2020), and the period covering the Covid-19 and energy crises (Feb 2020 – Oct 2022). Initially, the research included a comprehensive review of theoretical background and empirical literature to gain insights into how stock exchange markets interact during periods of crisis and stability.

Drawing from existing research, the paper concluded that correlations among stock exchanges were generally greater during the GFC compared to the pre- and post-GFC timaspans. In contrast, correlations were notably lower during the Covid-19 and energy crises. The analysis using linear regression indicated higher correlations between the Macedonian Stock Exchange (MBI10) and the Belgrade Stock Exchange (BELEX15) and Italian Stock Exchange (FTSE MIB) during the GFC crisis compared to the pre- and post-crisis periods, which was not observed during the Covid-19 and energy crises. Additionally, higher correlations between the Macedonian Stock Exchange (MBI10) and the Spanish Stock Exchange (IBEX35) were observed before and during the GFC.

Given the focus on investigating the interdependency of the Macedonian Stock Exchange with both emerging and developed stock exchange markets, these findings hold practical significance for decision-making, portfolio investment, and policymaking, particularly for Macedonian and regional investors. While both crises impacted investor confidence and market dynamics, differences existed in their origins and effects. The GFC stemmed from financial sector breakdowns, whereas the Covid-19 crisis arose from a global health emergency, affecting multiple industries simultaneously. Consequently, responses to these crises varied, necessitating an understanding of their similarities and differences to evaluate their influence on stock exchange interdependence.

In summary, this study underscores the susceptibility of the Macedonian Stock Exchange to market fluctuations and emphasizes the potential long-term ramifications of even minor fluctuations in various crisis scenarios.

NOTE: This paper continues the study initiated in a previous paper (Srbinoska *et al*., 2021), expanding the timeline to encompass the crises that ensued the GFC: Covid-19 pandemic and energy crisis.

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GROȘI, MARAMUREȘ: AN ATTRACTIVE DESTINATION DURING THE COVID-19 PANDEMIC?

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ABSTRACT. In Romania, the COVID-19 pandemic determined the development of rural areas and consequently, the evolution of rural tourism, one of the most important contributors to sustainable tourism. The current study examines the rural tourism potential of a village in North-Western Transylvania (Romania), Groși. The main goal of this study is to evaluate the potential for sustainable growth by means of rural tourism in this commune. This assessment also considers the potential impact on the social and economic aspects of the destination, as well as the factors that could positively or negatively influence this entire process. The data was gathered using the survey-based inquiry. Therefore, a questionnaire including 32 questions, consisting of three parts in all, was developed. The first part included questions used by the researchers aimed to gather information regarding the respondents' orientation towards remote rural destinations. The second part of the questionnaire was designed with the end goal of establishing to what extent the respondents are familiar with the resources of Groși, respectively to assess to what extent the destination can benefit from the development of hospitality services. The last part of the survey

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enabled researchers to collect identification data regarding the 117 respondents of the self-implemented survey. The main conclusions of the study highlight that respondents are mostly pleased or very satisfied regarding rural tourism in the region under analysis. Among the benefits that certainly are to everyone's liking were found to be tranquility, beautiful landscapes, fresh air, important sights, and local gastronomy. In the end, the main disadvantages of the area and the opportunities of developing rural tourism in Groşi commune are presented.

Keywords: rural tourism, sustainability, Groşi, Maramureş County, COVID-19

JEL classification: L83, Z32, L80.

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Introduction and literature review

The global health crisis that was faced since the end of 2019 and continued to be faced due to the COVID-19 pandemic, and the restrictions imposed by it, have a significant influence on all forms of tourism. Among the main forms, one may recall rural tourism, leisure tourism, cultural tourism, sports tourism (sports events), business tourism (professional meetings), commercial tourism (conferences, congresses, or business), religious tourism (seen as pilgrimages to various religious tourist attractions, but also as cultural activities involving religious sites), etc. From among these, rural tourism holds unquestionable advantages which minimize the risk of infection, i.e. reduced human interaction, low population density, unpolluted air, easy social distancing, and smaller lodgings. Particularly, in this context, Romania as a tourist destination, has the advantage of its main characteristics emphasized by the national tourism brand *Explore the Carpathian Garden!*. Thus, the stress falls on four aspects: the intact nature, the authenticity, the unique culture, and the safety of local destinations. While these features were initially identified with the purpose of focusing on international tourists visiting Romania who come from the nation's target markets, the new global health context has put national rural destinations on the maps of Romanian tourists as well. Moreover, researchers found that the personality of the brand should emphasize traits like goodness, purity, greenery, and innocence while highlighting the tourism brand's central ideals of spirituality and discovery, and a nice and simple life. As a result, Romania's differentiation features are related

to its untouched natural beauty, distinctive cultural history, and genuine rural lifestyle. Six types of tourism are prioritized to be further developed and promoted abroad: travel routes, rural travel, pristine environments and parks, wellness and beauty travel, action-packed travel, and city-breaks, capitalizing on four widely recognized features: authenticity, rurality, hospitality, and sustainability (MRDT, 2011; Coroș, 2015: 491-492; Ministry of Tourism, 2019).

Regardless of the form of tourism practiced by tourists, in most cases they are real threats to the environment, sustainable tourism being the only type of tourism able to provide a balance between visiting the sites and respecting nature and the environment. Basically, sustainable tourism mitigates for the reduction of pollution, the destruction of goods within tourist attractions and destinations but also for the reduction of the consumption of natural resources. In addition to the negative effects underlined, the authors can also highlight some positive ones, such as the generation of material resources for locals, the acceptance and tolerance of other cultures, and the existence of opportunities to discover new crafts, musical instruments, and to practice non-intrusive activities, etc. (Iorio & Corsale, 2010; Coroș & Gică, 2016). Sustainable tourism aims at long-term goals, with its main objectives being related to bringing to a minimum the degradation of the cultural heritage, of the natural environment, and of providing long-lasting opportunities for the growth of the economy at a local level. Under the umbrella of sustainable tourism in the countryside, rural tourism can be found.

Utilizing three coordinate systems: people, space, and products, numerous people are drawn to tourism in rural destinations and spaces that serve as recreational areas, and also guarantee cultural, spiritual and environmental development. This happens mainly because of the unique characteristics of the landscape, as well as due to the abundance of resources at a local level (Baldacchino, 2015). Additionally, the tourist is polarized in a preferential way by the usual locations of production in a certain area in order to understand local production methods and systems, learn about cuisine, discover material evidence (heritage sites, authentic buildings, etc.), to immerse themselves in the local culture (folk art, crafts, cuisine, etc.), and to access resources that define the concept of territorial identity (Matlovičová & Pompura, 2013). In the same line, Woods (2012) describes rural tourism as "touristic activities that are focused on the consumption of rural landscapes, artifacts, cultures, and experiences". Like Haven-Tang & Jones (2012), Privitera et al., (2018) bring up the importance of the connection between culinary heritage, agricultural goods, and tourism which facilitate tourists' involvement in local supply chains for food and beverages, enriching their rural experience but also their direct support of local development.

Rural tourism refers to a type of tourism that can undoubtedly enjoy sustainable development, and which creates a perfect balance by capitalizing

on the cultural heritage of destinations and by also ensuring the conservation of the natural environment. When rural tourism is discussed, one finds the idea of spending holidays in rural areas, an idea that includes the tourists' participation and immersion in various recreational and entertainment activities, the consumption of local products specific to the area, or the involvement in farm-specific activities, included under the umbrella of agritourism. The pandemic context has put a stronger emphasis on the importance of local development and consumption. Thus, rural destinations have gained a privileged position on the market. On one hand, due to the limitations regarding the free movement of people during lockdowns, they have understood that consuming local goods benefits both communities by enabling them to sell their products and end consumers, as they gain access to fresh and more affordable products.

Three key pillars are at the base of sustainable development in tourism. They are the environment, economy, and sociocultural development. All of them are highly dynamic and produce a direct impact on any destination's competitiveness (Cucculelli & Goffi, 2016; Lee & Jan, 2019).

Some of the most important categories of sustainable tourism as mentioned by Jugănaru et al. (2008) include tourism that is responsible, equitable, green, rural, and eco-friendly. Other researchers (Pan et al., 2018) outline under the concept of sustainability in the tourist industry future-oriented techniques including community-based tourism, ecotourism, rural tourism, historical tourism, and nature-based tourism.

The goal of sustainable tourism is to enhance destination sustainability by contributing directly to the enhancement of the local population's conditions of living and standards, by ensuring the thin balance between the safeguarding of natural resources, the environment, economic gains of the community, social justice, and cultural heritage conservation and valorization (Rodríguez Díaz & Espino Rodríguez, 2016).

As noted by Lane & Kastenholz (2015) and Coroș (2020), during the 1970s, rural tourism gained popularity; furthermore, the same authors also focused on examining its development and growth in Romania. However, communist Romania failed to capitalize on the nation's rural heritage. It was only after 1989 that rural tourism truly began to develop in Romania. In fact, this only happened after the mid-1990s. Over the past nearly 30 years tourism-related activities in Romania's rural regions have increased significantly in many destinations. Several case studies covering various Romanian destinations have been elaborated on and presented in the literature dedicated to rural tourism. Some focused on the various destinations of Romania (Naghiu et al., 2005; Popescu et al., 2014; Bălan & Burghelea, 2015; Coroș, 2020; Coroș et al., 2021a; Coroș et al., 2021b), while others discussed the development of countryside lodgings

(Pop et al., 2019; Pop & Georgescu, 2020). Maramureș has been investigated by many scholars, with Muica & Turnock (1999) and Turnock (2002) being among the first to discuss its rural tourism potential, while Hall (2004) brought up the issue of sustainability in rural destinations. More recent studies have continued to discuss sustainability issues in Romanian rural tourism (Bran et al., 2010; Dorobanțu & Nistoreanu, 2012; Andrei et al., 2014; Matei (Titilina), 2015; Gică et al., 2021), and also in the case of Maramureș (Dezsi, et al., 2014).

Worldwide, and also in Romania, the orientation of tourists towards authentic experiences has become a post-COVID-19 trend. However, not many studies have yet captured this interest. Attempting to address this gap, Dobre et al. (2023) assessed the increased interest of Romanians towards rural tourism experiences and focused on the potential of authentic/vernacular rural tourism. Another increasing sector in terms of tourist demand is that of ecotourism, as a particular form of rural tourism. Thus, ecotourism destinations have started to be commonly visited in Romania. Viewed as a part of rural tourism, it makes sustainable contributions to the development of rural areas, and therefore of the local communities. Undoubtedly, this form of tourism has received the main impulse for its development at the national level and has been increasingly and constantly supported especially by the Romanian Ecotourism Association (AER). Ecotourism promotion publications (i.e *Discover Eco-Romania yearly Catalogue*, *Discover Eco-Romania: 10 Destinations for Ecotourism, Wild Carpathians – Dare to explore*) in Romania have been concerned with promoting the main rural destinations, such as Marginimea Sibiului, Danube Delta area, Hațeg area, Dornelor area, Băile Tușnad area or Maramureș destination.

Mateoc-Sîrb et al. (2022) analyzed tourists' perceptions of Maramures tourist villages, i.e. Săpânța, Breb, Ieud, Giulești, Deseşti, Botiza, and Bârsana. Since tourists can appreciate both the positive and the negative aspects of a place, they revealed their desire to visit each time an ecological village built on sustainable principles where they can observe the unique way of life in the countryside and actively participate in rural activities. On the other hand, tourists appreciated most of all their experience in villages from Maramureș, considering it a memorable one. It can be pointed out that the advantages of Maramureș villages and their future business card are originality, naturalness, and distinctive local aspects.

Besides the Maramures area, among the most important regions of rural tourism in Romania presents more rural destinations, among which the most important ones are the following: Rucăr-Bran-Moeciu area, Bukovina, the Saxon villages, Transylvania, Mărginimea Sibiului, Szekler Land, the Danube Delta, and the renown Maramureș. Undoubtedly, Romanian rural tourism's focal point is its uniqueness, enriched by its well-preserved heritage, traditions, and cuisine.

Romania abounds in rural destinations, and among them, of particularly great interest are those located on the territory of Maramureș (Michelin, 2011). Located in the North-Western region of the country, this area separates Romania from Ukraine, it is a depression crossed by rivers, isolated by mountains. The destination is a genuine open-air museum known across borders. The county is rich in oak and fir forests. Due to the wood-based crafts and arts, it is also called the Land of Wood. The locals are skilled in the art of carving, and the masterpieces that have made the destination renowned are the wooden churches with sharp and high bell towers and also the carved gates. The landscapes of the area reflect the fact that the people of Maramureș have preserved ancient traditions and artisanal crafts. This is best drawn in the four valleys that form the historic Maramureș, i.e., Cosău, Iza, Mara, and Vișeu. These are the soul of the region, inheriting the customs, architecture, music, folk costumes, and traditions. There are almost 100 wooden churches in Maramureș, and the wood culture covers a larger area than the churches, with magnificent houses with steep roofs and carved porches. The high gates of the peasant households express the fact that the people from Maramureș own land and have a sense of self-respect that goes beyond material wealth.

The charm of this area is not only represented by the sceneries but also by the fact that despite the pressure of modernity, Maramureș has kept alive the old soul of Europe. The area is very rich in tourist attractions, local gastronomy, fresh air, and hospitable hosts. Its strength as a destination is the lifestyle of the village, which includes crafts, folk costumes, and especially, the traditions that tourists can take part in and build great memories, which in time, make them return to the area. Overall, Maramureș is among the most visited places in Romania, attracting both international and national visitors.

The current study examines the rural tourism potential of a village located in Maramureș, namely Groși. The village is located 7 km away from Baia Mare Municipality, in the Western-Central part of Maramureș County, on the road towards Târgu Lăpuș. The relief is represented by hill-specific forms in the Baia Mare depression, with a mountainous area. The commune of Groși comprises three villages: Groși, which is the residence of the commune, Ocoliș, and Satu Nou de Jos. In 1946 it became a parish. Groși village is a hospitable place full of traditions and history. From among the most relevant and well-known tourist attractions located in the village of Groși, the authors emphasize the Habra Monastery (located on the Harul Hill in Groși), the home of Dumitru Fărcaș (the one who brought the taragot/tárogató to Romania for the first time and made it known all over the world; his memorial house is a place of pilgrimage for tourists), respectively the loft of the well-known taragot/tárogató-player Dumitru Dobrican (Primăria Groși, 2023).

Given its rich cultural heritage, the authors consider that rural travel is bound to have a successful development in this rural area from Romania. Thus, the goal of this study is mainly to determine and assess rural tourism's potential to grow sustainably in Groși commune, while also considering any potential impact on the destination's social and economic life, as well as the elements that might have an influence on this entire process, either positively or negatively affecting it.

The subsequent sections of the paper are organized as follows: the second part describes in depth the employed research methodology, while the research findings are presented and discussed in the third one. Finally, the most important research findings are summarized in the last section of this paper.

Material and method

Aiming at understanding whether Romanian tourists acknowledge the rural tourism potential of the resources available in Groși given the new context brought on by the COVID-19 global pandemic, the authors opted for the survey-based inquiry as a research method. Consequently, a questionnaire was developed; it comprised 32 questions and was composed of three parts in all. The first part consisted of questions by the means of which the researchers aimed at gathering information regarding the respondents' orientation towards remote rural destinations. The questionnaire's second part was thought of with the end goal of establishing to what extent the respondents are familiar with the resources of Groși, respectively to assess to what extent the destination could benefit from the development of hospitality services. The last part of the survey enabled the researchers to gather identification data about the 117 respondents.

Both structured and unstructured questions, open-ended questions, multiple-choice, Likert-scale and dichotomous questions were all employed. The questionnaire's length was taken into consideration when it was being developed, and the researchers made sure that the responses were as accurate as possible and could be gathered in a timely manner using a self-administered online survey tool. The research was conducted shortly after the 2020's spring declaration of the state of emergency and took more than four months to complete. The social-distancing measures imposed by the authorities made it impossible to directly interact with the respondents. Furthermore, given the context and the research topic, it was rather complicated to reach a larger number of respondents. The goal of the questionnaire-based research was measuring respondents' perceptions of potential holiday destination choices in this specific rural region as well as to identify the benefits and drawbacks of

Groși commune from a tourism viewpoint. Aiming at achieving valid responses, the sample members were randomly chosen.

Briefly, the analyzed sample's structure is further described. Out of all respondents, 62% of them are female and 38% are male. Regarding marital status, 73% are in a relationship or married, while 27% are single. The majority of those who completed the survey, 55% of respondents, do not have any children, while a quarter of them have one child, and 19% have two children. Only 1% of those surveyed have more than two children. In the case of the respondents who have children (45%) there is a clear agreement regarding the fact that destination choice is influenced by the age of their younger family members; thus, in most cases, when deciding upon holiday destinations, parents consider the comfort of the lodgings and also look for a multitude of activities for children to undertake on vacation, so as not to reach monotony. Almost a quarter of the respondents have grown-up children (over 18 years old), a fact that influences the average age of respondents. Further, among the children of the respondents, 10% are between the ages of 10 and 15. The youngest children are found in a percentage of 3% (children under 2 years), which certainly limits the choice of the parents in terms of holidays and travel for leisure tourism.

Another important aspect regards the respondents' behavior to travel individually or in groups. Thus, 67% of respondents choose to visit different tourist attractions in groups of up to four people. A larger gang is preferred by a quarter of respondents, namely, these are accompanied by about 5 people on a vacation. The study reveals that only 7% of the respondents choose to go in a group of more than 6 people, while only 1% travel unaccompanied. Most of the tourists often spend their holidays with their family and only 2% have no family or never go with their family on vacations. Regarding children, only a low percentage choose to spend the holidays without children, while regarding the group of friends, 15% of the individuals surveyed opt to travel on vacation with their pals often, and 10% of them rarely do so.

In terms of the respondents' age categories, 30% of the investigated persons are youngsters, aged between 24 and 35 years, and 29% are young active adults, between 46 and 55 years old. Another 7% aged less than 23 years. Furthermore, another 9% belong to the active adults' category (aged 56 to 65 years), and only 5% are seniors (over 65 years old). As other studies have shown, young people and younger generations prefer autonomous travel and isolated rural places, consequently, the research respondents' predominance of young sample members is not necessarily biased (Cozma et al., 2021). Most of the respondents are rather young and educated, thus, one may notice that such visitors opt for rural travel, stating certain plausible expectations, wants, and expectations about quality, particularly with regard to infrastructure and

telecommunications as well as hygiene. This is in fact a dynamic majority, which also has the capacity of revitalizing Romania's rural tourism.

Destination choice is also influenced by the respondents' occupation and revenues. The occupation and/or profession always define one's schedule and often set one's financial limits. For example, an entrepreneur or freelancer will apparently have much more freedom when making vacation plans. On the other hand, those who are employed in the private or public sectors must consider more limitations, related to the moment when they can take days off, this being not only their choice but in most cases a group decision, involving holiday scheduling for more employees. Nearly one-third of the respondents are employed in the private sector, while another 35% of them hold jobs in the public sector. Entrepreneurs, self-employed, and freelancers together represent a percentage of 18%. A small part is represented by students (both employed and unemployed categories), who only add up to 7%. Few of the respondents are retired (6%), and fortunately, only 1% are unemployed.

The majority, accounting for 78% of the respondents, have graduated at least undergraduate (55%) and post-graduate studies (23%), which presumably opens the horizons in terms of knowledge, expectations, and sophistication related to tourism. Only less than a quarter of the respondents are still undergraduate students or persons without graduate studies. Thus, the sample tends to consist of rather highly educated persons.

Another factor of influence is the residential environment. This is particularly important under the circumstances of the pandemic situation. Certainly, when living in a large city, the trend is to try to visit as many destinations as possible. In fact, more travel opportunities open up for people in larger cities, on the one hand, due to the presumably higher revenues and also due to the highly diversified offers provided by travel agencies and travel services providers. Moreover, the highly intense city life is also one of the triggering factors that determine the demand for remote and quiet destinations. The large majority of the respondents live in a large city (69%), followed by people living in smaller towns (24%), and in the countryside (7%). The majority of the respondents originate in Cluj County (around 65%), with many others living in other counties from Transylvania (Bihor, Bistriţa-Năsăud, Braşov, Hunedoara, Satu Mare, Sălaj, and Sibiu), respectively in other areas of Romania (Bucureşti and Ilfov, Argeş, and Constanţa), or even abroad (in Spain).

The respondents' financial situation at the moment of the investigation, revealed that 18% were earning less than 2,500 lei per month, 41% had revenues between 2,500 and 4,000 lei per month, 33% were gaining between 4,000 and 7,000 lei, respectively 8% were making earnings worth more than 7,000 lei per month. Overall, the respondents are representatives of the middle-

upper economic class, educated young active adults, with established families, living in Cluj County or in other Transylvanian areas, having well-paid jobs, and earnings above average.

Results and discussions

One of the initial findings concerns respondents' inclination with regards to certain types of holiday destinations. In order to better capture this aspect, a Likert-scaled question was inserted, ranging from very often (5) to never (1). Out of all respondents, most have opted for short-term trips in the country, anytime during the year, most of them opting to spend their spare time in a rural area rich in popular traditions in Romania (Figure 1). Next in the list of preferences follow the mountainous areas of Romania and the Romanian seaside. These results indicate positive perspectives for Romanian rural tourism development with local destinations being the most commonly chosen. A lower interest towards external destinations can also be noted.

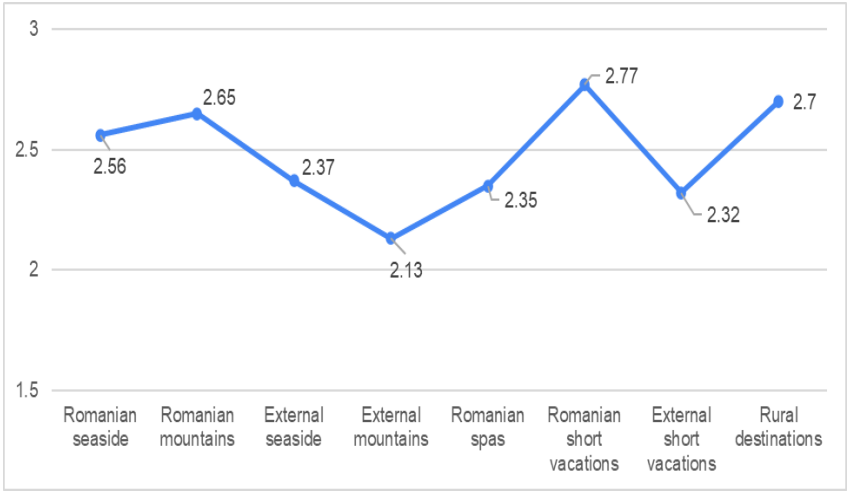

Figure 1. Holiday Destination Preference (Assessed on a 5-point Likert scale)
Source: authors' own processing based on survey data

Another finding relates to the frequency of respondents' choice of rural and traditional tourist destinations in Romania over the past five years (Figure 2). Thus, from the total number of investigated persons, around 39% indicated the fact that they normally opt for rural and traditional areas 2-3 times annually,

while almost 23% have opted for such destinations at least once a year, nearly 25% do not at all opt for such destinations or have chosen one less than once a year; close to 9% have mentioned that they select these destinations more than 3 times annually.

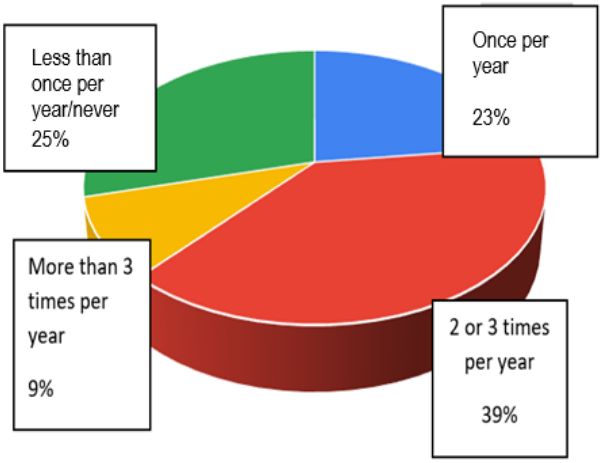

Figure 2. Orientation towards Romanian rural destinations over the past 5 years
Source: authors' own processing based on survey data

When asked to analyze and indicate the most traditional Romanian destinations chosen over the most recent past 5 years, the interviewed individuals' answers point, without any doubt, towards their association of well-preserved heritage with the Maramureș region, which encompasses Groși commune (Figure 3a). Indeed, the County has many rural areas where traditions are still kept alive, and this differentiates it from the rest of the counties. Next in the respondents' list follow Bucovina and cumulated, other areas, well ranked in the top of areas rich in traditions, crafts, hiking, and pure mountain air. Mărginimea Sibiului and Transylvania have turned out to be the 3rd, respectively the 4th option but they have not been chosen that often by the interviewed people, even if they enjoy a similar richness in terms of areas abundant in traditions and traditional crafts.

Remarkable is the fact that Maramureș seems to have always been perceived as the destination managing to best preserve its heritage (Figure 3b). This indicates either greater notoriety of the destination among the respondents or a well-established brand image built exactly on the idea of heritage conservation and valorization.

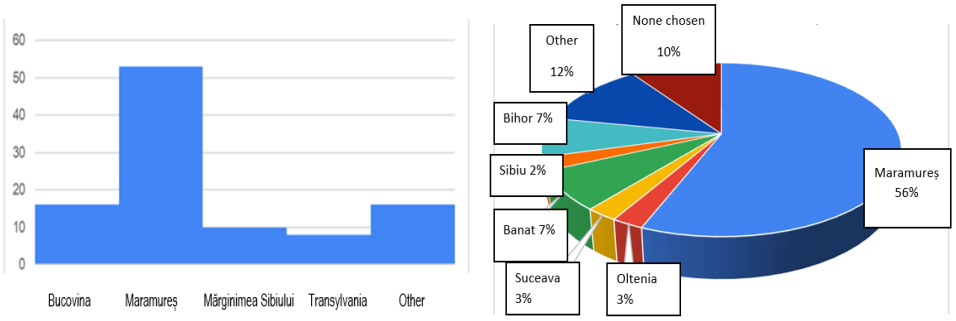

Figure 3. The destinations that best preserve traditions in the respondents' perception based on the destinations chosen over the past 5 years (a) and more than 5 years ago (b)
Source: authors' own processing based on survey data

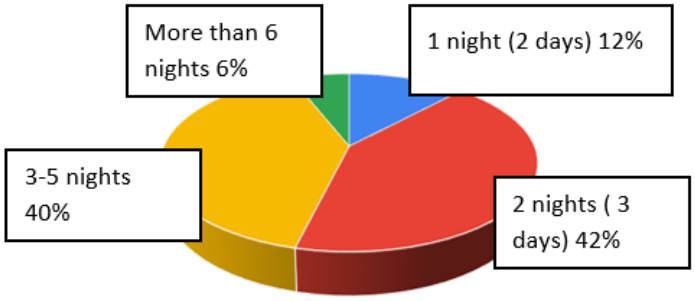

Figure 4. The average length of stay in rural destinations
Source: authors' own processing based on survey data

As revealed by the data in Figure 4, the typical duration of stay in rural areas rich in traditions is relatively evenly split between short and longer stays. Therefore, out of all respondents, 42% had accommodated for a minimum of 2 nights during a holiday in such an area. These are the majority because most of Romania's population has a free weekend, so these short stays, most likely take place during the weekends. Overall, this is perhaps one of the main reasons why rural destinations face overcrowding. Another 40% have stayed longer, indicating breaks of 3 to 5 nights. This is, in fact, the most desired situation which can generate benefits for both established and emerging destinations, as during longer stays (of more than 3 nights) tourists get involved in more activities at local level, explore more locations and activities, thus contributing to local spending; implicitly, this also determines destinations to develop more amenities and to

diversify their offer. Trips of only one night, most probably transit tourism, are not necessarily a top choice of the respondents, registering only a percentage of 12%. At the same time, holidays involving longer stays, of more than 6 nights are, apparently, in most cases, either a luxury or something unrealizable, from different points of view, such as due to financial barriers, to the lack of available time but also due to the insufficiently diversified options at destination level.

Given the circumstances generated by the pandemic, the next question aimed at enabling the researchers the possibility of identifying the areas in which the respondents would be willing to spend their holidays. Furthermore, another goal was that of understanding what aspects are taken into consideration by the respondents when deciding on the next holiday destination (Figure 5).

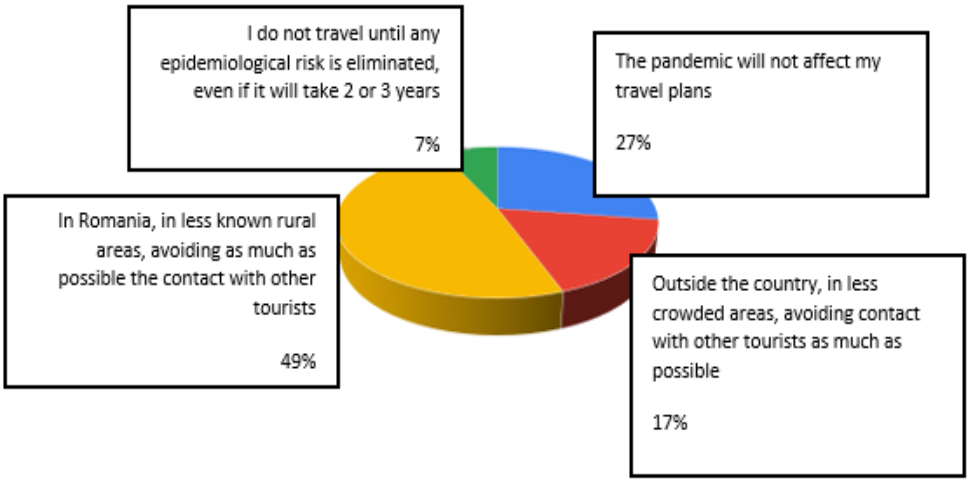

Figure 5. The impact of Covid-19 upon respondents' travel plans
Source: authors' own processing based on survey data

Taking into account interviewed individuals' perception regarding the pandemic, 49% of them indicated that for the coming 2-3 years they would choose Romanian travel destinations, pointing towards a clear preference for less known rural areas, where they would be able to avoid as much as possible the contact with other tourists, maintaining the already adopted social distancing measures. If in the previous years, a large part of the Romanian tourists would have opted for a vacation in crowded places, in the new context, their orientation towards mass tourism destinations has clearly changed. With around 27% of the respondents declaring that they are immune to the effects generated by Covid-19 and their travel plans would not be affected, one may undersee a positive attitude towards traveling. However, the statement must also be regarded as

wishful thinking rather than fact, due to the lack of control among people relative to governmental and international travel policies and rules. Around 17% of the surveyed individuals would choose destinations outside the country, in less crowded areas, avoiding contact with other tourists as much as possible. At the time, vaccination was not yet available so it was unclear how travel policies would evolve, wherefrom the reluctance expressed by 7% of the respondents who would no longer want to travel until all epidemiologic risks would disappear, even if that would have lasted up to 3 years or more.

The research paper's results depict that, in the event that they were to take a vacation during the Covid-19 epidemic, 27% of respondents would favor rural tourist sites over those located abroad. Further, almost 22% of the sample members were even categorical on this subject, while for 28% of them, the choice was somewhat indifferent. Only 13% indicated a categorical denial and pointed towards no intention of choosing a Romanian rural destination, but rather of orienting towards an external destination (Figure 6).

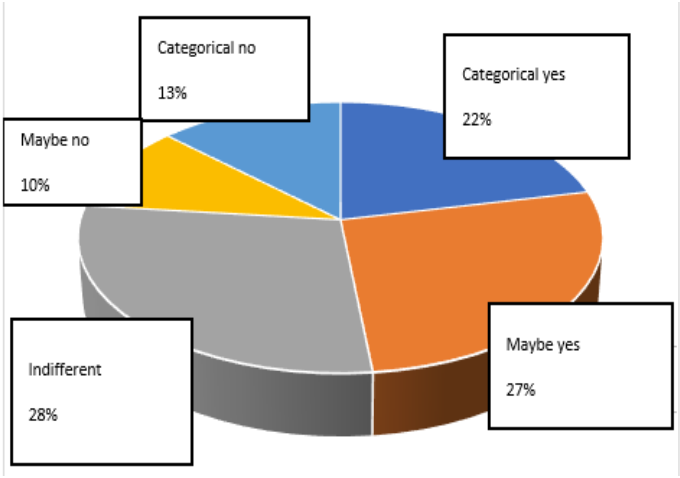

Figure 6. The influence of Covid-19 on the orientation towards Romanian rural destinations
Source: authors' own processing based on survey data

When asked about the activities they prefer to get involved in when traveling to rural areas, most of the respondents indicated the following main triggering factors for rural destinations (Figure 7). By far the highest factor that determines destination choice is the quietness and tranquility of the destination.

It turns out that more than half of the respondents look for destinations that feature relaxation opportunities, away from the noise and city life typical agitation. Next, they indicate curiosity, which is associated with gaining knowledge related to both traditions and crafts. Fortunately, Maramureş is one of the top destinations in this respect, with many lodgings and hospitable hosts who involve tourists in various activities of this kind. Of high interest are other activities, too. Among these, spending time outdoors and relaxing in the fresh air, practicing hiking and tracking, respectively enjoying local gastronomy. Given the still developing infrastructure, bicycle riding is at the end of the preferences but gaining interest. In the pandemic context, the shift away from mass tourism destinations becomes obvious. One may conclude that the respondents are quite eager to opt for holiday destinations in the fresh air, seeking relaxation opportunities that also facilitate cultural enrichment.

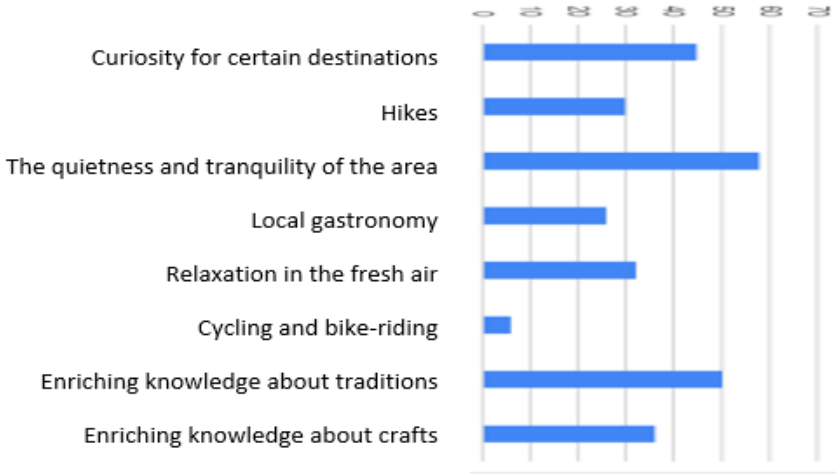

Figure 7. Respondents' preferred activities in rural destinations
Source: authors' own processing based on survey data

Not surprisingly, the feature that the respondents appreciate most is the destination's peacefulness and tranquility, looked for and found in the various rural areas they had visited. Hospitality is also a key factor, with many respondents declaring that they enjoyed and appreciated the hospitality of their hosts, considering their interactions to have been qualitative ones. This is also in line with the typology of the lodgings in most destinations of Maramureş and with the orientation of the tourists towards small and remote facilities. The hosts' hospitality can also be regarded from the perspective of the supplied amenities

and goods. The novelty of the places fascinates other respondents. Among the most appreciated aspects is also the conservation and featuring of folk arts and crafts. Next in line come the host, the local gastronomy, and the beautiful and varied landscapes. The quality of the accommodation facilities and that of the hiking trails appear among the least appreciated factors as indicated by the tourists.

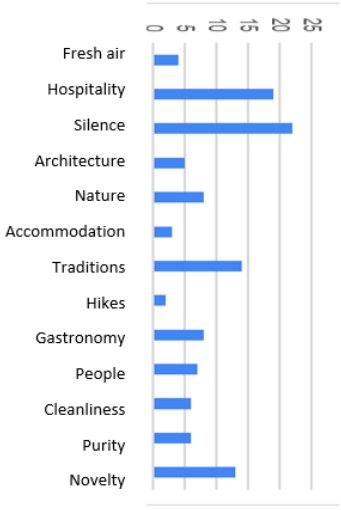

Figure 8. What respondents appreciated in the visited rural destinations
Source: authors' own processing based on survey data

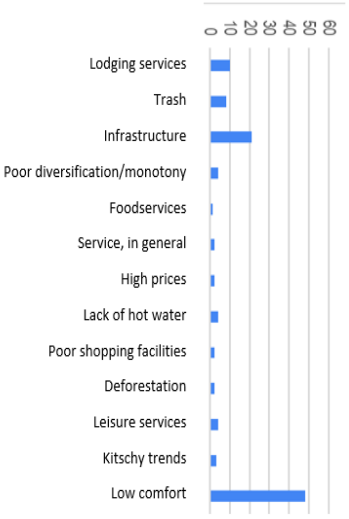

Figure 9. What respondents disliked in the visited rural destinations
Source: authors' own processing based on survey data

When asked to refer to the less pleasant elements recalled relative to their previous holidays in rural areas, the respondents found the low level of comfort to be the most disturbing one. This low level of comfort must be further discussed from various perspectives. A gap may exist between the expectations of the tourists and the provided services; in fact, some tourists might expect upper-scale hotel services in rural destinations, which is rather an unrealistic expectation. However, hosts should also understand that preserving authenticity can be also done with increased care for the provided sanitary services (with a focus on modern and tidy bathroom facilities, quality toiletries, and towels) and also of lodging services (cases in which, tourists mainly focus on the quality of the matrasses, pillows, and blankets, on the tidiness of the bedsheets, and overall, practical, and nice room amenities); kitchen facilities also need to be properly prepared in order to please those tourists oriented towards self-catering services.

Furthermore, destination infrastructure can and must be improved, falling under the responsibility of the public authorities. One of the most disturbing elements pointed towards by tourists is waste management and the presence of trash at destination level. Again, an area that clearly needs coherent public policies, solutions, and law enforcement. Gastronomy was also mentioned as a less-appreciated fact by some respondents. An already acknowledged weakness of many Romanian rural destinations is the poor diversification of leisure services and destination-based amenities. The missing souvenir shops and the poor shopping facilities are also a drawback indicated by some respondents. These are all areas that impose the intervention and involvement of both the public and private sectors. Given the Covid-19 worldwide epidemic, the lack of access to basic products was perceived as an important negative aspect by those tourists oriented towards self-catering services.

Overall, the very large majority of the respondents express a very good (49%) and good (48%) opinion relative to their previous rural experiences and indicate high trust in such Romanian destinations and openness towards novel rural tourism sites. Only very few (3%) dislike rural sites and do not (re)consider them. The same respondents were also asked to mention whether under normal travel conditions, they would or not opt for Romanian rural destinations. Again, the large majority indicated their preference for national rural destinations (61%), followed by those who would split their vacation and have one abroad and one in Romania (31%), and leaving only a low percent (8%) of the respondents to clearly chose international destinations if possible. Furthermore, Maramureş enjoys the leading position as preferred destination (47%), being followed by Transylvania (22%), Bucovina (16%), Moldova and Dobrogea (6%, each), and other (3%).

When asked about how much they would be willing to spend for a night (2-days stay) in a Romanian rural destination, the respondents indicated in average 330 lei per night for a double room, respectively a total of 1,307 lei for a 5-night stay in a double room. These amounts are consistent with the prices at the moment of the survey, indicating a realistic perception among the respondents and an orientation towards mid-upper scale small lodgings.

The next part of the survey aimed at assessing the notoriety of Groşi as a destination and its capacity to develop into an attractive tourist destination among the surveyed respondents.

Unfortunately, however expected, a very high percentage (76%) of the respondents proved to be unfamiliar with Groşi commune from Maramureş County. Perhaps, the main reason is its absolute lack of notoriety and the total absence of any promotional efforts both from a tourism and cultural perspective. In this regard, certain actions can be undertaken by the local authorities aiming at attracting more visitors and, thus, increasing the local economy and reducing

the unemployment rate of the settlement. Some of the directions to be developed include the development, implementation, and advertisement of a program designed to educate and inspire travelers to visit this location, making it more attractive and bringing up-front the local heritage, particularly the quality folk music that makes this place special.

Furthermore, looking through the lens of a tourist, the most important aspects that could contribute to the attractiveness of the commune include the development of local folk festivals, along with the growth of accommodation and of food services, all supported by appropriate infrastructure and by the notoriety building and destination promotion. The effort is worth as the gains of the destination are translated into attracting educated tourists who are willing and can afford to spend higher budgets in rural destinations, which they highly appreciate.

On the other hand, a small interview was also realized with some persons who are familiar with the resources of Groși aiming at a better understanding and assessment of the commune's resources and potential. The aspects that best describe Groși are the rich folklore hearth, the clean air, and the tranquility of the community, which by no means faces over-tourism. Folkloric festivals should be organized with the involvement of the locals in hosting participants and in providing unique cultural interactions, by immersion in various local traditional and agritourism activities. An example of such a festival that creates beautiful relations between tourists and hosts can be found in the case of Sâncraiu, Cluj County.

As for the tranquility and fresh air, they can be harnessed through lodge-type accommodations in hilly areas with beautiful views or by organizing trekking activities to enjoy nature and its richness in the surrounding areas. Aiming at proposing various solutions in order to make the commune more attractive, the respondents were asked what they would improve to add value to the commune. They unanimously indicated the need to promote the commune's cultural heritage but also the need to develop lodging and foodservice units. By means of events, the traditions and the folklore hearth would be brought before the tourists and thus the commune would gain positive notoriety and would eventually become attractive as a tourist destination.

Another identified advantage of the commune is its location, which enables the visiting of many objectives in the area, but also an easy access to get to the municipality of Baia Mare and of spending the night out in the city and enjoying city life. Finally, the tourist attractions concentrated in this area represent another advantage. Fortunately, quietness and cleanliness are also points that attract tourists in destination choice. The hospitality of the hosts is another important aspect. Traditions such as Christmas caroling, the cornflower, the "Danțul la Șură" are small pastimes of the locals that can immerse visitors into the authentic atmosphere and create great experience-based tourism activities.

Conclusions

The present paper reinforces the existing literature, which highlights that among the increasingly central forms of tourism in Romania nowadays is rural tourism. Fortunately, almost all respondents (97%) have a positive impression of the rural touristic areas that exist in our country. The feedback of these respondents is relevant in our analysis and can be used constructively to improve the less pleasant or less developed aspects in any rural touristic destination in Romania.

Most of the respondents turned out to be interested in discovering the local cultural and natural attractions, in discovering the local gastronomy, but also spending time outdoors, cycling, and going hiking. Overall, tranquility and destination peacefulness and quietness, along with its fresh air are the most important triggering factors of Romanian rural tourists.

This research highlights the opportunity that the rise of rural tourism represents in Maramureş county, in the Groşi commune. This is a great place to spend one's vacation, because there is a lot of tranquility, beautiful landscapes, fresh air, important sights, and local gastronomy is most probable main goal of our study. On the other hand, creating opportunities in this parish is relevant, as it opens tourists' horizons to ideas that help in the development of Groşi parish. From among the opportunities that can create feelings of belonging to tourists in the sphere of the commune of Groşi, cultural and folklore events ought to be emphasized.

Obviously, the Coronavirus pandemic influences Romanians' decisions regarding tourist destinations. An interesting finding of our study is that over 50% of the individuals surveyed will choose a traditional Romanian village for their future vacation, which is a real advantage for the Romanian hospital industry affected very much nowadays. Nevertheless, 31% of the respondents chose the middle way, namely, they want to share their vacation between Romanian villages and abroad. Fortunately, only 8% of respondents will want to go on holiday abroad, which again, is an advantage for Romania's hospitality industry.

The present research highlights that the shortcomings of the travel industry in the Groşi parish are exemplified by the subsequent main disadvantages: lack of promotion of this touristic area and the existence of promotion of other similar areas in the Maramureş county. Obviously, with various marketing and promotion strategies, this threat can also be mitigated, and promotion can also become a strength of the municipality of Groşi.

Unfortunately, in the village of Groşi there are no official accommodations, such as hostels, motels, or cottages for rent, but the villagers are always eager and hospitable, so the tourists who announce themselves are always welcome and treated with the utmost respect and friendship by the hosts.

In conclusion, around all these sights, village histories, customs, crafts, and dates can create many tourist packages, which would certainly be very appreciated by visitors.

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PORTFOLIO DIVERSIFICATION OPPORTUNITIES IN TRADITIONAL ENERGY AND ALTERNATIVE/ RENEWABLE ENERGY ETF SEGMENTS

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ABSTRACT. This study evaluates the diversification benefits of investing in traditional and alternative/renewable energy Exchange Traded Funds (ETFs) using the VAR-ADCC-GARCH model to analyze yields, correlations, and volatilities. The results demonstrate that alternative/renewable energy ETFs not only offer higher average returns but also significantly reduce portfolio risk compared to traditional energy ETFs. The research underscores the distinct investment dynamics between the two ETF segments, highlighting the advantages of incorporating renewable energy assets into diversified portfolios. These findings support the inclusion of environmentally-conscious investment strategies that effectively balance risk and return, emphasizing their importance for investors aiming to optimize their portfolios in line with sustainable practices.

Keywords: portfolio diversification, ETFs, traditional energy, renewable energy, VAR-ADCC-GARCH Model

JEL classification: G11, C58, A100, A110

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Introduction

In the rapidly evolving investment landscape, diversification strategies are increasingly vital, particularly within the dynamic energy sector. This sector is distinctly segmented into traditional energy sources, primarily fossil fuels, and alternative/renewable energy sources, which have risen in prominence due to environmental considerations and technological advances. Given the volatile nature of the energy markets, influenced by geopolitical factors, economic cycles, and technological innovations, investors are continually seeking strategies to optimize asset allocations while managing inherent risks.

This study delves into the potential for portfolio diversification through investments in Exchange Traded Funds (ETFs) that focus on these two contrasting energy segments. ETFs offer several advantages including liquidity, cost-efficiency, and the ability to provide investors with broad exposure to various market segments. This makes them an ideal vehicle for exploring investment strategies across diverse energy sources, from traditional commodities like oil and gas to emerging markets in solar, wind, and other renewable energies.

Employing the sophisticated econometric model, Vector Autoregression Asymmetric Dynamic Conditional Correlation Generalized Autoregressive Conditional Heteroskedasticity (VAR-ADCC-GARCH), this research rigorously analyzes yields, correlations, and volatilities. The VAR-ADCC-GARCH model is particularly suited for this study as it can effectively capture the complex dynamics and interdependencies between multiple financial time series. This model extends the foundational principles of the asymmetric dynamic conditional correlation model initially introduced by Cappiello et al. (2006), which has been widely recognized for its ability to model time-varying correlations in financial data. Further inquiries by Gupta & Donleavy (2009), Kalotychou et al. (2014), Zhou & Nicholson (2015), Yuan et al. (2016), and Badshah (2017) and Miralles-Marcelo et al. (2018) have highlighted its utility in assessing the economic implications of investment diversification across varied portfolios, and have elucidated that the ADCC model's covariant asymmetry significantly augments its economic utility through prompt, favorable shifts subsequent to the adverse returns of conditional volatility and financial yields.

The primary aim of this inquiry is to elucidate and compare the behaviors of investments in conventional energy sectors versus alternative/renewable energy market segments. The research not only considers these segments as mere alternatives but seeks to define a broader, more integrative approach to understanding their roles within the investment portfolios. By dissecting the market dynamics and financial characteristics of these ETFs, the study aims to demonstrate how the inclusion of renewable energy investments can mitigate risks and enhance returns, particularly under typical market conditions.

This bifurcation of energy investments includes an examination of markets related to renewable energies such as smart grids and infrastructure, which are increasingly relevant in the context of global energy transitions. The study's methodology, leveraging the VAR-ADCC-GARCH model, facilitates a nuanced analysis of the estimated returns, volatilities, and covariances, providing a comprehensive picture of how these energy segments perform relative to one another and within the broader market ecosystem.

Through this scholarly endeavor, the paper aims to substantiate the economic viability of diverse investment strategies in managing economic utilities and adjusting to market volatilities. By providing empirical insights derived from advanced econometric analyses, this research seeks to guide investors toward more informed decision-making within an environmentally-conscious investment framework. It contributes significantly to the discourse on integrating alternative/renewable energy market segments within the broader framework of investment portfolio diversification, aiming to inspire both theoretical advancement and practical investment strategies in the evolving energy markets.

The inaugural segment of this research establishes the theoretical and methodological underpinnings, delineating the investment instrument construct under scrutiny, the elected optimal methodology, and the pertinent database. The ensuing segment elucidates the findings via the deployment of the stipulated methodology, encompassing the incorporation of time-series data and the requisite modification of software formulae to align with the methodological framework. The findings are articulated through the dissemination of descriptive statistical tabulations, the undertaking of regression analyses, and the construction of portfolio strategies. The culmination of this research entails a comprehensive evaluation of the outcomes attributable to the aforementioned computational analyses.

Objectives and hypotheses

The primary aim of the research is to investigate investment opportunities within traditional and alternative/renewable energy sectors, particularly through ETFs. It aims to validate the potential of these sectors for enhancing portfolio diversification and to develop investment strategies using the multivariate GARCH model, focusing on analyzing returns, volatilities, and covariances. This exploration includes a detailed examination of the inherent market dynamics and the systemic risks associated with each sector, shedding light on their unique investment profiles. Furthermore, the study seeks to identify optimal investment segments that offer superior returns and/or reduced risks.

Employing a VAR-ADCC-GARCH model, the research enhances the investment analysis by incorporating advanced statistical techniques to more accurately predict market behaviors and potential financial outcomes. Presented in two main sections, the study first establishes the theoretical and methodological foundations, followed by the empirical findings and the application of these methodologies. The first section outlines the theoretical assumptions underpinning the models used, while the second section applies these models in practical scenarios to test the hypotheses.

The outcomes, particularly concerning the alternative/renewable energy sector, are showcased through the development of various strategies, supported by minimum and mean-variance optimization, and illustrated through descriptive statistical tables and regression analyses. These strategies are designed to capitalize on the volatility and growth potential inherent in the renewable energy market, reflecting a shift towards more sustainable investment practices.

Hypothesis 1: Traditional and alternative/renewable energy ETFs, under typical market conditions, exhibit distinct and separate behaviors. This hypothesis is tested through a comparative analysis of historical performance data, aiming to highlight the distinct investment attributes of each sector.

Hypothesis 2: Diversifying across different ETFs optimizes risk and return profiles. This is explored through portfolio simulation techniques that demonstrate how strategic asset allocation can mitigate risks and enhance returns.

Hypothesis 3: Alternative/renewable energy investments outperform traditional energy investments both in risk and return. This assertion is examined through a series of regression models and variance analysis to validate the superior performance of renewable energy investments over traditional energy investments, especially in terms of risk-adjusted returns.

Database and methodology

Database

The dataset under examination encompasses daily return metrics for a collection of ten ETFs spanning the interval from January 4, 2010, to December 31, 2020, with careful consideration given to the volume of data points. The rationale for selecting this period for this study is to analyze the behavior of the segments under normal market conditions. This timeframe encompasses an era characterized by economic expansion phases, devoid of any observable recessionary trends. The choice of this specific investigational period was motivated by the intent to scrutinize the markets during a phase of relative stability, where economic conditions are conducive to evaluating the standard operations and performance of the segments.

However, it is important to acknowledge that the latter part of this period is marked by the unprecedented impact of the COVID-19 pandemic, an anomaly that is reflected in the data and the segments' performance as well.

The number of observations examined over the 11-year period is 2768. The daily return of the ETFs is the quotient of the difference between the assets' closing and opening adjusted prices, and the opening adjusted price, expressed as a percentage. The assortment of funds is bifurcated into two distinct categories: five ETFs are aligned with the conventional energy sector, while the remaining five are categorized under alternative or renewable energy sectors.

Within the taxonomy of these ETFs, the conventional energy contingent is representative of the sectors engaged in natural gas and petroleum markets. Conversely, the ETFs classified under alternative or renewable energy encapsulate a broad spectrum of energy sources, including but not limited to, wind, solar, geothermal, hydroelectric, as well as marine energies such as wave and tidal. This category further extends to encompass markets related to biomass and biofuels, thereby illustrating the diverse energy modalities considered within this dataset.

In pursuit of elucidating the potential for diversification within the realm of alternative and renewable energy markets, as well as delineating the distinctions between traditional and emergent energy market segments, the present study elects to engage with both conventional and alternative/renewable ETFs as the principal instruments of investment. ETFs, recognized for their passive investment nature, mirror the dynamics of stocks by encapsulating the performance of either a specific sector or a broader market benchmark. It is noteworthy that extant scholarly works have predominantly leveraged investments in stock market indices for analogous inquiries. For instance, Bouri et al. (2017) in their exploration of the diversification potential of renewable energy investments, rely heavily on stock indices to gauge market trends. Similarly, Henrique et al. (2019) employ market indices to assess the volatility and risk-return profiles of renewable energy investments, underscoring their utility in traditional financial analysis frameworks. In a departure from this traditional approach, this investigation gravitates towards the utilization of ETFs, owing to their broad accessibility to a spectrum of investors, encompassing both individuals and institutional entities.

The five traditional energy ETFs are: Energy Select Sector SPDR (XLE), Vanguard Energy ETF (VDE), SPDR S&P Oil & Gas Exploration & Production ETF (XOP), iShares Global Energy ETF (IXC), and VanEck Vectors Oil Services ETF (OIH). The five alternative/renewable energy ETFs are: iShares Global Clean Energy ETF (ICLN), Invesco Solar ETF (TAN), First Trust NASDAQ Clean Edge Green Energy Index Fund (QCLN), First Trust Nasdaq Clean Edge Smart GRID Infrastructure Index (GRID), and Invesco MSCI Sustainable Future ETF (ERTH). The ETFs in question stand out for their exemplary representation of their respective sectors, bolstered by an extensive archive of historical data reaching back to 2010.

Differences between the segments manifest in their investment strategies and portfolio compositions. Within the traditional energy ETF sector, the Energy Select Sector SPDR (XLE) ETF primarily targets companies engaged in conventional energy extraction, processing, and transportation within the United States, including oil, gas, and other fossil fuels. The XLE ETF is aimed at investors seeking diversification and outstanding returns within the traditional energy industry. Similarly, the Vanguard Energy ETF (VDE) focuses its portfolio on major energy corporations in the U.S. involved in oil, gas, and other fossil fuel industries, catering to investors looking for long-term growth and returns in the energy sector. The SPDR S&P Oil & Gas Exploration & Production ETF (XOP) mainly operates in on the U.S. oil and gas exploration and production sectors, appealing to investors interested in these areas. The iShares Global Energy ETF (IXC) concentrates on companies across the global energy sector, enabling diversification across various industry areas. The VanEck Vectors Oil Services ETF (OIH) focuses on oil service companies worldwide that provide services at different stages of the extraction process.

In the alternative/renewable energy ETF segment, the iShares Global Clean Energy ETF (ICLN) focuses on companies worldwide involved in the clean energy sector, including wind and solar energy and other environmentally friendly technologies, targeting environmentally conscious investors who anticipate long-term growth from the clean energy sector. The Invesco Solar ETF (TAN) is centered on the global solar energy industry, including companies that manufacture solar collectors and photovoltaic cells. The First Trust NASDAQ Clean Edge Green Energy Index Fund (QCLN) concentrates on the stocks of companies operating in the green energy field. The First Trust Nasdaq Clean Edge Smart GRID Infrastructure Index (GRID) is focused on companies globally involved with smart grids and infrastructure, aimed at investors focusing on the development of network technologies and infrastructure. Finally, the Invesco MSCI Sustainable Future ETF (ERTH) focuses globally on sustainable companies and developments, targeting investors who prioritize sustainability and social responsibility.

Methodology

The VAR-ADCC-GARCH approach

To compare the two ETF segments, the study employs the VAR-ADCC-GARCH model. The VAR-ADCC-GARCH model is a commonly used modeling technique in the field of financial investment for forecasting volatility in time series. The model has been successfully applied to the examination of ETFs within the concept of financial portfolio diversification (Miralles-Marcelo et al., 2018).

The development of the model unfolds in two distinct phases. The initial phase entails the delineation of the time series model. Precise articulation of the mean equation is imperative, given that any inaccuracies in its specification can result in the erroneous establishment of the variance equation (Ewing & Malik, 2005). The return generation process is theorized as follows:

$$r_{i,t} = c_i + \sum_{\substack{i=1 \\ j=1}}^{5} \alpha_{(ij)} r_{i,t-j} + \varepsilon_{i,t}$$

$$\varepsilon_{i,t} \mid \Omega_{t-1} \approx \mathrm{N}(0, \mathrm{H_t}) \tag{1}$$

In the VAR-ADCC-GARCH model $r_{i,t}$ is the ETF's daily return, c_i and α_{ij} are the estimated parameters, and $\varepsilon_{i,t}$ is a 5 × 1 vector of error terms which is assumed to be conditionally normal with zero mean and conditional variance matrix H_t. In each model the conditional variances $h_{i,t}$ and the standardized residuals $\delta_{i,t} = \varepsilon_{i,t}/\sqrt{h_{i,t}}$ are generated separately. Thus, the covariance matrix is specified as:

$$H_t = D_t R_t D_t \tag{2}$$

In the conditional variance matrix H_t, $D_t = diag(\sqrt{h_{it}})$ is a diagonal matrix which contains the time varying conditional volatilities of the previous GARCH models and R_t is a time-varying 3 × 3 correlation matrix with diagonal elements equal to 1 which is specified as:

$$R_t = (Q_t^*)^{-1} Q_t (Q_t^*)^{-1} \tag{3}$$

In the VAR-ADCC-GARCH model $Q_t = \{q_{ij,t}\}$ is a covariance matrix of the standardized residuals denoted as:

$$Q_t = (1-\alpha-\beta) - \gamma + \alpha(\delta_{t-1}\delta'_{t-1}) + \gamma\eta_{t-1}\eta'_{t-1} + \beta Q_{t-1} \tag{4}$$

$= E[\delta_t \delta'_t]$ is the unconditional correlation matrix of the standardized residuals; $Q_t^* = diag(\sqrt{q_{ij,t}})$ is a diagonal matrix containing the square root of the diagonal elements of the n × n positive matrix Q; $\eta_t = I[\delta_t < 0] \odot \delta_t$ ($I[\,.\,]$ is a 3×1-es indicator function which takes on value 1 if the argument is true and 0 otherwise while $\odot$ is the Hadamard-product and $= [\eta_t \eta'_t]$. Positive definiteness of Q_t is ensured by imposing $\alpha + \beta + \lambda\gamma < 1$, where λ = maximum Eigen-value $[^{-1/\ 2-1/2}]$.

The investment strategies

Using the insights gained from Miralles-Marcelo et al. (2018), the study applies the analysed returns, volatilities, and correlations from the earlier VAR-ADCC-GARCH approach to create four different investment strategies. These strategies are rooted in two traditional approaches to optimizing portfolios. The first approach tackles to develop a portfolio that aims to minimize risk, known as the minimum-variance portfolio, defined by the following equation:

$$min_{w_t} w_t' H_{\{t+1|t\}} w_t \tag{5}$$

where $w_t' H_{\{t+1|t\}} w_t$ is the portfolio risk equation to be minimized. Pursuing this strategy, one can assume that the investor's sole focus is on reducing volatility. Yet, in practice, investors are not solely concerned with lowering risk; they are also keen on generating returns from their investments.

Concurrently, the alternative optimization issue tackled is the traditional mean-variance strategy introduced by Markowitz in 1952. This strategy's objective remains to curtail portfolio risk while incorporating a constraint that ensures the portfolio reaches a specified return target. Hence, the optimization challenge is established as follows:

$$\begin{aligned} &min_{w_t} w_t' H_{\{t+1|t\}} w_t \\ &s.t. w_t' E\left[R_{\{t+1\}}\right] \geq R^{\square} \end{aligned} \tag{6}$$

In this strategy R^* denotes the desired target return performance. The adopted approach uses an equally distributed portfolio, often referred to as the naïve portfolio, as the reference point for R^*. Portfolios can be created with or without short-selling constraints.

Initially, the optimization problem is solved by excluding short-sellings. Therefore, the general constraints $w_t' 1 = 1$ $w_i 1 \geq 0$ i = 1,2, …, N are included. The impact of short-selling constraints on portfolio management is an area with divergent findings in academic research, as highlighted by Grullon et al. (2015). A number of studies have explored portfolio management strategies both in the context of the presence and absence of short-selling constraints. For instance, Diether et al. (2009), and Beber & Pagano (2012) have provided various insights, though consensus on the effects is still evolving. Compellingly, Bohl et al. (2016) presented econometric findings suggesting that volatility persistence intensified during the financial crisis, especially in stocks with short-selling constraints. Their work not only contributes to understanding the nuances of market dynamics under such constraints but also advises against the imposition of short-selling bans by regulators. Drawing from these diverse academic perspectives, the optimization

problems are approached by including scenarios where short-selling constraints are factored in, in line with the recommendations and observations made by Bohl et al. (2016). In that case only the constraints $w_t'1 = 1\ i = 1,2, \dots, N$ were included. In both cases w_i is the weight of each asset from the portfolio vector, $w_t = [w_1, w_2, \dots, w_N]$, and 1 is a vector of ones.

Ultimately, the effectiveness of the optimization models is assessed over the period t = τ + 1, ..., T, in terms of the Sharpe ratio, SR_p which is defined as the average returns divided by their sample standard deviation:

$$SR_p = \frac{\mu_p}{\sigma_p} \tag{7}$$

Descriptive statistics

Table 1 and 2 contain the descriptive statistics for the daily return series for the energy ETFs (XLE, VDE, XOP, IXC and OIH) and alternative/renewable energy ETFs (ICLN, TAN, QCLN, GRID and ERTH), respectively, for the sample period from January 4, 2010, to December 31, 2020. Probabilities are is brackets and represent 1% significance level. The last column reports the mean and variance equality tests using the ANOVA and Levene statistics, respectively. Skewness and Kurtosis refer to the series skewness and kurtosis coefficients. The Jarque–Bera statistic tests the normality of the series. This statistic has an asymptotic $\chi^2(2)$ distribution under the normal distribution hypothesis. ARCH (1) is the Engle test for the 1st-order ARCH. These three tests are distributed as $\chi^2(1)$. The p values of these tests are reported in brackets.

Table 1. Energy ETFs

	XLE	VDE	XOP	IXC	OIH	Equality test
Mean	0.011428	0.006693	-0.00268	0.005156	-0.024095	0.131754 (0.9708) 113.6213 (0.0000)
Std. Dev.	1.732848	1.74955	2.488797	1.628015	2.401432	
Skewness	-0.447939	-0.403428	-0.662624	-0.616186	-0.529481	
Kurtosis	20.17057	18.12251	25.30851	23.51928	20.94285	
Jarque-Bera	34096.14 (0.0000)	26450.7 (0.0000)	57600.47 (0.0000)	48735.21 (0.0000)	37260.42 (0.0000)	
ARCH (1)	0.110208 (0.0000)	0.103251 (0.0000)	0.111364 (0.0000)	0.116454 (0.0000)	0.088525 (0.0000)	

Source: author's compilation

Table 2. Alternative/renewable Energy ETFs

	ICLN	TAN	QCLN	GRID	ERTH	Equality test
Mean	0.031365	0.03934	0.071838	0.048674	0.052021	0.200523 (0.9382) 181.5350 (0.0000)
Std. Dev.	1.645187	2.438284	1.81066	1.52775	1.36383	
Skewness	-0.4229	0.047349	-0.26563	-0.35896	-0.61126	
Kurtosis	9.221772	6.79016	8.440482	11.47175	10.59155	
Jarque-Bera	4547.113 (0.0000)	1657.834 (0.0000)	3446.285 (0.0000)	8336.987 (0.0000)	6819.22 (0.0000)	
ARCH (1)	0.087671 (0.0000)	0.055898 (0.0000)	0.071818 (0.0000)	0.096181 (0.0000)	0.102340 (0.0000)	

Source: author's compilation

The energy and alternative/renewable energy ETFs exhibit non-normal return distributions with evidence of volatility clustering. The daily returns show evidence of leptokurtic behaviour, indicating the presence of outliers and the potential for extreme returns. The equality test results suggest that while the average returns may be similar for the Energy ETFs, the volatilities are significantly different within both sets of ETFs. This has implications for portfolio construction and risk management as ETFs with higher volatility may contribute more to the risk of the portfolio. In the GARCH model and its extensions, which particularly adept at modelling the thick tails and volatility clustering typical of financial time series data, leptokurtosis indicates that data have heavy tails and a sharp peak around the mean, which is more pronounced than that seen in a normal distribution. This feature of financial datasets can lead to underestimating the likelihood of extreme events if not modelled correctly, see Bollerslev (1986). The differences highlight distinct risk-return profiles between traditional energy ETFs and alternative/renewable Energy ETFs. The former appear to be more volatile, while the latter offer higher average returns, which may appeal to different types of investors depending on their risk appetite and investment goals. Engle's introduction of the ARCH model provided a methodological breakthrough for analyzing and forecasting volatile financial markets to adequately address the inadequacy of assuming constant volatility, which is a common limitation in standard financial models, see Engle (1982). Additionally, the presence of non-normal distributions and volatility clustering in both groups calls for sophisticated risk management strategies that go beyond standard models assuming normal distributions and constant volatility.

The return diagrams of the two segments

To depict the contrasts between the two ETF categories, Figures 1 and 2 provide the yield charts reflecting observations throughout the timeframe from January 4, 2010, to December 31, 2020. There are noticeable parallels in the trends of ascent and descent. It becomes apparent that the alternative/ renewable energy ETF category exhibits greater volatility when contrasted with the conventional energy ETF category. Patterns of fluctuating behaviour are discernible across both categories, with the conventional ETF group particularly showing this trend beyond the 2500th observation in the final year under review, 2020. This period coincides with the advent of the COVID-19 pandemic, a global crisis that significantly disrupted demand dynamics across energy markets, see Salisu et al. (2021). The imposition of lockdowns and the ensuing slump in industrial activity and mobility led to an abrupt contraction in energy consumption, injecting considerable uncertainty and erratic price movements into energy ETFs. Concurrently, an oil price skirmish among leading oil-exporting nations compounded these disruptions. The subsequent oversupply, amid an already waning demand, intensified the volatility of energy ETFs, with pronounced impacts on investor sentiment and market liquidity. These perturbations were further exacerbated by reactive monetary policies, including the Federal Reserve's interest rate cuts and asset purchases, which introduced additional liquidity into the markets, amplifying the magnitude of price swings. Further aggravating the sector's instability is the accelerating transition towards renewable energy sources, signalling a structural shift that imbues traditional energy markets with long-term uncertainty. This inflection point, marked by both cyclical pandemic-related shocks and secular changes in energy preferences, is a crucible for heightened volatility.

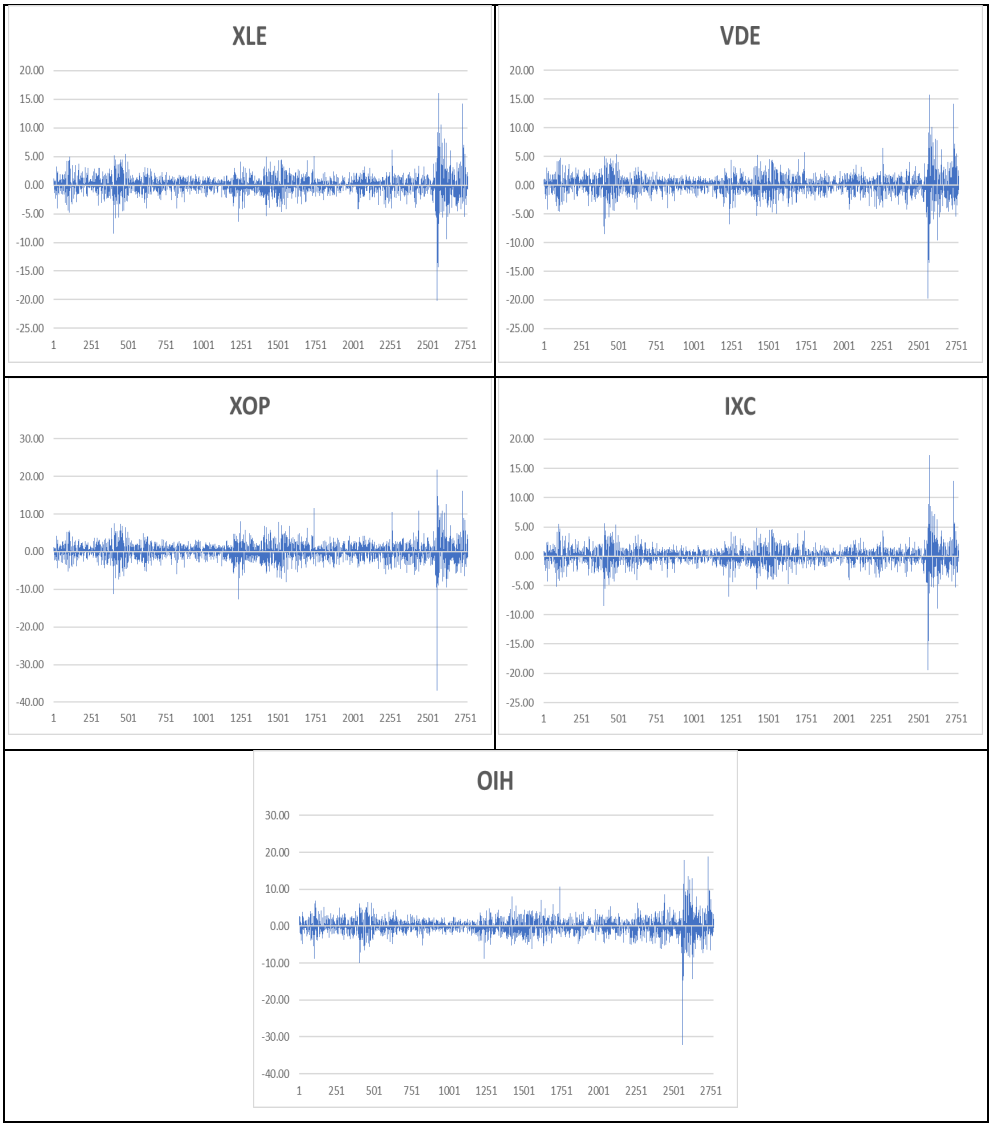

Figure 1. The return diagrams of the energy ETFs
Source: author's compilation

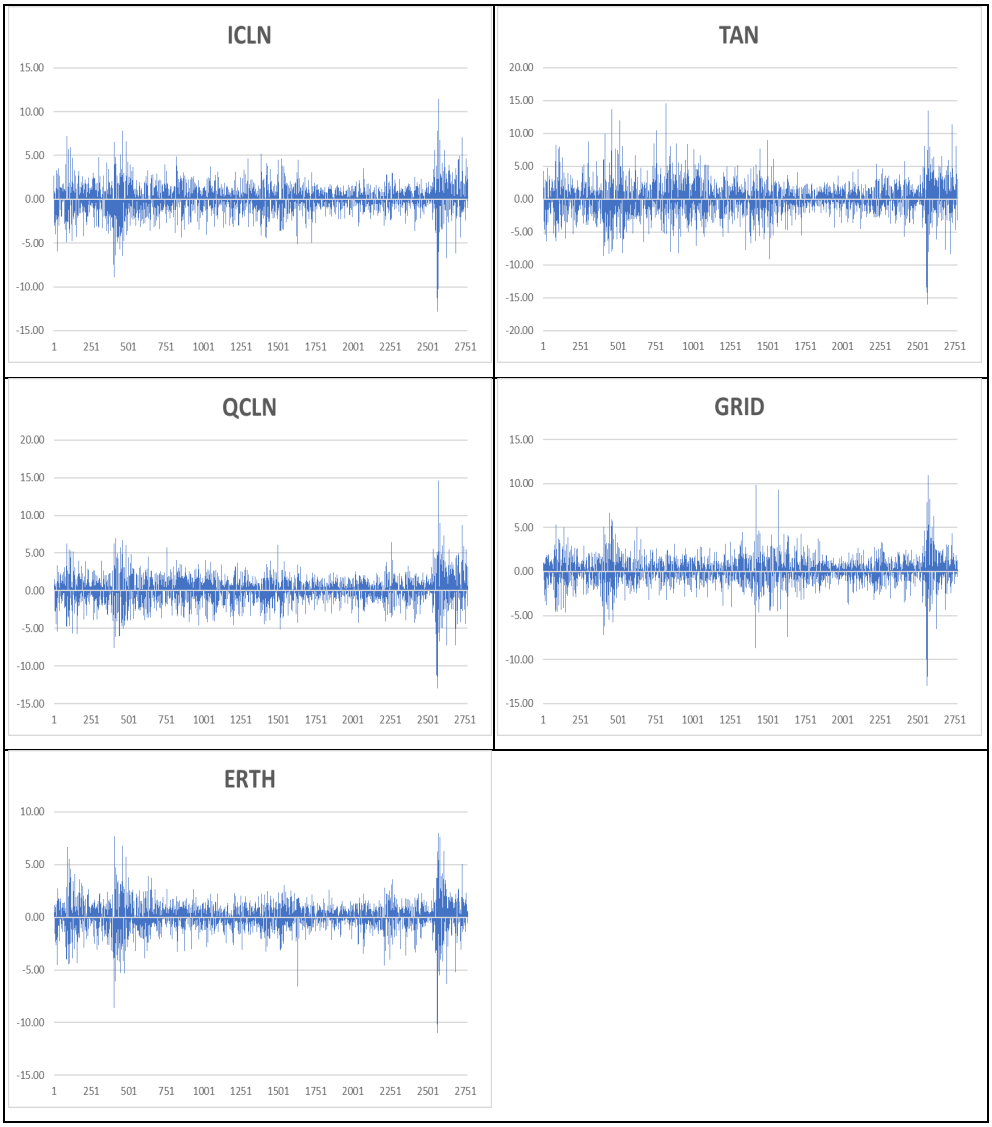

Figure 2. The return diagrams of the alternative/renewable energy ETFs
Source: author's compilation

Results and discussion

GARCH parameters

Table 3 and 4 detail the GARCH parameters (C, ω, α and β) and their probabilities in brackets for energy and alternative/renewable energy ETFs from January 4, 2010, to December 31, 2020. ∗∗∗ represents the 1% significance level, ∗∗ represents the 5% significance level, ∗ represents the 10% significance level, - represents not significant. In this research GARCH models are employed to understand the volatility dynamics of financial assets. Through modelling the variance of the current error term as a function of the previous periods' error terms and variances. The importance of the statistical significance of these parameters in his paper helps to affirm that the model's outputs are robust and not due to random variations, see Bollerslev (1986). The Constant (C) term represents the long-term mean of the dataset. ω is the baseline variance, or the long-run average volatility when previous periods' shocks are not considered. It is the intercept of the variance equation and reflects the part of the current variance that is unexplained by the lagged terms. α is a parameter (associated with (RESID(-1)^2), which measures the response of the variance to shocks in the previous period. A higher value indicates that recent shocks have a greater impact on current volatility, a phenomenon often referred to as volatility clustering. The β parameter (associated with GARCH(-1)) indicates the persistence of volatility shocks to future periods. A high β suggests that volatility tends to be persistent through time, (Bollerslev, 1986). The probability values associated with each parameter signifies the statistical significance. Low probability values (typically less than 0.05) indicate that the parameter is statistically significant and not likely the result of random variation.

Table 3. Energy ETFs

ETF	Constant (C)	ω	α (RESID(-1)^2)	β (GARCH(-1))
XLE	0.049762 (0.0224)**	0.032596 (0.0020)***	0.110230 (0.0000)***	0.881210 (0.0000)***
VDE	0.046133 (0.0413)**	0.032646 (0.0024)***	0.103309 (0.0000)***	0.888169 (0.0000)***
XOP	0.067069 (0.0538)*	0.065611 (0.0049)***	0.111506 (0.0002)***	0.883950 (0.0000)***
IXC	0.045537 (0.0215)**	0.027961 (0.0008)***	0.115383 (0.0000)***	0.878901 (0.0000)***
OIH	0.030812 (0.3231)-	0.036321 (0.0043)***	0.089336 (0.0001)***	0.908370 (0.0000)***

Source: author's compilation

Table 4. Alternative/renewable energy ETFs

ETF	Constant (C)	ω	α (RESID(-1)^2)	β (GARCH(-1))
ICLN	0.045249 (0.0646)*	0.044073 (0.0015)***	0.089155 (0.0000)***	0.894564 (0.0000)***
TAN	0.045939 (0.2187)-	0.032528 (0.0096)***	0.056151 (0.0000)***	0.940136 (0.0000)***
QCLN	0.073212 (0.0072)***	0.042165 (0.0024)***	0.071358 (0.0000)***	0.915175 (0.0000)***
GRID	0.075973 (0.0013)***	0.054969 (0.0002)***	0.096392 (0.0000)***	0.878326 (0.0000)***
ERTH	0.075050 (0.0001)***	0.035039 (0.0001)***	0.103609 (0.0000)***	0.875798 (0.0000)***

Source: author's compilation

It can be observed that for energy ETFs, the constants (C) across different ETFs vary slightly, suggesting differences in their long-term average returns. The α and β parameters are highly significant (p-values close to 0), which indicates strong support for the GARCH modelling approach in describing the volatility of these ETFs. The magnitude of the α coefficients is relatively small but significant, indicating that while past shocks have an impact, it is not overwhelmingly large. The β coefficients are close to 1, suggesting a high degree of volatility persistence. This means that when the volatility level changes, these changes are likely to persist into the future. For alternative/renewable energy ETFs the constants (C) are similar in magnitude to those of the Energy ETFs, but the interpretation might differ due to the nature of the assets. The α coefficients again are significant and similar in magnitude to the Energy ETFs, indicating a consistent impact of past shocks across different types of ETFs. The β values are very high (also close to 1), suggesting that volatility is highly persistent, which is a common characteristic in financial time series data.

While the structure of the GARCH model is consistent across both types of ETFs, the interpretation may differ based on the sector. For instance, alternative/ renewable energy ETFs might be subject to different market dynamics compared to traditional energy ETFs, including different reactions to market-wide events or news about technological developments and regulatory changes. The degree of persistence in volatility (β) might suggest that the market's view of risk in these sectors remains consistent over time. It is important to consider that these GARCH parameters alone do not provide the complete picture. Overall, the GARCH parameters show the existence of some significant dynamic relationships between the ETFs. In practice, analysts would further investigate the causes behind the volatility patterns. This is why the VAR-ADCC-GARCH approach is applied in the next section.

VAR-ADCC-GARCH parameters

Table 5 exhibits the VAR-ADCC-GARCH parameters on the energy and alternative/renewable energy ETFs for the sample period from January 4, 2010, to December 31, 2020. $***$ represents the 1% significance level, $**$ represents the 5% significance level, $*$ represents the 10% significance level, - represents not significant. To analyze ETFs from two different segments, a cross-segment comparison is created by evaluating them in pairs. With 25 distinct pairs, the relationship between each pair can be individually examined. This approach allowed to understand the interconnectivity and correlation within each pair across different market segments.

Table 5 contributes to the understanding of the persistence of volatility and correlation shocks in financial time series data. Theta (1) shows the direct correlation, and indicates the immediate impact of a new shock to the correlation between the two time-series. A significant theta (1) with a low probability value suggests a strong response in the direct correlation to new information or market events. Theta (2) shows the indirect correlation via latent variable, and captures the impact of shocks to the indirect correlation. The latent variable could represent unobserved market factors or risk drivers that affect both time series. A significant and persistent theta (2) suggests that the latent variable plays an important role in the correlation dynamics between the ETFs over time. Theta (3) is the latent variable correlation which reflects the persistence of shocks to the latent variable itself. It shows how changes in the latent variable's volatility affect the correlation with the time series. A non-significant theta (3), indicated by a high p-value, suggests that the latent variable's own shocks do not persistently influence the correlation between the ETFs. If the sum of theta (1) and theta (2) is below 1, the stability condition is met, which means the ADCC-GARCH model is stable. If this condition is not met, it suggests that shocks to the correlation have a unit root, implying non-mean reverting behavior which could indicate instability in the correlation over time. Impact of market volatility on the returns highlights the importance of the DCC and ADCC-GARCH models in capturing the time-varying correlations and the asymmetric effects of volatilety transmission between prices and industry returns, see Ullah (2021).

Table 5. The two-pair ADCC-GARCH analysis of the energy and alternative/renewable energy ETFs

ETF-pairs	theta (1)	theta (2)	theta (3)	Stability condition (theta(1)+theta(2) < 1)
XLE – QCLN	0.059521 (0.0000)***	0.911542 (0.0000)***	0.001642 (0.4705)-	met
XLE – TAN	0.042641 (0.0000)***	0.931255 (0.0000)***	0.005787 (0.0015)***	met
XLE – ICLN	0.042036 (0.0000)***	0.938956 (0.0000)***	0.009459 (0.0000)***	met
XLE – GRID	0.060644 (0.0000)***	0.925223 (0.0000)***	-0.000409 (0.8925)-	met
XLE – ERTH	0.026467 (0.0000)***	0.968446 (0.0000)***	0.009196 (0.0000)***	met
VDE – QCLN	0.058482 (0.0000)***	0.914059 (0.0000)***	0.001827 (0.4071)-	met
VDE – TAN	0.043466 (0.0000)***	0.930813 (0.0000)***	0.005518 (0.0025)***	met
VDE – ICLN	0.050385 (0.0000)***	0.929259 (0.0000)***	0.007846 (0.0000)***	met
VDE – GRID	0.063460 (0.0000)***	0.922654 (0.0000)***	-0.000848 (0.7978)-	met
VDE – ERTH	0.037096 (0.0000)***	0.951546 (0.0000)***	0.007362 (0.0000)***	met
XOP – QCLN	0.052234 (0.0000)***	0.924091 (0.0000)***	0.001469 (0.6126)-	met
XOP – TAN	0.056101 (0.0000)***	0.915152 (0.0000)***	-0.001239 (0.7577)-	met
XOP – ICLN	0.040881 (0.0000)***	0.945385 (0.0000)***	0.002526 (0.2378)-	met
XOP – GRID	0.039117 (0.0006)***	0.952030 (0.0000)***	0.000296 (0.9143)-	met
XOP – ERTH	0.027061 (0.0000)***	0.965296 (0.0000)***	0.003482 (0.0046)***	met
IXC – QCLN	0.044771 (0.0000)***	0.934226 (0.0000)***	0.002049 (0.0173)**	met
IXC – TAN	0.035276 (0.0000)***	0.942587 (0.0000)***	0.005239 (0.0005)***	met
IXC – ICLN	0.046829 (0.0000)***	0.935071 (0.0000)***	0.004076 (0.0002)***	met
IXC – GRID	0.082453 (0.0001)***	0.900418 (0.0000)***	-0.004360 (0.3164)-	met
IXC – ERTH	0.106607 (NA)-	0.936824 (NA)-	-0.001248 (NA)-	met
OIH – QCLN	0.031031 (0.0000)***	0.953922 (0.0000)***	0.003845 (0.0173)**	met
OIH – TAN	0.041720 (0.0000)***	0.934111 (0.0000)***	0.004916 (0.0215)**	met
OIH – ICLN	0.048118 (0.0000)***	0.934648 (0.0000)***	0.004804 (0.0033)***	met
OIH – GRID	0.046334 (0.0000)***	0.940388 (0.0000)***	0.000717 (0.8028)-	met
OIH – ERTH	0.047112 (NA)-	0.964977 (NA)-	-0.005089 (NA)-	not met

Source: author's compilation

Most pairs met the stability condition, meaning that the correlations are stable and revert to a long-term average after a shock. The ADCC-GARCH model is particularly useful in financial econometrics to model time-varying correlations among multiple financial assets. The results are beneficial for portfolio optimization, risk management, and in understanding the behavior of the two segments. The persistence parameters provide insight into how quickly correlations adjust to new information and the role of underlying, unobserved factors in driving these correlations. For investors and risk managers, the model's ability to capture the dynamic nature of correlations can lead to better-informed investment decisions and risk assessments. The probabilities associated with each theta value are important in assessing the statistical significance of the parameters. Low p-values (typically less than 0.05) indicate that the corresponding theta parameter is statistically significant and provides meaningful insights into the correlation dynamics between the ETF pairs. The theta parameters across most ETF pairs are significant with very low p-values, indicating a high level of persistence in the correlations. This suggests that shocks to the correlations between these ETFs tend to have lasting effects, see Ullah (2021).

With the exception of the OIH – ERTH pair, all ETF pairs have met the stability condition, indicating that their correlations are stable over time and revert to a long-term mean. This implies that while the market may experience short-term fluctuations, the relationship between these pairs tends to remain consistent in the long term, which is reassuring for strategic asset allocation. For most pairs, the theta (2), which captures the impact of shocks through a latent variable, is statistically significant. This reveals the presence and importance of unobserved factors (such as macroeconomic indicators or policy changes) that are affecting multiple assets simultaneously. It points to a market driven by underlying systemic factors, which could be a focal point for further research or for investors looking to understand broader market dynamics. Theta (1) is significant for all ETF pairs, indicating that the direct correlation between ETFs is resilient to shocks. When creating portfolio strategies, investors might use this information to assess the risk of direct contagion between assets or sectors represented by these ETFs. The lower significance of theta (3) for some pairs suggests that the immediate impact of shocks to the latent variable's own variance may not have a long-lasting direct effect on the correlations. This could be useful for hedging against specific types of risk; for example, when focusing less on the latent variable shocks when one is more concerned about long-term investment horizons. The OIH – ERTH pair does not meet the stability condition, signaling potential instability in their correlation over time. This could be indicative of unique market forces or sector-specific risks affecting these assets differently

compared to others. It highlights an area that may require special attention from risk perspective and could be a subject for further investigation.

In conclusion, the findings provide significant insights into the correlation dynamics between different ETFs. For practitioners in finance, understanding these dynamics can assist in diversifying portfolios, managing risk, and in the design of investment strategies that account for the persistent and dynamic correlations between different segments of the market. When constructing investment portfolios, the ADCC-GARCH performance persistent parameters, stability of correlations, the role of the latent variables, direct and indirect correlations, sector-specific dynamics, diversification opportunities, and market conditions and external shocks should be taken into account.

Overall, asymmetric dynamic correlations in the markets are supported by the significant parameters. The theta parameters indicated a high level of persistence in the correlations, especially between traditional and alternative/renewable energy ETFs. This implies that market shocks and volatility tend to have a lasting impact on these assets. When constructing portfolios, understanding the degree of persistence helps in analyzing potential risks and returns. Most of the ETF pairs, except OIH – ERTH, met the stability condition of the VAR-ADCC-GARCH model. This suggests that the dynamic correlations between the ETFs are stable over time, which is essential for long-term portfolio planning. This stability can aid in setting expectations for the correlations between assets in future market conditions. The significance of theta (2) across many pairs suggests a notable impact of latent variables on ETF correlations. This represents broader economic or policy-related factors affecting the energy sector. The latent variables may be crucial for strategic asset allocation. The importance of direct correlations (theta (1)) indicates the immediate and significant response to new information or market events. In contrast, indirect correlations (theta (2)) signify the influence of unobserved factors. Balancing direct and indirect correlations in portfolio construction can help manage immediate and long-term risks. The non-compliance of the OIH – ERTH pair with the stability condition implies sector-specific dynamics that could lead to unstable correlations. This insight is vital when considering the diversification benefits or risks associated with the respective ETF-pair. The distinct behavior of traditional and alternative/renewable energy ETFs supports the hypothesis that diversifying across these segments can optimize the risk and return profile of an investment portfolio. The data suggest that alternative/renewable energy ETFs might provide a real alternative for investors, potentially offering superior risk-adjusted returns. The research period in the study spans phases of economic expansion and does not feature recessionary trends until the emergence of COVID-19. The pandemic's impact on the market underscores the importance of considering external shocks and market conditions

when constructing portfolios. It suggests the need for strategies that can adapt to sudden market changes. When applying this knowledge to portfolio construction, it is crucial to utilize a forward-looking approach, integrating insights from the VAR-ADCC-GARCH analysis to manage expected volatility and correlations.

Investment strategies

Table 6 contains the performance evaluation of the proposed portfolios based on the annualized mean, annualized standard deviation and annualized Sharpe ratios for the sample period from January 4, 2010, to December 31, 2020. The performance considers scenarios both with and without short-selling constraints, juxtaposed against a naïve strategy for benchmarking purposes. The analysis is segmented into Panels A and B, which encompass the minimum variance and mean-variance strategies for energy ETFs, respectively, and Panels C and D, which detail the corresponding strategies for alternative/ renewable energy ETFs.

The Sharpe ratio is a very good measure in finance to evaluate the performance of an investment relative to its risk. Sharpe's initial findings and later academic studies underscore that the Sharpe Ratio effectively measures the risk-adjusted return of an investment. This means it accounts for the volatility of the investment, providing a more comprehensive view of its performance compared to just looking at raw returns. Research has demonstrated that the Sharpe Ratio is particularly useful as a comparative tool, allowing investors to compare the performance of different investments or portfolios on a level playing field. This aspect is especially helpful in portfolio management and strategy formulation, see Sharpe (1966).

Table 6. Portfolio performance evaluation

	Naïve	**Short-selling constraints**	**No short-selling constraints**
Energy: Panel A Minimum variance			
Return	-5.20%	-3.40%	-0.26%
Std. Dev.	31.09%	28.66%	25.36%
Sharpe ratio	-24.36%	-20.14%	-10.36%
Energy: Panel B Mean-variance (naïve)			
Return	-5.20%	-3.32%	2.18%
Std. Dev.	31.09%	29.33%	27.44%
Sharpe ratio	-24.36%	-19.39%	-0.69%
Alternative/renewable energy: Panel C Minimum variance			

	Naïve	**Short-selling constraints**	**No short-selling constraints**
Return	8.62%	9.67%	11.09%
Std. Dev.	25.18%	22.91%	20.90%
Sharpe ratio	24.83%	31.85%	41.71%
Alternative/renewable energy: Panel D Mean-variance (naïve)			
Return	8.62%	11.07%	14.76%
Std. Dev.	25.18%	24.81%	21.91%
Sharpe ratio	24.83%	35.08%	56.58%

Source: author's compilation

From the data presented, several conclusions can be discerned. The investment strategies deployed, particularly those pertaining to alternative/ renewable energy ETFs, exhibit a marked enhancement in the Sharpe ratio relative to the naïve strategy, signaling an improvement in risk-adjusted returns. The removal of short-selling constraints tends to favor portfolio performance, as indicated by higher Sharpe ratios across the board. This suggests that the ability to short-sell enables more efficient portfolio optimization, taking advantage of negative market movements. Amongst the various strategies, those applied to alternative/renewable energy ETFs (Panels C and D) not only transcend the naïve strategy's performance but also register substantive positive Sharpe ratios, with the no short-selling constraint mean-variance strategy in Panel D evidencing particularly robust outcomes. This implies a favorable environment for investment in alternative/renewable energy ETFs, with these vehicles yielding the most efficacious risk-adjusted returns in comparison to traditional energy ETFs. In summary, the empirical evidence suggests that investors could potentially gain by allocating resources to alternative/renewable energy ETFs and adopting mean-variance optimization techniques, especially when constraints on short-selling are absent, to optimize their investment portfolios.

The results indicated in Table 6 provide a clear comparative advantage for alternative/renewable energy ETFs over traditional energy ETFs during the period analyzed. The higher Sharpe ratios for the alternative/renewable energy ETFs, particularly under the mean-variance portfolio construction without short-selling constraints, suggest that these investments offered better risk-adjusted returns. The conclusion that alternative/renewable energy ETFs outperformed traditional energy ETFs is supported by both the higher returns and more favorable Sharpe ratios, indicating that they not only provided higher returns but did so with a more efficient management of risk relative to the expected return. This outperformance aligns with broader investment trends that favor sustainable and green energy sources, reflecting both a shift in consumer preference and perhaps advancements in technology within the sector.

Tables 7 and 8 detail the portfolio weights for energy ETFs and alternative/ renewable energy ETFs, respectively, for the sample period from January 4, 2010, to December 31, 2020. The tables are divided into panels representing different strategies and constraints. In the naïve strategy weights are evenly distributed across all ETFs, implying no optimization based on historical data. This strategy assumes equal risk and potential return from each ETF. In the minimum variance strategy the goal is to minimize portfolio risk, see Markowitz (1952). The allocation in Panels A and C shows more significant weights in certain ETFs even with short-selling constraints, suggesting that these ETFs are considered less volatile. Without short-selling constraints (Panels B and D), one can see that some ETFs are assigned negative weights (indicating short positions), which suggests that taking short positions in certain ETFs can contribute to lowering the portfolio's overall volatility. The mean-variance strategy aims to optimize the trade-off between return and risk. In Panels A and C (with short-selling constraints), the allocations are more conservative in terms of short positions compared to the minimum variance strategy. However, when short-selling constraints are removed (Panels B and D), one can obserce significantly larger negative weights, indicating an aggressive stance to short-sell certain ETFs to achieve the desired risk-return profile. The negative weights in Panels B and D for the minimum variance and mean-variance strategies suggest a conviction that the short-sold ETFs will underperform relative to the others. This is particularly notable for the mean-variance strategy without short-selling constraints in the renewable energy sector (Panel D), where large negative weights indicate a strong position taken against certain ETFs to maximize the portfolio's Sharpe ratio. The differences in the portfolio weights between Panels A and B for energy ETFs and Panels C anis empd D for alternative/renewable energy ETFs highlight the impact of short-selling constraints on portfolio construction. When these constraints are lifted, the optimization algorithm takes more extreme positions, which can either increase the potential return or decrease the risk, depending on the strategy chosen. Overall, the tables suggests that the inclusion or exclusion of short-selling constraints has a significant impact on the construction of optimized portfolios, particularly for the minimum variance and mean-variance strategies. The data implies that the freedom to short-sell allows for a more flexible and potentially more profitable portfolio allocation, assuming the investor is comfortable with the increased risks associated with short selling.

Table 7. Portfolio weights for the energy ETFs

	XLE	VDE	XOP	IXC	OIH
Panel A: with short-selling constraints					
Naïve	20%	20%	20%	20%	20%
Minimum variance	30%	10%	10%	40%	10%
Mean-variance	40%	30%	10%	10%	10%
Panel B: without short-selling constraints					
Naïve	20%	20%	20%	20%	20%
Minimum variance	40%	40%	-17%	40%	-3%
Mean-variance	40%	40%	40%	40%	-60%

Source: author's compilation

Table 8. Portfolio weights for the alternative/renewable energy ETFs

	ICLN	TAN	QCLN	GRID	ERTH
Panel C: with short-selling constraints					
Naïve	20%	20%	20%	20%	20%
Minimum variance	10%	10%	10%	30%	40%
Mean-variance	10%	10%	40%	10%	30%
Panel D: without short-selling constraints					
Naïve	20%	20%	20%	20%	20%
Minimum variance	40%	-30%	11%	38%	40%
Mean-variance	39%	-59%	40%	40%	40%

Source: author's compilation

Conclusions

Based on the comprehensive analysis conducted using the VAR-ADCC-GARCH approach and the detailed examination of traditional and alternative/ renewable energy ETFs, one can draw the following main findings and overall conclusions.

Regarding Hypothesis 1 - Traditional and alternative/renewable energy ETFs, under typical market conditions, exhibit distinct and separate behaviors, the study utilized a VAR-ADCC-GARCH model to analyze daily return series for a selection of ETFs representing both traditional and alternative/renewable energy sectors. This model allowed the study to capture the time-varying

conditional correlations and volatilities, offering insights into the behaviors of the ETFs under typical market conditions. The results indicated that traditional energy ETFs and alternative/renewable energy ETFs have different volatility and return profiles. Traditional energy ETFs generally showed higher volatility, while alternative/renewable energy ETFs exhibited higher returns. This distinct behavior was supported by the statistical tests conducted, confirming the hypothesis.

With reference to Hypothesis 2 - Diversifying across different ETFs optimizes risk and return profiles, the study compared portfolio performances under different strategies, both with and without short-selling constraints. The analysis looked at naïve diversification (equal weights), minimum variance portfolios, and mean-variance portfolios to understand how diversification across the ETFs could affect the risk-return profile. Portfolio performance metrics (Sharpe ratios, standard deviation, and returns) demonstrated that diversification across traditional and alternative/renewable energy ETFs did optimize the portfolios' risk and return profiles. The alternative/renewable energy ETFs especially improved portfolio efficiency when they were included, and the mean-variance strategy without short-selling constraints showed the most significant benefits.

As for Hypothesis 3 - Alternative/renewable energy investments outperform traditional energy investments both in risk and return, the performance of alternative/renewable energy ETFs was benchmarked against traditional energy ETFs using Sharpe ratios, returns, and volatilities as key metrics. The Sharpe ratios and returns were consistently higher for portfolios consisting of alternative/renewable energy ETFs compared to those with traditional energy ETFs, especially when no short-selling constraints were applied. This suggested that alternative/renewable energy ETFs not only offered higher returns but also managed risk more effectively, thus outperforming traditional energy ETFs and confirming the hypothesis.

In conclusion, the study provided empirical support for all three hypotheses. It showed distinct behaviors between the two types of ETFs, confirmed the benefits of diversification for optimizing risk and return, and demonstrated the superior performance of alternative/renewable energy investments compared to traditional energy investments during the period analyzed. These findings were substantiated through a rigorous methodological framework, utilizing advanced econometric models, and a thorough analysis of investment strategies and portfolio performances.

Both traditional and alternative/renewable energy ETFs exhibit non-normal return distributions characterized by volatility clustering and leptokurtosis. This suggests a tendency for high-volatility events to cluster together, and for

the returns to have fat tails, indicating a higher likelihood of extreme returns than would be predicted by a normal distribution. The study indicates distinct volatility profiles within each ETF category. Traditional energy ETFs, which include assets in natural gas and petroleum markets, generally showed higher volatility levels compared to alternative/renewable energy ETFs. The GARCH parameters for both ETF categories showed significant and persistent volatility. The α coefficients, though relatively small, indicated that past shocks do impact current volatility. The β coefficients, close to 1 for most ETFs, suggest that volatility is highly persistent, meaning that once the level of volatility changes, these changes are likely to continue into the future.

The VAR-ADCC-GARCH methodology provides evidence of dynamic correlations, with significant theta parameters suggesting a high level of persistence in correlations, especially between traditional and alternative/renewable energy ETFs. This means that market shocks and volatility tend to have lasting impacts on the correlations between these assets. Except for the OIH – ERTH pair, all ETF pairs met the stability condition, meaning that the dynamic correlations between the ETFs are stable over time. This provides a measure of predictability and stability for investors using these correlations to inform their asset allocation decisions. The significance of theta (2) across many pairs reveals the notable impact of latent variables on ETF correlations. These latent variables likely represent broader economic or policy-related factors that simultaneously affect the energy sector.

The alternative/renewable energy ETFs showed higher returns than traditional energy ETFs, according to the study's findings. This is consistent with broader market trends and investor preference shifts towards sustainable energy. Investment strategies, particularly those applied to alternative/renewable energy ETFs, significantly affected the returns. The mean-variance strategy without short-selling constraints was especially effective, leading to higher returns and outperformance over the naïve strategy. The research indicates that alternative/renewable energy ETFs not only provide potentially higher returns but also offer a different risk profile compared to traditional energy ETFs. The dynamic nature of correlations and volatilities, as revealed through the GARCH and VAR-ADCC-GARCH models, underscores the complexity of managing portfolios in these sectors and highlights the importance of advanced statistical models for portfolio construction and risk assessment.

Alternative/renewable energy ETFs demonstrated superior risk-adjusted returns compared to traditional energy ETFs, particularly under the mean-variance portfolio strategy without short-selling constraints. The Sharpe ratios were significantly higher for alternative/renewable ETFs, indicating more efficient risk management in relation to the expected return. Portfolio performance

was generally better without short-selling constraints. The ability to short-sell within the portfolios allowed for a more flexible strategy that could capitalize on negative market movements, leading to an improved Sharpe ratio. The portfolio weights varied significantly depending on the investment strategy and the presence or absence of short-selling constraints. Negative weights in some portfolios suggest a strategic position taken to short-sell underperforming ETFs to enhance overall portfolio performance. The alternative/renewable energy sector not only outperformed the traditional energy sector but also provided strong positive Sharpe ratios, which supports the market trend towards sustainable and green energy sources.

The study points out that diversification across traditional and alternative/renewable energy ETFs can optimize the risk and return profile of investment portfolios. Insights from the VAR-ADCC-GARCH analysis can aid in strategic asset allocation, taking into account the persistent and dynamic correlations between different market segments. Employing mean-variance optimization techniques, especially without constraints on short-selling, can potentially enhance portfolio performance. This is particularly relevant for alternative/renewable energy ETFs, which have shown to offer the most efficacious risk-adjusted returns in comparison to traditional energy ETFs. In light of these findings, it is evident that alternative/renewable energy investments offer compelling advantages for portfolio diversification and performance enhancement, reflecting broader shifts towards sustainable energy and the importance of considering advanced optimization and risk management techniques in portfolio construction.

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MUNICIPAL BONDS AT BUCHAREST STOCK EXCHANGE: WHAT THE CORRELATIONS ARE REVEALING?

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ABSTRACT. As highlighted by Pop & Georgescu (2024), the Romanian academic literature concerning municipal bonds is sparse, while the investigations regarding the factors that can influence the sub-sovereign bond trading at Bucharest Stock Exchange is quasi non-existent, to the best of authors' knowledge.

The present paper continues the work of Pop & Georgescu (2024) by trying to identify which of the public available information regarding various interest rates and Bucharest Stock Exchange (henceforth BVB) indices returns influence the trading activity of municipal bond market segment.

The correlations presented within this paper imply that the modest profile of municipal bond segment at BVB is related to a relative small number of individual investors that dominate the transactions, using mostly observed data to decided when to trade and what to trade. The scarce correlations that appear in relation with the trading volume and trading value point toward the idea that only a small portion of the listed municipal bonds are owned by individual investors.

Key words: municipal bond, Romania, correlations

JEL Classification: G12

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Introduction and a brief literature review

During the past two decades, the decentralization process that occurred in numerous emerging and frontier economies contributed to the increase of fiscal capabilities for sub-sovereign governments (Mendoza-Velazquez et al., 2023). Therefore, the local (sub-sovereign) administrations and entities garnered access to more diversified and sophisticated debt markets for financing their needs – mainly infrastructure and various other public investments (Bethlendi et al., 2020).

As the recent work of Hutahayan et al. (2023) shows regarding the municipal bond academic literature, USA authors are the most prolific and USA is the most cited country, proving the concentration of most published works concerning sub-sovereign bonds around US market, considered one of the largest in the world with over 50,000 issuers (Bessembinder et al., 2020). Nonetheless, the literature on municipal bonds issued within European Union (EU) is slowly growing (Hutahayan et al., 2023; Pop & Georgescu, 2024). The recent work of Ioannou (2023) presents the Euro-zone notable domestic diversity, based on the analysis of 58 regional and municipal governments under scrutiny.

As highlighted by Pop & Georgescu (2024), the Romanian academic literature concerning municipal bonds is sparse, while the investigations regarding the factors that can influence the sub-sovereign bond trading at Bucharest Stock Exchange is quasi non-existent, to the best of authors' knowledge.

The present paper continues the work of Pop & Georgescu (2024) by trying to identify which of the public available information regarding various interest rates and Bucharest Stock Exchange (henceforth BVB) indices returns influence the trading activity of municipal bond market segment. This paper is concentrating only on the correlations as a first step for a more in-depth analysis. The main research question is: how correlated is the municipal bond trading activity with the public information available regarding various interest rates and indices returns? A secondary research question emerged: how correlated is the municipal bond trading activity with the information that can be derived from the public available information?

To the best of authors' knowledge, no such analysis was performed for Romanian sub-sovereign bonds. Therefore, the paper contributes to the existing knowledge about Romanian municipal bond trading by revealing these correlations.

A brief update of municipal bond sector at BVB for 2023

The data and information presented by Pop & Georgescu (2024) for the period 2001-2022 are here updated for 2023.

Three private municipal bond offerings were registered through BVB system: a) one for the bonds issued by the municipality of Bucharest (PMB30), with the maturity in 2030; this issue was registered in April 2023; b) one for the bonds issued by municipality of Resita, the county residence for Caras-Severin, registered in November 2023 (RES33E); and c) one for the bonds issued by the county of Cluj, registered in December 2023 (CJC33E). The premiere here is represented by the last two municipal bond issues that were denominated in Euros (EUR), can be traded and settled in the same currency. While for corporate segment bonds denominated EUR are available since 2017, and for Treasury segment EUR denominated bonds were introduced in 2020, the municipal bond segment lagged behind until 2023. The last two issues, RES33E and CJC33E have the maturity in 2033 and were listed starting with the first quarter of 2024.

Only one new municipal bond was listed, increasing the number of listed municipal bonds to 35 at the end of 2023. No municipal bond matured during 2023. The new municipal bond listed was the one issued by the municipality of Bucharest, PMB30. PMB30 bonds have the nominal (face) value of RON 10,000 and have a fixed interest rate. Therefore, the structures presented by Pop & Georgescu (2024) in the figures 16.9 to 16.15 are not significantly changed.

The trading activity involved 16 of the listed issues, similar to 2022, recorded an increase in number of trades by 2.7 times compared with 2022, an increase in trading volume by 1.5 times compared with 2022, but the turnover (trading value) was only 40% of the 2022 turnover. Municipal bond trading value represented only 1.31% of the bond market segment in 2023, and 8.22% of total bond offerings at BVB. Therefore, no important changes occurred within the municipal bond segment trading at BVB during 2023.

Data and methodology

The data for this paper are secondary data and were extracted from publicly available sources: BVB, Romanian National Bank (RNB), and the Ministry of Finance (MoF).

Given the fact that municipal bond segment at BVB does not registered transactions every day and only some of the bond are traded, for the present paper the monthly trading activity was used. Another motive for the use of monthly transaction data is given by the fact that an important amount of information regarding various interest rates, that can be linked to municipal bond trading, are reported monthly.

In order to capture the trading activity of municipal bond segment at BVB, the following six variables were considered (note that BVB municipal bond sector does not have a dedicated index):

a) frequency (the % of trading days within a month), calculated as the ration between the days when trading occurred and the total number of trading days within a month; the data were extracted from BVB daily reports.

b) number of trades for each month, based on data extracted from BVB daily reports.

c) volume (number of traded bonds) for each month, based on data extracted from BVB daily reports.

d) value, in Romanian lei (RON), for each month, based on data extracted from BVB daily reports.

e) percent of traded issues is the ratio calculated between the number of municipal issues for each trading occurred and the total number of listed issues; based on data extracted from BVB daily reports.

f) liquidity based on volume (in percent); this ratio was calculated between the traded volume and the total outstanding volume for municipal bonds for each month; since the majority of listed municipal bonds (68 of 75) were amortized bonds, the liquidity based on value was to difficult to compute and the liquidity based on volume was chosen instead.

Two periods were considered: a) Nov.2001 to Dec.2023, the entire period of municipal bond segment existence; and b) July 2007 to Dec.2023 the period for which the Ministry of Finance made available the yield curves for Treasury bills and bonds.

The following interest rates and index returns were taken into consideration as potential influencing factors for municipal bond trading, for both periods:

1. the monthly average of listed bond interest rate, calculated based on BVB data for the outstanding bonds.

2. the monthly inflation rate (annualized) as reported by RNB in monthly bulletins.

3. the inter-bank interest rates ROBID – ROBOR provided by RNB via its interactive data base (https://www.bnr.ro/Baza-de-date-interactiva-604.aspx), where the data are reported daily. The monthly average was calculated for: 3.1. ROBID overnight and ROBOR overnight (as proxy for very short term decisions); 3.2. ROBID for 3 months (ROBID 3M) and ROBOR for 3 months (ROBOR 3M); 3.3. ROBID for 6 months (ROBID 6M) and ROBOR for 6 months (ROBOR 6M); 3.4. ROBID for 12 months (ROBID 12M) and ROBOR for 12 months (ROBOR 12M) as a proxy for 1 year horizon decisions; 3.5. the simple average for ROBID 3M

and ROBOR 3M due to the fact that this average is the base for calculating the interest rate of 37 municipal bond issues; 3.6. the simple average for ROBID 6M and ROBOR 6M due to the fact that this average is the base for calculating the interest rate of 22 municipal bond issues.

4. the credit interest rate for non-banking clients as reported by RNB in monthly bulletins.

5. the savings interest rate for non-banking clients as reported by RNB in monthly bulletins.

6. the T-bills average yield as reported by RNB in monthly bulletins; these instruments are discounted T-bills.

7. the T-bonds average interest rate as reported by RNB in monthly bulletins.

8. the annualized monthly returns for the following indices reported by BVB: BET index, BET-C/Plus index, and BET-Fi index. BET (Bucharest Exchange Trading) is the oldest BVB index including in its portfolio the best companies; BET-C/Plus is the former BET-Composite index, currently BET-Plus; it used to include almost all BVB companies; currently is the index with the largest portfolio of companies listed at BVB; BET-Fi or BET-Financial is a sector index that comprises the 6 closed-end funds listed on BVB main market.

For the period July 2007 – Dec.2023, the following new series of data were added:

9. The yields for <1year, 3 years, 5 years, and 10 years as reported within the monthly reports of MoF

10. the annualized monthly returns for the following indices reported by BVB: ROTX, and index developed by BVB and Wiener Borse AG, reflecting the BVB blue chips and serving as underlying asset for various derivatives at Vienna Stock Exchange; BET-XT or BET extended which is a combination between BET and BET-Fi index; and BET-NG a sector index dedicated to the companies related to the energy sector. This 3 indices were all launched after February 2005.

For both periods the following premiums were calculated:

i) the premium (+/-) of average interest rate of municipal bonds over all the other inflation, interest rates, and returns presented above.

ii) the premium (+/-) of all the considered interest rates over the monthly inflation rate; the monthly inflation rate was used as a proxy for a reference interest rate.

iii) the premium (+/-) of all the considered interest rates over T-bills average yield; the T-bills average yield was used as a proxy for the risk-free rate.

For the period July 2007 – Dec.2003 a fourth premium was introduced: iv) the premium (+/-) of all the considered interest rates over the yield for <1 year; the yield for <1 year maturities was also used as a proxy for the risk free rate. It must be specify that since July 2007 when MoF started reporting this yield, no yield for 3 months was announced.

For both periods, the monthly variations (expressed in percentages) of all the series were also calculated.

The descriptive statistics for the data series are available in Annex 1.

The correlation coefficients were calculated using JASP program. For the significant correlation coefficients the following degrees of strength (see Table 1) would be used within this paper.

Table 1. Degrees of strength for significant correlation coefficients

Correlation intervals	Degree of strength
Between -0.199 and 0 & 0 and +0.199	Very weak
Between -0.349 and -0.200 & +0.200 and +0.349	Weak
Between -0.499 and -0.350 & +0.350 and +0.499	Weak to moderate
Between -0.650 and -0.500 & +0.500 and +0.650	Moderate

Source: authors compilation

Findings and discussions

Period Nov.2001 to Dec.2023

Table 2, below, presents the significant correlation coefficients at a confidence level of 95% and down to 90%.

Table 2. The correlation coefficients for the municipal bond segment trading activity (observed values) between Nov.2001 and Dec.2023

	Frequency (% of trading days)	No. of trades	Trading volume	Trading value	Percent of traded issues	Liquidity (based on volume)
Observed data series						
Listed muni.bonds average interest rate p-value	-0.438 <0.001	-0.312 <0.001	NS*	NS	NS	NS
Monthly inflation rate p-value	-0.187 0.002	NS	NS	NS	0.105 0.086	NS
ROBID overnight p-value	-0.392 <0.001	-0.271 <0.001	NS	NS	NS	NS
ROBID 3M p-value	-0.413 <0.001	-0.286 <0.001	NS	NS	NS	NS
ROBID 6M p-value	-0.404 <0.001	-0.278 <0.001	NS	NS	NS	NS

	Frequency (% of trading days)	No. of trades	Trading volume	Trading value	Percent of traded issues	Liquidity (based on volume)
ROBID 12M	-0.391	-0.267	NS	NS	NS	NS
p-value	<0.001	<0.001				
ROBOR overnight	-0.408	-0.289	NS	NS	NS	NS
p-value	<0.001	<0.001				
ROBOR 3M	-0.427	-0.303	NS	NS	NS	NS
p-value	<0.001	<0.001				
ROBOR 6M	-0.428	-0.305	NS	NS	NS	NS
p-value	<0.001	<0.001				
ROBOR 12M	-0.418	-0.297	NS	NS	NS	NS
p-value	<0.001	<0.001				
(ROBID3M+ROBOR3M)/2	-0.421	-0.295	NS	NS	NS	NS
p-value	<0.001	<0.001				
(ROBID6M+ROBOR6M)/2	-0.418	-0.293	NS	NS	NS	NS
p-value	<0.001	<0.001				
Credits interest rates (non-banking clients)	-0.500	-0.376	NS	NS	NS	NS
p-value	<0.001	<0.001				
Savings interest rates (non-banking clients)	-0.417	-0.282	NS	-0.104	NS	NS
p-value	<0.001	<0.001		0.091		
T-bills average yield	-0.408	-0.289	NS	-0.105	NS	NS
p-value	<0.001	<0.001		0.088		
T-bonds average interest rate	-0.378	-0.232	NS	NS	NS	0.119
p-value	<0.001	<0.001				0.053
BET monthly returns	-0.110	NS	NS	NS	NS	NS
p-value	0.075					
BET-C/Plus monthly returns	-0.115	NS	NS	NS	NS	NS
p-value	0.061					
BET-Fi monthly returns	NS	NS	NS	NS	NS	NS
p-value						

Premium (+/-) of average muni.bonds interest rate over various rates

Muni.bonds interest rate – monthly inflation rate	-0.211	-0.185	NS	NS	NS	NS
p-value	<0.001	0.002				
Muni.bonds interest rate – ROBID overnight	-0.351	-0.270	NS	NS	-0.131	NS
p-value	<0.001	<0.001			0.033	
Muni.bonds interest rate – ROBID 3M	-0.349	-0.280	NS	NS	-0.106	NS
p-value	<0.001	<0.001			0.085	
Muni.bonds interest rate – ROBID 6M	-0.394	-0.313	NS	NS	-0.113	NS
p-value	<0.001	<0.001			0.066	
Muni.bonds interest rate – ROBID 12M	-0.421	-0.335	NS	NS	-0.127	NS
p-value	<0.001	<0.001			0.039	
Muni.bonds interest rate – ROBOR overnight	-0.137	-0.106	NS	NS	-0.158	NS
p-value	0.025	0.083			0.010	
Muni.bonds interest rate – ROBOR 3M	NS	NS	NS	NS	-0.140	NS
p-value					0.022	

	Frequency (% of trading days)	No. of trades	Trading volume	Trading value	Percent of traded issues	Liquidity (based on volume)
Muni.bonds interest rate – ROBOR 6M p-value	NS	NS	NS	NS	-0.143 0.020	NS
Muni.bonds interest rate – ROBOR 12M p-value	-0.124 0.044	NS	NS	NS	-0.185 0.002	NS
Muni.bonds interest rate – (Robid3M-Robor3M)/2 p-value	-0.231 <0.001	-0.189 0.002	NS	NS	-0.133 0.030	NS
Muni.bonds interest rate – (Robid6M-Robor6M)/2 p-value	-0.282 <0.001	-0.224 <0.001	NS	NS	-0.138 0.024	NS
Muni.bonds interest rate – credits interest rates p-value	0.517 <0.001	0.479 <0.001	NS	NS	0.172 0.005	NS
Muni.bonds interest rate – savings interest rates p-value	-0.377 <0.001	-0.291 <0.001	NS	NS	NS	NS
Muni.bonds interest rate – T-bills average yield p-value	-0.322 <0.001	-0.238 <0.001	NS	NS	NS	0.136 0.026
Muni.bonds interest rate – T-bonds average interest p-value	-0.281 <0.001	-0.234 <0.001	NS	NS	NS	NS
Muni.bonds interest rate – BET returns p-value	NS	NS	NS	NS	NS	NS
Muni.bonds interest rate – BET-C/Plus returns p-value	NS	NS	NS	NS	NS	NS
Muni.bonds interest rate – BET-Fi returns p-value	NS	NS	NS	NS	NS	NS

Premiums (+/-) of various rates over the monthly inflation rate

ROBID overnight – monthly inflation rate (MIR) p-value	-0.105 0.086	-0.106 0.085	NS	NS	NS	NS
ROBID 3M – monthly inflation rate p-value	-0.144 0.018	-0.133 0.030	NS	NS	NS	NS
ROBID 6M – monthly inflation rate p-value	-0.130 0.034	-0.122 0.047	NS	NS	NS	NS
ROBID 12M – monthly inflation rate p-value	-0.115 0.062	-0.110 0.074	NS	NS	NS	NS
ROBOR overnight – monthly inflation rate p-value	-0.182 0.003	-0.163 0.008	NS	NS	NS	NS
ROBOR 3M – monthly inflation rate p-value	-0.212 <0.001	-0.185 0.003	NS	NS	NS	NS

	Frequency (% of trading days)	No. of trades	Trading volume	Trading value	Percent of traded issues	Liquidity (based on volume)
ROBOR 6M – monthly inflation rate p-value	-0.208 <0.001	-0.183 0.003	NS	NS	NS	NS
ROBOR 12M – monthly inflation rate p-value	-0.196 0.001	-0.175 0.004	NS	NS	NS	NS
(ROBID3M+ROBOR3M)/2 – MIR p-value	-0.180 0.003	-0.160 0.009	NS	NS	NS	NS
(ROBID6M+ROBOR6M)/2 – MIR p-value	-0.171 0.005	-0.154 0.012	NS	NS	NS	NS
Credits interest rates (non-banking clients) – MIR p-value	-0.289 <0.001	-0.257 <0.001	NS	NS	-0.112 0.067	NS
Savings interest rates (non-banking clients) – MIR p-value	NS	NS	NS	NS	NS	NS
T-bills average yield – monthly inflation rate p-value	-0.155 0.012	-0.145 0.018	NS	NS	NS	NS
T-bonds average interest rate – MIR p-value	NS	NS	NS	NS	-0.131 0.033	NS
BET monthly returns – monthly inflation rate p-value	-0.104 0.091	NS	NS	NS	NS	NS
BET-C/Plus monthly returns – MIR p-value	-0.107 0.080	NS	NS	NS	NS	NS
BET-Fi monthly returns – monthly inflation rate p-value	NS	NS	NS	NS	NS	NS

Premiums (+/-) of various rates over the T-bills average yield

ROBID overnight – T-bills average yield (T-bAY) p-value	0.203 <0.001	0.164 0.007	NS	NS	0.130 0.035	NS
ROBID 3M – T-bills average yield p-value	NS	0.106 0.084	NS	NS	NS	NS
ROBID 6M – T-bills average yield p-value	0.211 <0.001	0.197 0.001	NS	0.107 0.081	0.119 0.052	NS
ROBID 12M – T-bills average yield p-value	0.304 <0.001	0.269 <0.001	NS	0.116 0.058	0.153 0.013	NS
ROBOR overnight – T-bills average yield p-value	-0.150 0.015	-0.106 0.085	NS	NS	0.121 0.049	NS
ROBOR 3M – T-bills average yield p-value	-0.333 <0.001	-0.238 <0.001	NS	NS	NS	0.145 0.018
ROBOR 6M – T-bills average yield p-value	-0.348 <0.001	-0.255 <0.001	NS	NS	NS	0.151 0.014
ROBOR 12M – T-bills average yield p-value	-0.293 <0.001	-0.215 <0.001	NS	NS	0.121 0.048	0.148 0.016
(ROBID3M+ROBOR3M)/2 – T-bAY p-value	-0.188 0.002	-0.115 0.061	NS	NS	NS	0.128 0.037

	Frequency (% of trading days)	No. of trades	Trading volume	Trading value	Percent of traded issues	Liquidity (based on volume)
(ROBID6M+ROBOR6M)/2 – T-bAY	-0.137	NS	NS	NS	0.113	0.134
p-value	0.025				0.066	0.028
Credits interest rates (non-banking clients) – T-bAY	-0.507	-0.429	NS	NS	-0.134	0.107
p-value	<0.001	<0.001			0.028	0.080
Savings interest rates (non-banking clients)– T-bAY	0.279	0.222	NS	NS	NS	NS
p-value	<0.001	<0.001				
T-bonds average interest rate – T-bAY	0.210	0.178	NS	NS	NS	NS
p-value	<0.001	0.004				
BET monthly returns – T-bAY	NS	NS	NS	NS	NS	NS
p-value						
BET-C/Plus monthly returns – T-bAY	-0.101	NS	NS	NS	NS	NS
p-value	0.099					
BET-Fi monthly returns – T-bAY	NS	NS	NS	NS	NS	NS
p-value						

Note*: NS means not significant correlation
Source: authors' calculation using JASP

As it can be observed from Table 2, above, for the majority of observed data series there exists a weak to moderate negative correlation with the frequency (% of trading days). A moderate negative correlation is registered in relation with the credit interest rates (-0.500), while a very weak negative correlation (-0.187) appears in relation with the monthly inflation. Further, the majority of observed data series have a weak negative correlation with the number of trades. Like in the case of frequencies, credit interest rates have a stronger influence (a weak to moderate negative correlation of -0.376), while the monthly inflation rate does not have any influence. One must note the appearance of two very weak correlations with the traded value, though these correlations have a confidence level between 90% and 95%.

The negative correlation might be explained by the inversely proportional relation between the price of a bond and almost any rate/return considered for calculation. It seems that this relation was transferred in the calculated correlations.

In the case of municipal bond interest rates premium over the other interest rates/returns, significant correlations exists in the case of frequency (% of trading days), number of trades, and percent of traded issues. An isolated very weak positive correlation exists between liquidity and the premium of municipal bonds interest rate over T-bills average yield. In the case of frequency, the majority of correlations are negative and weak or weak to moderate, while in

two cases are very weak. The following exceptions must be noted: the moderate positive correlation in the case of municipal bonds interest premium over credit interest rates (+0.517) and the absence of significant correlations in the case of the municipal bonds interest premiums over ROBOR 3M and ROBOR 6M. Also in the case of number of trades, the majority of the correlations are negative and weak and very weak in two cases. The exception of the weak to moderate positive correlation between the municipal bonds interest premium over credit interest rates (+0.479) persist, while the absence of correlation appears for ROBOR 3M, 6M, and 12M. For the percent of traded issues, the majority of reported correlations are negative and very weak, with the persistent positive (but very weak) correlation in the case of municipal bonds interest premium over credit interest rates.

In the case of premiums of various rates/returns over the monthly inflation rate, the correlations are concentrated (similar with the observed data) on frequency and number of trades. In both cases, the majority of correlations are negative and very weak, with the exceptions in the case of credit interest rates premiums over monthly inflation rate which are negative and week (-0.289 for frequency and -0.257 for number of trades. Two random negative and very weak correlations appear for the percent of traded issues.

In the case of premiums of various rates/returns over the T-bills average yield, one can observe that the highest number of correlations occurred. Correlation were not only registered in the case of frequency and number of trades, but also in the case of percent of traded issues and liquidity. In the case of frequency and number of trades, a mix of negative and positive very weak and weak correlations are registered, with the exception of negative and moderate of -0.507 (for frequency) and weak to moderate of -0.429 (for number of trades) in the case of credit interest rate premium over T-bills average yield. In the cases of percent of traded issues and liquidity, the majority of correlations are positive and very weak. One must note the appearance of two very weak correlations with the traded value, though these correlations have a confidence level between 90% and 95%.

For the monthly variations of the series of data, the correlation coefficients significant at 95% and down to 90% confidence levels are presented in Table 3, below:

Table 3. The correlation coefficients for the municipal bond segment trading activity for the monthly variations, period Nov.2001-Dec.2023

	Frequency (% of trading days)	No. of trades	Trading volume	Trading value	Percent of traded issues	Liquidity (based on volume)
Monthly variations of observed data series						
ROBID overnight p-value	NS	-0.110 0.073	NS	NS	NS	NS
ROBOR overnight p-value	-0.111 0.072	-0.123 0.046	NS	NS	NS	NS
T-bonds average interest rate p-value	NS	NS	0.336 <0.001	0.246 <0.001	NS	0.336 <0.001
Monthly variations of premium of average muni.bonds interest rate over various rates						
Muni.bonds interest rate – ROBID 6M p-value	NS	-0.153 0.012	NS	NS	-0.123 0.046	NS
Muni.bonds interest rate – ROBID 12M p-value	NS	-0.130 0.034	NS	NS	-0.126 0.040	NS
Muni.bonds interest rate – BET-C/Plus returns p-value	NS	NS	NS	NS	0.124 0.043	NS
Monthly variations of premiums of various rates over the monthly inflation rate						
ROBOR 3M – monthly inflation rate p-value	NS	-0.116 0.060	NS	NS	NS	NS
BET monthly returns – monthly inflation rate p-value	NS	NS	NS	NS	0.311 <0.001	NS
BET-C/Plus monthly returns – MIR p-value	NS	NS	NS	-0.189 0.002	NS	NS
Monthly variations of Premiums of various rates over the T-bills average yield						
ROBID overnight – T-bills average yield (T-bAY) p-value	NS	0.120 0.051	NS	NS	NS	NS
ROBID 3M – T-bills average yield p-value	NS	-0.148 0.016	NS	NS	NS	NS
ROBID 6M – T-bills average yield p-value	NS	0.127 0.039	NS	NS	NS	NS
ROBOR 12M – T-bills average yield p-value	NS	NS	NS	-0.102 0.099	NS	NS

Note*: NS means not significant correlation
Source: authors' calculation using JASP

As presented in Table 3, above, the correlation for monthly variations of data series are few and for the majority of cases are a mix of positive and negative and very weak and in 3 cases the confidence level is between 90% and

905%. The only exceptions occur in the cases of a)T-bonds average interest rates which have a positive weak correlation with the trading volume, trading value, and liquidity; and b) premium of BET over monthly inflation rate which has a positive weak correlation with the percent of traded issues.

For both Tables 2 and 3, the very weak correlation with a confidence level lower than 95% but higher than 90% are difficult to interpret since they seem to appear randomly. They were reported for highlighting rather the curious pattern of they occurrence.

Period Jul.2007 to Dec.2023

Table 4, below, presents the significant correlation coefficients at a confidence level of 95% and down to 90%.

Table 4. The correlation coefficients for the municipal bond segment trading activity (observed values) between Jul.2007 and Dec.2023

	Frequency (% of trading days)	No. of trades	Trading volume	Trading value	Percent of traded issues	Liquidity (based on volume)
Observed data series						
Listed muni.bonds average interest rate p-value	-0.250 <0.001	NS*	NS	NS	NS	NS
Monthly inflation rate p-value	NS	NS	NS	NS	NS	NS
ROBID overnight p-value	-0.167 0.019	NS	NS	NS	0.218 0.002	NS
ROBID 3M p-value	-0.221 0.002	NS	NS	NS	0.168 0.018	NS
ROBID 6M p-value	-0.221 0.002	NS	NS	NS	0.159 0.025	NS
ROBID 12M p-value	-0.213 0.003	NS	NS	NS	0.163 0.021	NS
ROBOR overnight p-value	-0.174 0.014	NS	NS	NS	0.223 0.002	NS
ROBOR 3M p-value	-0.216 0.002	NS	NS	NS	0.181 0.011	NS
ROBOR 6M p-value	-0.237 <0.001	NS	NS	NS	0.156 0.028	NS
ROBOR 12M p-value	-0.231 0.001	NS	NS	NS	0.160 0.024	NS
(ROBID3M+ROBOR3M)/2 p-value	-0.219 0.002	NS	NS	NS	0.175 0.014	NS
(ROBID6M+ROBOR6M)/2 p-value	-0.230 0.001	NS	NS	NS	0.158 0.026	NS

	Frequency (% of trading days)	No. of trades	Trading volume	Trading value	Percent of traded issues	Liquidity (based on volume)
Credits interest rates (non-banking clients) p-value	-0.388 <0.001	-0.215 0.002	NS	NS	NS	NS
Savings interest rates (non-banking clients) p-value	-0.278 <0.001	NS	NS	NS	NS	NS
T-bills average yield p-value	-0.263 <0.001	NS	NS	-0.122 0.086	NS	NS
T-bonds average interest rate p-value	-0.247 <0.001	NS	NS	NS	NS	NS
BET monthly returns p-value	NS	NS	NS	NS	NS	NS
BET-C/Plus monthly returns p-value	NS	NS	NS	NS	NS	NS
BET-Fi monthly returns p-value	NS	NS	NS	NS	NS	NS
Yield <1 year p-value	-0.254 <0.001	NS	NS	-0.123 0.085	NS	NS
Yield 3 years p-value	-0.260 <0.001	NS	NS	NS	NS	NS
Yield 5 years p-value	-0.245 <0.001	NS	NS	NS	NS	NS
Yield 10 years p-value	-0.256 <0.001	NS	NS	NS	NS	NS
ROTX monthly returns p-value	NS	NS	NS	NS	NS	NS
BET-XT monthly returns p-value	NS	NS	NS	NS	NS	NS
BET-NG monthly returns p-value	NS	NS	NS	NS	NS	NS
Premium (+/-) of average muni.bonds interest rate over various rates						
Muni.bonds interest rate – monthly inflation rate p-value	NS	NS	NS	NS	NS	NS
Muni.bonds interest rate – ROBID overnight p-value	-0.348 <0.001	-0.292 <0.001	NS	NS	-0.214 0.002	NS
Muni.bonds interest rate – ROBID 3M p-value	0.416 <0.001	0.355 <0.001	NS	NS	0.134 0.060	NS
Muni.bonds interest rate – ROBID 6M p-value	NS	NS	NS	NS	NS	NS
Muni.bonds interest rate – ROBID 12M p-value	-0.123 0.085	-0.124 0.081	NS	NS	NS	NS
Muni.bonds interest rate – ROBOR overnight p-value	-0.167 0.019	-0.125 0..080	NS	NS	-0.281 <0.001	NS

	Frequency (% of trading days)	No. of trades	Trading volume	Trading value	Percent of traded issues	Liquidity (based on volume)
Muni.bonds interest rate – ROBOR 3M p-value	NS	NS	NS	NS	-0.209 0.003	NS
Muni.bonds interest rate – ROBOR 6M p-value	0.247 <0.001	0.191 0.007	NS	NS	NS	NS
Muni.bonds interest rate – ROBOR 12M p-value	0.177 0.013	0.119 0.095	NS	NS	0.331 <0.001	NS
Muni.bonds interest rate – (Robid3M-Robor3M)/2 p-value	-0.266 <0.001	-0.192 0.007	NS	NS	-0.123 0.085	NS
Muni.bonds interest rate – (Robid6M-Robor6M)/2 p-value	-0.125 0.079	NS	NS	NS	NS	NS
Muni.bonds interest rate – credits interest rates p-value	0.631 <0.001	0.580 <0.001	NS	NS	0.503 <0.001	NS
Muni.bonds interest rate – savings interest rates p-value	0.261 <0.001	0.236 <0.001	NS	NS	NS	NS
Muni.bonds interest rate – T-bills average yield p-value	NS	NS	NS	NS	NS	NS
Muni.bonds interest rate – T-bonds average interest p-value	NS	NS	NS	NS	NS	NS
Muni.bonds interest rate – BET returns p-value	NS	NS	NS	NS	NS	NS
Muni.bonds interest rate – BET-C/Plus returns p-value	NS	NS	NS	NS	NS	NS
Muni.bonds interest rate – BET-Fi returns p-value	NS	NS	NS	NS	NS	NS
Muni.bonds interest rate – Yield <1 year p-value	NS	NS	NS	NS	NS	NS
Muni.bonds interest rate – Yield 3 years p-value	-0.123 0.085	NS	NS	NS	NS	NS
Muni.bonds interest rate – Yield 5 years p-value	-0.177 0.013	NS	NS	NS	NS	NS
Muni.bonds interest rate – Yield 10 years p-value	-0.189 0.008	NS	NS	NS	0.141 0.047	NS
Muni.bonds interest rate – ROTX returns p-value	NS	NS	NS	NS	NS	NS
Muni.bonds interest rate – BET-XT returns p-value	NS	NS	NS	NS	NS	NS

	Frequency (% of trading days)	No. of trades	Trading volume	Trading value	Percent of traded issues	Liquidity (based on volume)
Muni.bonds interest rate – BET-NG returns p-value	NS	NS	NS	NS	NS	NS
Premiums (+/-) of various rates over the monthly inflation rate						
Credits interest rates (non-banking clients) – MIR p-value	-0.137 0.054	-0.141 0.048	NS	NS	NS	NS
Premiums (+/-) of various rates over the T-bills average yield						
ROBID overnight – T-bills average yield (T-bAY) p-value	0.328 <0.001	0.244 <0.001	0.126 0.077	0.145 0.042	0.320 <0.001	0.134 0.060
ROBID 3M – T-bills average yield p-value	0.161 0.024	0.146 0.040	0.145 0.042	0.158 0.026	0.332 <0.001	0.174 0.014
ROBID 6M – T-bills average yield p-value	0.206 0.004	0.193 0.007	0.162 0.023	0.179 0.012	0.332 <0.001	0.187 0.008
ROBID 12M – T-bills average yield p-value	0.263 <0.001	0.246 <0.001	0.160 0.025	0.184 0.01	0.353 <0.001	0.180 0.011
ROBOR overnight – T-bills average yield p-value	0.206 0.004	0.162 0.022	NS	NS	0.324 <0.001	0.128 0.072
ROBOR 3M – T-bills average yield p-value	NS	NS	NS	NS	0.327 <0.001	0.141 0.048
ROBOR 6M – T-bills average yield p-value	NS	NS	NS	NS	0.245 <0.001	0.139 0.050
ROBOR 12M – T-bills average yield p-value	NS	NS	NS	NS	0.263 <0.001	0.139 0.051
(ROBID3M+ROBOR3M)/2 – T-bAY p-value	NS	NS	NS	NS	0.348 <0.001	0.163 0.022
(ROBID6M+ROBOR6M)/2 – T-bAY p-value	NS	NS	NS	NS	0.295 <0.001	0.167 0.019
Credits interest rates (non-banking clients) – T-bAY p-value	-0.421 <0.001	-0.381 <0.001	NS	NS	-0.348 <0.001	NS
Savings interest rates (non-banking clients)–T-bAY p-value	-0.155 0.030	-0.131 0.066	NS	NS	NS	NS
T-bonds average interest rate – T-bAY p-value	0.246 <0.001	NS	0.139 0.051	0.164 0.021	NS	NS
BET monthly returns – T-bAY p-value	NS	NS	NS	NS	NS	NS
BET-C/Plus monthly returns – T-bAY p-value	NS	NS	NS	NS	NS	NS
BET-Fi monthly returns – T-bAY p-value	NS	NS	NS	NS	NS	NS

	Frequency (% of trading days)	No. of trades	Trading volume	Trading value	Percent of traded issues	Liquidity (based on volume)
Yield <1 year – T-bAY	0.120	0.126	NS	NS	NS	NS
p-value	0.093	0.077				
Yield 3 years – T-bAY	0.184	NS	0.185	0.178	-0.136	0.135
p-value	0.010		0.009	0.012	0.056	0.058
Yield 5 years – T-bAY	0.240	NS	NS	NS	-0.120	NS
p-value	<0.001				0.093	
Yield 10 years – T-bAY	0.227	NS	NS	0.133	-0.163	NS
p-value	0.001			0.062	0.021	
ROTX monthly returns – T-bAY	NS	NS	NS	NS	NS	NS
p-value						
BET-XT monthly returns – T-bAY	NS	NS	NS	NS	NS	NS
p-value						
BET-NG monthly returns – T-bAY	NS	NS	NS	NS	NS	NS
p-value						
Premiums (+/-) of various rates over the Yield <1 year						
ROBID overnight – Yield <1 year	0.243	0.155	NS	0.118	0.387	0.135
p-value	<0.001	0.029		0.096	<0.001	0.059
ROBID 3M – Yield <1 year	NS	NS	NS	NS	0.352	0.142
p-value					<0.001	0.046
ROBID 6M – Yield <1 year	NS	NS	NS	NS	0.347	0.143
p-value					<0.001	0.044
ROBID 12M – Yield <1 year	NS	NS	NS	NS	0.365	0.139
p-value					<0.001	0.051
ROBOR overnight – Yield <1 year	0.129	NS	NS	NS	0.355	0.121
p-value	0.069				<0.001	0.089
ROBOR 3M – Yield <1 year	NS	NS	NS	NS	0.330	0.118
p-value					<0.001	0.099
ROBOR 6M – Yield <1 year	NS	NS	NS	NS	0.261	NS
p-value					<0.001	
ROBOR 12M – Yield <1 year	NS	NS	NS	NS	0.275	NS
p-value					<0.001	
(ROBID3M+ROBOR3M)/2 – Yield <1 year	NS	NS	NS	NS	0.350	0.132
p-value					<0.001	0.065
(ROBID6M+ROBOR6M)/2 – Yield <1 year	NS	NS	NS	NS	0.304	0.130
p-value					<0.001	0.069
Credits interest rates (non-banking clients) – Yield <1year	-0.486	-0.449	NS	NS	-0.289	NS
p-value	<0.001	<0.001			<0.001	
Savings interest rates (non-banking clients) – Yield <1year	-0.223	-0.205	NS	NS	NS	NS
p-value	0.002	0.004				
T-bills average yield – Yield <1 year	-0.120	-0.126	NS	NS	NS	NS
p-value	0.093	0.077				

	Frequency (% of trading days)	No. of trades	Trading volume	Trading value	Percent of traded issues	Liquidity (based on volume)
T-bonds average interest rate – Yield <1 year p-value	0.140 0.049	NS	NS	0.128 0.072	NS	NS
BET monthly returns – Yield <1 year p-value	NS	NS	NS	NS	NS	NS
BET-C/Plus monthly returns – Yield <1 year p-value	NS	NS	NS	NS	NS	NS
BET-Fi monthly returns – Yield <1 year p-value	NS	NS	NS	NS	NS	NS
Yield 3 years – Yield <1 year p-value	NS	NS	0.184 0.010	0.163 0.022	NS	0.153 0.032
Yield 5 years – Yield <1 year p-value	0.171 0.016	NS	NS	NS	NS	NS
Yield 10 years – Yield <1 year p-value	0.191 0.007	NS	NS	0.129 0.070	-0.127 0.075	NS
ROTX monthly returns – Yield <1 year p-value	NS	NS	NS	NS	NS	NS
BET-XT monthly returns – Yield <1 year p-value	NS	NS	NS	NS	NS	NS
BET-NG monthly returns – Yield <1 year p-value	NS	NS	NS	NS	NS	NS

Note*: NS means not significant correlation
Source: authors' calculation using JASP

For the observed data series, for the new period, the correlations appear in the case of frequency and percent of traded issues, while there are no significant correlations (with the exception of credit interest rates case) for the number of trades, the main difference compared with the period Nov.2001-Dec.2023. In the case of frequencies the majority of correlations are negative and weak, with the exception of a negative and weak to moderate correlation in the case of credit interest rates, and the negative and very weak correlation in the case of ROBID overnight. One also must note the absence of correlation in the case of monthly inflation rate. In the case of percent of traded issues all the correlation are positive, most of them very weak and, in two cases, weak. Similar with the situation for the period Nov.2001-Dec.2003, two very weak correlations appear for value, but at a confidence level between 90% and 95%. It is worth pointing out that yields communicated by the MoF are in the range of negative and weak correlations related only to frequency.

In the case of premiums of municipal bond rates over various rates/ returns, the situation up to a point similar with results the period Nov.2001-Dec.2023, with correlations appearing mostly for frequency, number of trades, and percent of traded issues. However, the main differences are generated by a mix of positive and negative correlations, while for the period Nov.2001-Dec.2023 the majority of the correlations were negative. In the majority of cases for Jul.2007-Dec.2003 the correlations are very weak and weak, the only notable exception occurring in the case of the premium of municipal bond rates over credit interest rates which shows moderate correlations for frequency (0.631), for the number of trades (0.580), and for percent of traded issues (0.507). One must highlight that the yields communicated by MoF either have no correlation with the municipal bond trading activity (for yield <1 year) or the correlation is very weak and only in the case of frequency. Further, the absence of correlation in the case of premium of municipal bond interest rates over monthly inflation deserves to be mentioned.

In the case of premiums of various rates over monthly inflation rates, only two very weak correlations occur for the premium of credit interest rates over monthly inflation rates, in line with the case mentioned for the premium of municipal bond interest rates over monthly inflation deserves to be mentioned. It seems that the premiums over monthly inflation rates do not play any role in decisions related to municipal bond trading since July 2007.

For premiums of various rates over T-bills average yield the correlations with the municipal bond trading activity are more numerous, covering all six variables that capture this activity. The most correlated variables are the frequency and the percent of traded issues (a mix of negative and positive correlations, ranging from very weak to weak), followed by number of trades and liquidity (most correlations being weak or very weak and positive). It is worth noting that within this cluster of data the most numerous correlation for trading volume and trading value can be found, though all the correlations are very weak. The premiums of yields reported by MoF have a modest influence over the municipal bond trading activity.

The premiums of various rates/returns over the Yield <1 year are mostly concentrated on frequency and percent of traded issues, while registering some correlations related to the number of trades. In the case of frequency (% of trading days) the correlations are a mix of negative and positive, mostly very weak and weak, with the exception of the negative and weak to moderated correlation (-0.486) of credit interest rates premiums over Yield <1 year. In the case of percent of traded issues, the majority of correlations are positive and either weak or weak to moderates. The only exception is the negative weak correlation (-0.289) for credit interest rates premiums over Yield <1 year.

For the monthly variations of the series of data, the correlation coefficients significant at 95% and down to 90% confidence levels are presented in Table 5, below:

Table 5. The correlation coefficients for the municipal bond segment trading activity for the monthly variations, period Jul.2007-Dec.2023

	Frequency (% of trading days)	No. of trades	Trading volume	Trading value	Percent of traded issues	Liquidity (based on volume)
Monthly variations of observed data series						
ROBID overnight p-value	-0.118 0.099	-0.122 0.087	NS*	NS	NS	NS
ROBOR overnight p-value	-0.126 0.078	-0.135 0.065	NS	NS	NS	NS
T-bonds average interest rate p-value	NS	NS	0.364 <0.001	0.277 <0.001	NS	0.364 <0.001
Yield 3 years p-value	NS	NS	0.449 <0.001	0.287 <0.001	NS	0.449 <0.001
Monthly variations of premium of average muni.bonds interest rate over various rates						
Muni.bonds interest rate – ROBID 3M p-value	NS	-0.208 0.003	NS	NS	NS	NS
Muni.bonds interest rate – ROBID 12M p-value	NS	-0.132 0.064	NS	NS	NS	NS
Muni.bonds interest rate – ROBOR overnight p-value	NS	NS	NS	NS	0.121 0.091	NS
Muni.bonds interest rate – BET-C/Plus returns p-value	NS	NS	NS	0.125 0.081	NS	NS
Monthly variations of premiums of various rates over the monthly inflation rate						
Yield 5 years – monthly inflation rate p-value	0.124 0.082	NS	NS	NS	NS	NS
BET-C/Plus monthly returns – MIR p-value	NS	NS	NS	-0.220 0.002	NS	NS
Monthly variations of premiums of various rates over the T-bills average yield						
ROBID overnight – T-bills average yield (T-bAY) p-value	0.161 0.023	0.204 0.004	NS	NS	NS	NS
ROBID 3M – T-bills average yield p-value	NS	0.139 0.051	NS	NS	NS	NS
ROBOR 12M – T-bills average yield p-value	NS	NS	NS	-0.120 0.092	NS	NS
Yield 3 years – T-bAY p-value	NS	NS	NS	NS	0.143 0.045	NS

	Frequency (% of trading days)	No. of trades	Trading volume	Trading value	Percent of traded issues	Liquidity (based on volume)
Monthly variations of premiums of various rates over the Yield <1 year						
ROBID overnight – Yield <1 year p-value	0.181 0.011	NS	NS	NS	NS	NS
ROBID 6M – Yield <1 year p-value	NS	-0.180 0.011	NS	NS	-0.272 <0.001	NS
ROBID 12M – Yield <1 year p-value	NS	NS	NS	NS	-0.238 <0.001	NS
ROBOR 6M – Yield <1 year p-value	NS	NS	NS	0.162 0.023	NS	NS
ROBOR 12M – Yield <1 year p-value	NS	NS	NS	0.208 0.003	NS	NS
Savings interest rates (non-banking clients) – Yield <1 year p-value	NS	NS	NS	NS	0.119 0.096	NS
T-bonds average interest rate – Yield <1 year p-value	NS	-0.174 0.014	NS	NS	NS	NS

Note*: NS means not significant correlation
Source: authors' calculation using JASP

The results in the Table 5, while showing a slightly increase number of correlations in comparison with the period Nov.2001-Dec.2023, also reveal that most of the correlations are weak or very weak. Only in the case of T-bond average interest rate variation and Yield 3 years variation the correlations with the trading volume and liquidity are moderate to strong, while the correlations with the trading value remain weak.

Conclusions

The research questions were: how correlated is the municipal bond trading activity with the public information available regarding various interest rates and indices returns? A secondary research question emerged: how correlated is the municipal bond trading activity with the information that can be derived from the public available information?

To the first research question the answer is that the correlation is mostly weak and moderate to weak for the period Nov.2001-Dec.2023 and weak for the period Jul.2007-Dec.2023. For the second research questions the answer is that the correlation is varying from very weak to weak to moderate, depending on the information derived from the observed data.

Most of the data used influence mainly the frequency (% of trading days), the number of trades and the percent of traded issues, for both periods under scrutiny.

Also for both periods the premiums of various rates over T-bills average yield generate the highest number of correlations, suggesting that T-bills average yield might play a role as risk free rate for investors.

The results in all the tables above also show that there is almost no relation between the returns exhibited by BVB equity market and municipal bonds market. However, some random weak correlations occurred. These results confirm indirectly the different profiles for investors in equity and municipal bonds.

The weak to very weak influence of the yields communicated by the MoF for T-bills and T-bonds show that this information is relatively ignored by municipal bond investors. The yield <1 year does not seem to play the role of risk free rate. This yield might be ignored due to the fact that until August 2012 the MoF reports mentioned just less than a year and since August 2012 recorded this information as yield at 6 months. The absence of T-bills with the classic maturity at 3 months for risk free rate might also determine MoF reports to be ignored.

All the results presented above point toward that the trading activity within the municipal bond segment is dominated by small, individual investors, that generate a relative small number of trades, trading volume and value. These information are further confirmed by the data in Annex 1a mainly regarding the number of tradings and trading volume which are relatively low, consistent with the dominance of individual investors. Also the data point toward a relative small number of individual investors.

Nonetheless, the credit interest rates, either directly observed or under the form of various premiums have the strongest correlations (often weak to moderate or moderate) with frequency (% of trading days), number of trades and sometime with percent of traded issues. Further investigations are needed to understand why this information seems to influence the presumed individual investors that dominate the trading within municipal bond sector.

The correlations presented within this paper imply that the modest profile of municipal bond segment at BVB is related to a relative small number of individual investors that dominate the transactions, using mostly observed data to decided when to trade and what to trade. The scarce correlations that appear in relation with the trading volume and trading value point toward the idea that only a small portion of the listed municipal bonds are owned by individual investors. Also the trading activity indicates that the institutional investors have the tendency to treasure their bonds. These indirect findings are

in line with Pop & Georgescu (2024) results related to the fact that the majority of municipal bonds are issued via private offerings, results enhanced by the same type of offerings chosen for 2023.

Therefore one can conclude that as long as the municipal bond segment will be dominated by the institutional investors ownership in combination with a limited number of issued bonds, this BVB segment will remain peripheral and low interest for various investors.

Though, it must be added that informal discussions with various intermediaries of Romanian financial market revealed that the municipal bonds are perceived in relation with the political influence/dominance at municipality and county levels and there is a disinclination to recommend these securities to their clients. While this aspect is difficult (and very sensitive) to investigate, these informal discussions are in line with the finding of Vasa et al. (2021) and Vasvari (2020) for Hungary showing that there is a political influence that impacts the access of local administrations to the credit market(s). This situation opens new avenues for research and indicate the need for higher levels of transparency regarding the use of the funds obtained via municipal bond issuance that can counterbalance the shady political influences.

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Annex 1: Descriptive statistics

Annex 1a

	Mean	Median	St.dev.	Minim	Maxim	Q1	Q3	Obs.
Descriptive statistics for the variables representing the trading activity for municipal bond segment for Nov.2001-Dec.2023								
Frequency (%)	29.644	23.810	24.464	0.000	90.909	9.524	45.455	266
No.of trades	16	9	20	0	116	2	21	266
Volume	22,132	1,651	231,400	0	3,748,000	217	6,365	266
Value (RON mil.)	2,380,000	121,311	14,990,000	0	218,600,000	22,128	698,674	266
Percent of traded issues (%)	17.581	16.216	13.369	0.000	100.000	7.692	25.000	266
Liquidity (%)	0.484	0.020	2.380	0.000	33.677	0.004	0.178	266
Descriptive statistics for the variables representing the trading activity for municipal bond segment for Jul.2007-Dec.2023								
Frequency (%)	36.290	34.058	24.387	0.000	90.909	14.464	55.000	198
No.of trades	21	14	22	0	116	5	30	198
Volume	28,024	1,814	267,599	0	3,748,000	416	6,365	198
Value (RON mil.)	3,073,000	130,898	17,320,000	0	218,600,000	37,618	1,037,000	198
Percent of traded issues (%)	17.629	18.421	10.971	0.000	50.000	8.571	24.324	198
Liquidity (%)	0.321	0.018	2.420	0.000	33.677	0.004	0.065	198
Descriptive statistics for the monthly variation of the variables representing the trading activity for municipal bond segment for Nov.2001-Dec.2023								
Frequency (%)	12.895	0.000	79.679	-100.000	354.545	-31.818	30.435	265
No.of trades (%)	41.979	0.000	166.255	-100.000	1,250.000	-50.000	61.538	265
Volume (%)	3,530.818	0.000	41,260.760	-100.000	666,842.705	-72.754	141.538	265
Value (%)	1,627.546	0.000	8,404.551	-100.000	102,843.590	-77.147	194.027	265
Percent of traded issues (%)	13.461	0.000	89.701	-100.000	580.556	-33.333	28.571	265
Liquidity (%)	3,513.675	0.000	41,242.448	-100.000	666,842.705	-72.754	125.503	265
Descriptive statistics for the monthly variation of the variables representing the trading activity for municipal bond segment for Jul.2007-Dec.2023								
Frequency (%)	14.036	0.000	77.262	-100.000	354.545	-30.000	31.250	197
No.of trades	45.019	0.000	169.205	-100.000	1,250.000	-50.000	75.000	197
Volume	4,627.054	0.000	47,822.734	-100.000	666,842.705	-72.754	150.990	197
Value (RON mil.)	1,909.844	0.000	9,196.422	-100.000	102,843.590	-76.402	297.243	197
Percent of traded issues (%)	13.013	0.000	82.470	-100.000	580.556	-27.344	28.571	197
Liquidity (%)	4,599.353	0.000	47,802.262	-100.000	666,842.705	-72.754	150.990	197

Source: authors' calculations using JASP

Annex 1b

	Mean	Median	St.dev.	Minim	Maxim	Q1	Q3	Obs.
Descriptive statistics for the variables representing the influence factors of municipal bond segment for Nov.2001-Dec.2023								
Muni.bonds avg.interest rate (%)	8.804	6.728	7.694	1.684	36.500	3.396	10.441	266
Monthly inflation (%)	6.617	5.158	8.443	-30.616	58.083	1.723	9.642	266
ROBID overnight (%)	5.923	3.760	6.133	0.040	29.530	1.645	7.535	266
ROBID 3M (%)	6.844	5.300	6.573	0.320	31.980	2.198	8.102	266
ROBID 6M (%)	6.825	5.645	6.420	0.420	32.390	2.268	8.045	266
ROBID 12M (%)	6.793	5.870	6.324	0.560	33.220	2.328	8.002	266
ROBOR overnight (%)	7.086	4.510	7.564	0.400	39.920	2.052	8.770	266
ROBOR 3M (%)	8.056	6.030	7.821	0.700	36.780	2.598	9.340	266
ROBOR 6M (%)	8.189	6.450	7.703	0.930	37.670	2.845	9.498	266
ROBOR 12M (%)	8.190	6.630	7.639	1.080	39.590	2.895	9.412	266
(Robid3M+Robor3M)/2 (%)	7.450	5.620	7.186	0.510	34.215	2.393	8.651	266
(Robid6M+Robor6M)/2 (%)	7.507	6.080	7.049	0.675	34.995	2.506	8.631	266
Credit interst rates (%)	12.757	10.600	8.185	5.145	40.570	6.691	15.140	266
Savings interest rate (%)	5.997	5.293	4.988	0.555	23.480	1.936	7.444	266
T-bills avg.yield (%)	7.264	5.780	6.896	0.510	35.700	2.658	8.338	266
T-bonds avg. interest rate (%)	6.839	6.470	4.430	0.000	26.000	3.832	7.818	266
BET month.returns (%)	61.209	11.616	258.069	-99.288	3,315.219	-17.569	65.742	266
BET-C/Plus month.returns (%)	50.353	10.691	191.093	-99.283	2,099.914	-18.073	70.175	266
BET-Fi month.returns (%)	1,151.524	10.099	14,428.103	-99.997	230,200.550	-29.513	76.584	266
Descriptive statistics for the variables representing the influence factors of municipal bond segment for Jul.2007-Dec.2023								
Muni.bonds avg.interest rate (%)	5.554	4.112	3.363	1.684	15.617	2.828	7.384	198
Monthly inflation (%)	4.988	4.033	7.689	-30.616	58.083	0.843	7.667	198
ROBID overnight (%)	3.484	2.480	3.100	0.040	14.420	1.085	5.195	198
ROBID 3M (%)	4.294	3.045	3.391	0.320	14.270	1.677	6.160	198
ROBID 6M (%)	4.410	3.075	3.352	0.420	14.020	1.763	6.277	198
ROBID 12M (%)	4.497	3.200	3.326	0.560	14.000	1.805	6.367	198
ROBOR overnight (%)	3.958	2.925	3.413	0.400	23.260	1.518	5.695	198
ROBOR 3M (%)	4.816	3.405	3.687	0.700	22.150	2.042	6.587	198
ROBOR 6M (%)	5.059	3.570	3.667	0.930	22.330	2.165	6.905	198

ROBOR 12M (%)	5.152	3.655	3.634	1.080	22.110	2.203	6.945	198
(Robid3M+Robor3M)/2 (%)	4.555	3.247	3.528	0.510	18.210	1.880	6.373	198
(Robid6M+Robor6M)/2 (%)	4.734	3.270	3.499	0.675	18.175	1.958	6.559	198
Credit interst rates (%)	9.071	7.885	3.611	5.145	20.130	6.022	11.102	198
Savings interest rate (%)	4.429	3.085	3.626	0.555	16.715	1.590	6.385	198
T-bills avg.yield (%)	4.700	3.355	3.266	0.510	14.230	2.070	6.740	198
T-bonds avg. interest rate (%)	5.565	4.660	2.627	2.110	13.000	3.377	7.218	198
BET month.returns (%)	35.654	8.926	150.625	-99.288	1,460.512	-19.707	53.534	198
BET-C/Plus month.returns (%)	29.103	3.537	132.307	-99.283	1,278.860	-24.826	50.888	198
BET-Fi month.returns (%)	304.280	6.236	3,551.105	-99.997	49,874.177	-27.707	60.844	198
Yield <1 year (%)	4.397	3.370	3.048	0.420	13.360	2.000	6.317	198
Yield 3 years (%)	5.203	4.555	2.712	1.390	12.220	3.077	6.808	198
Yield 5 years (%)	5.438	4.840	2.452	1.810	11.060	3.232	6.925	198
Yield 10 years (%)	5.678	5.265	1.965	1.860	10.350	3.905	7.170	198
ROTX month.returns (%)	48.656	8.343	273.212	-99.463	3,458.364	-23.028	53.445	198
BET-XT month.returns (%)	53.549	8.214	351.749	-99.826	4,482.983	-20.318	54.158	198
BET-NG month.returns (%)	27.667	1.815	100.662	-99.869	757.452	-26.901	53.356	198
Descriptive statistics for the monthly variations of variables representing the influence factors of municipal bond segment for Nov.2001-Dec.2023								
Muni.bonds avg.interest rate (%)	-0.446	0.000	5.959	-20.290	28.450	-2.244	0.915	265
Monthly inflation (%)	1.419	-18.126	474.951	-3,531.517	3,258.711	-74.832	67.264	265
ROBID overnight (%)	5.516	-0.173	39.625	-90.533	221.591	-12.218	12.542	265
ROBID 3M (%)	0.419	-0.702	15.655	-49.757	110.606	-5.738	4.372	265
ROBID 6M (%)	-0.047	-0.722	11.315	-38.136	90.541	-3.699	2.968	265
ROBID 12M (%)	-0.196	-0.333	9.631	-32.347	63.333	-3.286	2.385	265
ROBOR overnight (%)	2.277	-0.374	26.033	-71.233	141.304	-10.658	8.672	265
ROBOR 3M (%)	-0.123	-1.124	11.128	-31.698	71.698	-4.984	3.195	265
ROBOR 6M (%)	-0.307	-0.926	9.085	-25.705	67.895	-3.600	2.446	265
ROBOR 12M (%)	-0.377	-0.617	8.319	-25.192	67.120	-3.495	1.788	265
(Robid3M+Robor3M)/2 (%)	0.009	-0.885	12.202	-34.792	86.628	-5.603	3.788	265
(Robid6M+Robor6M)/2 (%)	-0.241	-0.744	9.517	-25.667	71.939	-3.675	2.595	265
Credit interst rates (%)	-0.496	-0.548	4.001	-14.237	15.113	-2.835	1.688	265
Savings interest rate (%)	-0.233	-0.987	8.041	-19.467	48.413	-3.876	2.400	265

T-bills avg.yield (%)	0.515	0.000	20.228	-58.537	272.308	-3.736	2.003	265
T-bonds avg. interest rate (%)	-0.253	0.000	7.420	-28.636	40.851	-3.226	1.938	265
BET month.returns (%)	99.720	-95.007	4,105.913	-26,200.687	52,784.302	-165.838	23.651	265
BET-C/Plus month.returns (%)	-149.777	-97.432	2,864.948	-40,820.863	14,092.800	-192.066	22.645	265
BET-Fi month.returns (%)	1,239.746	-94.159	20,945.947	-12,722.705	336,335.553	-168.538	15.662	265
Descriptive statistics for the monthly variations of variables representing the influence factors of municipal bond segment for Jul.2007-Dec.2023								
Muni.bonds avg.interest rate (%)	0.062	0.000	6.096	-17.054	28.450	-1.891	0.901	197
Monthly inflation (%)	-16.498	-23.679	539.369	-3,531.517	3,258.711	-85.902	58.945	197
ROBID overnight (%)	6.494	-0.173	40.183	-90.533	221.591	-12.183	15.730	197
ROBID 3M (%)	1.093	-0.702	16.659	-49.757	110.606	-5.516	6.400	197
ROBID 6M (%)	0.520	-0.722	11.386	-32.353	90.541	-3.583	3.398	197
ROBID 12M (%)	0.382	-0.317	9.490	-29.612	63.333	-3.093	2.837	197
ROBOR overnight (%)	3.242	-0.165	27.254	-71.233	141.304	-10.676	11.111	197
ROBOR 3M (%)	0.580	-1.082	12.418	-31.698	71.698	-4.930	4.672	197
ROBOR 6M (%)	0.355	-0.888	10.018	-25.705	67.895	-3.284	2.992	197
ROBOR 12M (%)	0.292	-0.302	9.139	-25.192	67.120	-2.959	2.381	197
(Robid3M+Robor3M)/2 (%)	0.700	-0.929	13.336	-34.792	86.628	-5.565	5.714	197
(Robid6M+Robor6M)/2 (%)	0.392	-0.791	10.129	-25.667	71.939	-3.566	3.180	197
Credit interst rates (%)	-0.067	-0.251	4.190	-14.237	15.113	-2.685	2.217	197
Savings interest rate (%)	0.242	-0.909	8.298	-17.705	48.413	-3.601	2.914	197
T-bills avg.yield (%)	1.300	0.000	22.775	-35.052	272.308	-4.747	2.985	197
T-bonds avg. interest rate (%)	0.248	-0.208	7.818	-18.545	40.851	-4.113	2.751	197
BET month.returns (%)	-18.296	-95.007	2,069.349	-12,090.467	20,294.052	-191.541	5.098	197
BET-C/Plus month.returns (%)	-197.619	-97.432	3,246.671	-40.820.863	14,092.800	-205.679	19.341	197
BET-Fi month.returns (%)	63.721	-94.248	3,844.391	-12,722.705	47,215.195	-177.558	4.598	197
Yield <1 year (%)	2.162	0.000	30.134	-59.603	350.769	-3.659	0.614	197
Yield 3 years (%)	0.560	0.000	11.523	-37.500	75.127	-4.545	3.583	197
Yield 5 years (%)	0.312	0.000	8.793	-27.798	47.601	-3.400	3.750	197
Yield 10 years (%)	0.325	0.000	9.427	-31.111	75.269	-4.110	2.680	197
ROTX month.returns (%)	-345.380	-101.672	3,465.894	-44,924.194	8,453.946	-227.500	-8.370	197
BET-XT month.returns (%)	-213.619	-106.604	1,141.406	-9,354.876	3,328.672	-196.088	12.025	197
BET-NG month.returns (%)	-241.794	-96.925	3,011.532	-23,048.986	19,133.954	-177.731	5.159	197

Source: authors' calculations using JASP

Annex 1c

	Mean	Median	St.dev.	Minim	Maxim	Q1	Q3	Obs.
Descriptive statistics for the premium of muni.bonds avg.interest rates over various rates/returns for Nov.2001-Dec.2023								
muni.rate – monthly inflation (%)	2.187	2.304	8.444	-54.229	33.016	-1.696	6.582	266
muni.rate – Robid overnight (%)	2.881	1.923	2.739	-1.990	17.380	1.472	3.317	266
muni.rate – Robid 3M (%)	1.960	1.476	1.879	-2.004	11.270	1.085	1.476	266
muni.rate – Robid 6M (%)	1.979	1.381	1.967	-2.104	11.240	0.985	2.266	266
muni.rate – Robid 12M (%)	2.011	1.271	2.126	-2.234	11.390	0.860	2.338	266
muni.rate – Robor overnight (%)	1.718	1.411	2.026	-10.830	9.950	0.902	2.319	266
muni.rate – Robor 3M (%)	0.748	0.876	1.402	-9.720	5.849	0.306	1.207	266
muni.rate – Robor 6M (%)	0.615	0.721	1.335	-9.900	5.720	0.138	1.018	266
muni.rate – Robor 12M (%)	0.614	0.596	1.388	-9.680	6.229	0.090	0.940	266
muni.rate – avg.Robid-Robor 3M (%)	1.354	1.131	1.481	-5.780	8.320	0.744	1.636	266
muni.rate – avg.Robid-Robor 6M (%)	1.297	1.026	1.497	-5.745	8.310	0.682	1.506	266
muni.rate – credit rate (%)	-3.953	-3.746	1.406	-8.906	-0.530	-4.494	-3.027	266
muni.rate – savings rate (%)	2.807	1.342	3.416	-1.742	16.060	0.979	2.461	266
muni.rate – T-bills yield (%)	1.540	1.092	1.720	-3.134	10.239	0.556	2.076	266
muni.rate – T-bonds rate (%)	1.965	0.298	5.602	-4.377	36.500	-0.491	2.629	266
muni.rate – BET returns (%)	-52.405	-4.618	255.963	-3,278.719	112.148	-53.322	26.759	266
muni.rate – BET-C/Plus returns (%)	-41.549	-2.832	188.972	-2,063.414	112.461	-57.387	28.043	266
muni.rate – BET-Fi returns (%)	-1,142.720	-2.930	14,426.311	-230,164.050	128.428	-70.102	36.763	266
Descriptive statistics for the premium of muni.bonds avg.interest rates over various rates/returns for Jul.2007-Dec.2023								
muni.rate – monthly inflation (%)	0.565	0.773	7.839	-54.229	33.014	-2.166	4.460	198
muni.rate – Robid overnight (%)	1.981	1.830	1.185	-5.750	4.899	1.493	2.401	198
muni.rate – Robid 3M (%)	0.294	0.045	3.190	-8.220	11.050	-1.560	1.510	198
muni.rate – Robid 6M (%)	0.579	0.394	7.531	-31.506	53.593	-3.081	3.187	198
muni.rate – Robid 12M (%)	-0.203	-0.160	0.322	-3.220	0.610	-0.270	-0.060	198
muni.rate – Robor overnight (%)	1.596	1.408	1.483	-10.830	5.586	1.003	2.208	198
muni.rate – Robor 3M (%)	-0.406	-0.290	0.647	-8.130	0.370	-0.450	-0.220	198
muni.rate – Robor 6M (%)	-0.561	-0.485	0.648	-8.330	0.040	-0.720	-0.280	198
muni.rate – Robor 12M (%)	-0.336	-0.300	0.259	-1.330	0.360	-0.420	-0.190	198

muni.rate – avg.Robid-Robor 3M (%)	0.504	0.445	0.366	-0.100	4.120	0.291	0.559	198
muni.rate – avg.Robid-Robor 6M (%)	0.418	0.385	0.283	0.185	3.935	0.320	0.440	198
muni.rate – credit rate (%)	-3.517	-3.546	0.887	-6.137	-1.245	-3.993	-2.913	198
muni.rate – savings rate (%)	1.124	1.133	0.634	-1.724	2.738	0.831	1.499	198
muni.rate – T-bills yield (%)	0.854	0.885	0.924	-3.134	4.147	0.423	1.261	198
muni.rate – T-bonds rate (%)	0.024	-0.062	1.420	-4.337	7.030	-0.631	0.594	198
muni.rate – BET returns (%)	-30.101	-3.778	149.727	-1,445.245	112.148	-49.298	25.578	198
muni.rate – BET-C/Plus returns (%)	-23.550	-0.804	131.537	-1,236.555	112.461	-46.917	30.079	198
muni.rate – BET-Fi returns (%)	-298.727	-0.504	3,550.258	-49,858.911	112.656	-56.228	32.533	198
muni.rate – yield <1 year	1.156	1.092	0.886	-2.254	5.316	0.694	1.450	198
muni.rate – yield 3 years	0.350	0.271	1.109	-2.658	4.966	-0.173	0.767	198
muni.rate – yield 5 years	0.115	-0.033	1.356	-3.667	4.937	-0.536	0.596	198
muni.rate – yield 10 years	-0.125	-0.507	1.788	-3.587	6.566	-1.338	0.512	198
muni.rate – ROTX returns (%)	-43.012	-4.036	272.338	-3,443.059	114.873	-49.065	26.066	198
muni.rate – BET-XT returns (%)	-47.996	-3.039	350.853	-4,467.717	112.865	-51.209	26.265	198
muni.rate – BET-NG returns (%)	-22.114	2.058	99.966	-742.186	112.299	-47.801	32.389	198
Descriptive statistics for the monthly variations of premium of muni.bonds avg.interest rates over various rates/returns for Nov.2001-Dec.2023								
muni.rate – monthly inflation (%)	31.825	-29.954	696.715	-2,616.908	8,826.714	-109.976	41.397	265
muni.rate – Robid overnight (%)	9.567	-2.785	116.167	-922.618	768.832	-20.598	15.635	265
muni.rate – Robid 3M (%)	2,753.262	0.506	44,732.687	-282.375	728,200.000	-14.286	14.863	265
muni.rate – Robid 6M (%)	3.528	0.284	92.180	-414.529	1,157.440	-14.258	14.282	265
muni.rate – Robid 12M (%)	-2.906	0.075	72.566	-685.730	348.207	-13.425	15.487	265
muni.rate – Robor overnight (%)	-48.006	-4.167	687.846	-8,197.470	2,993.764	-36.671	17.363	265
muni.rate – Robor 3M (%)	-10.258	-1.163	283.652	-2,172.619	2,341.093	-30.717	25.887	265
muni.rate – Robor 6M (%)	22.722	-0.885	225.645	-1,012.683	2,149.254	-30.867	30.009	265
muni.rate – Robor 12M (%)	-50.767	-1.233	519.461	-5,850.000	871.767	-35.859	28.538	265
muni.rate – avg.Robid-Robor 3M (%)	44.695	0.131	487.661	-613.407	7,383.889	-19.516	23.718	265
muni.rate – avg.Robid-Robor 6M (%)	7.536	1.284	174.696	-869.164	1,718.593	-19.203	22.487	265
muni.rate – credit rate (%)	5.254	0.286	78.566	-75.349	1,237.736	-8.259	6.737	265
muni.rate – savings rate (%)	7.414	-0.346	89.006	-215.971	1,101.254	-8.477	8.358	265
muni.rate – T-bills yield (%)	6.332	-0.443	254.871	-2,728.863	1,675.325	-25.478	24.803	265

muni.rate – T-bonds rate (%)	-86.029	-4.725	882.539	-12,717.647	1,004.972	-35.334	17.456	265
muni.rate – BET returns (%)	-528.466	-95.381	7,092.081	-95,687.316	38,880.211	-179.527	23.204	265
muni.rate – BET-C/Plus returns (%)	-195.778	-102.622	1,210.580	-8.756.112	8,156.748	-220.732	5.473	265
muni.rate – BET-Fi returns (%)	3,346.219	-94.510	46,015.057	-32,588.947	720,889.156	-171.828	13.603	265
Descriptive statistics for the monthly variations of premium of muni.bonds avg.interest rates over various rates/returns for Jul.2007-Dec.2023								
muni.rate – monthly inflation (%)	19.535	-38.379	748.745	-2,616.908	8,826.714	-124.348	44.723	197
muni.rate – Robid overnight (%)	5.307	-0.588	63.712	552.929	275.174	-12.107	16.979	197
muni.rate – Robid 3M (%)	-4.338	-0.538	281.333	-3,050.000	1,600.000	-14.189	6.542	197
muni.rate – Robid 6M (%)	-142.910	-54.306	964.206	-9,621.838	1,510.041	-122.912	34.574	197
muni.rate – Robid 12M (%)	25.046	-3.448	278.219	-833.333	2,600.000	-37.500	25.974	197
muni.rate – Robor overnight (%)	-86.662	-3.703	755.308	-8,197.470	693.912	-28.888	10.418	197
muni.rate – Robor 3M (%)	-10.140	-3.030	304.557	-3,800.000	1,050.000	-16.129	10.526	197
muni.rate – Robor 6M (%)	3.756	-1.370	69.324	-112.500	891.667	-6.522	4.348	197
muni.rate – Robor 12M (%)	-20.064	-2.326	208.734	-2,100.000	633.333	-21.053	14.754	197
muni.rate – avg.Robid-Robor 3M (%)	9.008	0.000	107.023	-280.000	1,273.333	-10.000	10.526	197
muni.rate – avg.Robid-Robor 6M (%)	5.001	0.000	82.768	-66.455	1,149.206	-5.755	5.063	197
muni.rate – credit rate (%)	0.711	0.321	14.237	-44.487	66.987	-6.632	6.643	197
muni.rate – savings rate (%)	10.425	0.278	102.747	-215.971	1,101.254	-9.578	10.283	197
muni.rate – T-bills yield (%)	9.201	-1.193	281.724	-2,728.863	1,675.325	-28.911	27.865	197
muni.rate – T-bonds rate (%)	-115.442	-13.622	1,022.492	-12,717.647	1,004.972	-47.736	24.508	197
muni.rate – BET returns (%)	-691.986	-90.844	7,103.424	-95,687.316	11,525.562	-187.262	24.497	197
muni.rate – BET-C/Plus returns (%)	-204.224	-96.187	978.787	-7,779.792	4,944.837	-220.732	14.575	197
muni.rate – BET-Fi returns (%)	723.739	-94.786	14,423.187	-32,588.947	199,231.035	-171.808	4.378	197
muni.rate – yield <1 year	30.117	0.000	356.667	-763.723	4,484.365	-15.804	18.574	197
muni.rate – yield 3 years	60.508	-4.539	824.386	-1,929.348	10.295.775	-54.875	32.922	197
muni.rate – yield 5 years	-41.832	-6.322	341.167	-3,124.638	1,433.333	-48.462	24.912	197
muni.rate – yield 10 years	72.027	-1.940	883.510	-2,019.713	11,882.870	-25.588	23.339	197
muni.rate – ROTX returns (%)	69.243	-103.271	3,294.028	-18,906.910	34,770.145	-216.215	-4.082	197
muni.rate – BET-XT returns (%)	-47.564	-104.074	1,627.927	-7,779.792	13,805.050	-217.668	4.396	197
muni.rate – BET-NG returns (%)	-81.598	-92.095	556.397	-2,919.745	3,263.395	-193.366	5.636	197

Source: authors' calculations using JASP

Annex 1d

	Mean	Median	St.dev.	Minim	Maxim	Q1	Q3	Obs.
Descriptive statistics for the premiums of various rates/returns over monthly inflation rate for Nov.2001-Dec.2023								
Robid overnight – monthly inflation (%)	-0.693	-0.200	7.809	-54.763	30.866	-3.922	3.287	266
Robid 3M – monthly inflation (%)	0.227	0.336	7.821	-53.663	31.416	-3.112	4.270	266
Robid 6M – monthly inflation (%)	0.208	0.284	7.778	-53.593	31.506	-2.896	3.846	266
Robid 12M – monthly inflation (%)	0.176	0.270	7.759	-53.523	31.556	-2.796	3.876	266
Robor overnight – monthly inflation (%)	0.469	1.031	8.274	-54.463	31.276	-3.448	4.880	266
Robor 3M – monthly inflation (%)	1.439	1.425	8.293	-53.363	31.876	-2.463	5.791	266
Robor 6M – monthly inflation (%)	1.572	1.756	8.246	-53.243	32.146	-2.219	6.025	266
Robor 12M – monthly inflation (%)	1.573	1.599	8.209	-53.173	32.206	-2.148	5.872	266
avg.Robid-Robor 3M – monthly inflation (%)	0.833	1.053	8.026	-53.513	31.646	-2.715	4.753	266
avg.Robid-Robor 6M – monthly inflation (%)	0.890	1.121	7.978	-53.418	31.826	-2.557	4.823	266
credit rate - monthly inflation (%)	6.140	5.882	8.702	-51.273	36.286	1.900	10.636	266
savings rate - monthly inflation (%)	-0.620	-0.154	7.731	-54.668	31.906	-3.878	3.557	266
T-bill yield - monthly inflation (%)	0.647	0.829	7.962	-53.833	31.926	-2.618	4.245	266
T-bond rate - monthly inflation (%)	0.222	0.891	8.106	-51.553	33.096	-2.493	4.702	266
BET return - monthly inflation (%)	54.592	3.957	256.939	-113.452	3,286.894	-24.795	58.628	266
BET-C/Plus return - monthly inflation (%)	43.736	3.504	190.035	-113.447	2,071.590	-25.886	60.244	266
BET-Fi return - monthly inflation (%)	1,144.907	6.783	14,426.829	-128.352	230,172.225	-37.548	72.270	266
Descriptive statistics for the premiums of various rates/returns over monthly inflation rate for Jul.2007-Dec.2023								
Robid overnight – monthly inflation (%)	-1.505	-0.919	7.589	-54.763	30.866	-4.053	2.275	198
Robid 3M – monthly inflation (%)	-0.684	-0.499	7.543	-53.663	31.416	-3.410	2.898	198
Robid 6M – monthly inflation (%)	-0.579	-0.394	7.531	-53.593	31.506	-3.187	3.081	198
Robid 12M – monthly inflation (%)	-0.491	-0.259	7.523	-53.523	31.556	-3.407	3.269	198
Robor overnight – monthly inflation (%)	-1.031	-0.585	7.661	-54.463	31.276	-3.694	2.703	198
Robor 3M – monthly inflation (%)	-0.173	-0.104	7.629	-53.363	31.876	-2.985	3.573	198
Robor 6M – monthly inflation (%)	0.070	0.148	7.648	-53.243	32.146	-2.796	3.861	198
Robor 12M – monthly inflation (%)	0.163	0.264	7.636	-53.173	32.206	-2.602	3.962	198
avg.Robid-Robor 3M – monthly inflation (%)	-0.434	-0.301	7.579	-53.513	31.646	-3.171	3.323	198
avg.Robid-Robor 6M – monthly inflation (%)	-0.254	-0.134	7.583	-53.418	31.826	-2.977	3.461	198

credit rate - monthly inflation (%)	4.082	4.333	8.025	-51.273	36.286	1.291	8.156	198
savings rate - monthly inflation (%)	-0.559	-0.319	7.840	-54.668	31.906	-3.383	3.282	198
T-bill yield - monthly inflation (%)	-0.228	-0.101	7.573	-53.833	31.926	-3.030	3.602	198
T-bond rate - monthly inflation (%)	0.576	0.945	7.390	-51.553	33.096	-1.908	4.504	198
BET return - monthly inflation (%)	30.666	2.376	150.790	-113.452	1,457.099	-26.866	51.161	198
BET-C/Plus return - monthly inflation (%)	24.115	0.741	132.380	-113.447	1,272.565	-27.653	46.974	198
BET-Fi return - monthly inflation (%)	299.292	1.902	3,551.115	-114.161	49,870.765	-33.855	55.795	198
Yield <1 year - monthly inflation (%)	-0.591	-0.288	7.567	-54.113	31.836	-3.339	3.259	198
Yield 3 years - monthly inflation (%)	0.215	0.505	7.446	-53.323	33.376	-2.334	4.275	198
Yield 5 years - monthly inflation (%)	0.450	0.856	7.357	-51.713	33.396	-2.003	4.460	198
Yield 10 years - monthly inflation (%)	0.690	1.183	7.275	-51.593	32.476	-1.565	4.575	198
ROTX return - monthly inflation (%)	43.577	3.698	273.237	-115.227	3,452.069	-24.972	50.589	198
BET-XT return - monthly inflation (%)	48.561	2.003	351.830	-113.990	4,479.571	-25.979	54.761	198
BET-NG return - monthly inflation (%)	22.679	1.593	100.378	-114.033	754.040	-33.747	48.782	198
Descriptive statistics for the monthly variations of the premiums of various rates/returns over monthly inflation rate for Nov.2001-Dec.2023								
Robid overnight – monthly inflation (%)	-14.790	-49.540	708.309	-3,455.454	6,974.216	-124.836	37.814	265
Robid 3M – monthly inflation (%)	-503.217	-50.531	6,567.053	-89,920.571	9,085.284	-120.051	32.257	265
Robid 6M – monthly inflation (%)	-125.866	-54.904	857.538	-9,621.838	2,472.905	-125.654	30.827	265
Robid 12M – monthly inflation (%)	-88.473	-55.187	617.540	-5,996.672	2,452.505	-126.964	26.478	265
Robor overnight – monthly inflation (%)	-182.388	-36.939	2,695.843	-37,654.107	15,682.477	-111.289	41.648	265
Robor 3M – monthly inflation (%)	-109.215	-36.762	915.887	-8,739.086	3,125.527	-111.712	34.788	265
Robor 6M – monthly inflation (%)	321.169	-39.260	5,351.492	-7,488.957	85,331.941	-109.321	33.766	265
Robor 12M – monthly inflation (%)	-201.387	-44.811	3,083.914	-44,878.040	16,232.835	-112.606	29.549	265
avg.Robid-Robor 3M – monthly inflation (%)	-18.300	-39.124	728.436	-7,028.239	4,228.088	-112.428	37.392	265
avg.Robid-Robor 6M – monthly inflation (%)	42.981	-40.421	1,166.604	-7,441.601	8,408.184	112.269	36.058	265
credit rate - monthly inflation (%)	76.171	-14.641	2,972.537	-20,891.334	43,351.797	-71.433	45.147	265
savings rate - monthly inflation (%)	10.094	-47.206	946.197	-4,594.446	7,934.324	-121.163	45.658	265
T-bill yield - monthly inflation (%)	267.024	-51.041	4,166.822	-2,781.090	66,482.854	-117.743	34.428	265
T-bond rate - monthly inflation (%)	-116.985	-59.076	1,643.684	-22,281.793	10,322.932	-137.382	19.739	265
BET return - monthly inflation (%)	-53.197	-96.032	3,338.043	-11,292.359	46,963.739	-189.362	15.776	265
BET-C/Plus return - monthly inflation (%)	-303.222	-97.014	2,104.273	-27,730.747	7,379.771	-199.988	14.634	265

BET-Fi return - monthly inflation (%)	1,228.306	-92.624	22,373.180	-22,249.428	362,282.633	-171.248	13.300	265
Descriptive statistics for the monthly variations of the premiums of various rates/returns over monthly inflation rate for Jul.2007-Dec.2023								
Robid overnight – monthly inflation (%)	6.302	-46.083	530.941	-2,923.938	3,904.872	-116.075	44.372	197
Robid 3M – monthly inflation (%)	-232.262	-44.318	4,075.085	-55,581.507	9,085.284	-119.107	39.815	197
Robid 6M – monthly inflation (%)	-142.910	-54.306	964.206	-9,621.838	1,510.041	-122.912	34.574	197
Robid 12M – monthly inflation (%)	-88.947	-54.188	689.722	-5,996.672	2,452.505	-121.433	33.851	197
Robor overnight – monthly inflation (%)	-270.457	-43.870	3,117.589	-37,654.107	15,682.477	-118.455	39.263	197
Robor 3M – monthly inflation (%)	-113.939	-50.401	925.137	-8,739.086	3,125.527	-114.902	34.788	197
Robor 6M – monthly inflation (%)	414.206	-51.588	6,161.601	-7,488.957	85,331.941	-114.416	37.616	197
Robor 12M – monthly inflation (%)	-200.593	-50.671	3,518.119	-44,878.040	16,232.835	-114.593	33.962	197
avg.Robid-Robor 3M – monthly inflation (%)	-36.555	-41.469	715.419	-7,028.239	3,879.615	-118.776	41.914	197
avg.Robid-Robor 6M – monthly inflation (%)	-24.250	-42.217	1,026.786	-4,003.862	8,408.184	-112.790	40.412	197
credit rate - monthly inflation (%)	113.039	-16.064	3,447.125	-20,891.334	43,351.797	-75.194	46.081	197
savings rate - monthly inflation (%)	37.713	-41.122	1,089.472	-4,594.446	7,934.324	-111.143	58.692	197
T-bill yield - monthly inflation (%)	400.471	-51.041	4,821.110	-2,781.090	66,482.854	-116.933	38.540	197
T-bond rate - monthly inflation (%)	-139.733	-55.804	1,702.531	-22,281.793	3,983.238	-129.241	37.161	197
BET return - monthly inflation (%)	-251.925	-89.762	1,337.190	-7,781.096	7,898.606	-210.939	0.556	197
BET-C/Plus return - monthly inflation (%)	-379.788	-92.978	2,178.179	-27,730.747	2,270.900	-215.384	13.106	197
BET-Fi return - monthly inflation (%)	-70.392	-94.345	2,298.241	-22,249.428	18,860.278	-181.235	-12.620	197
Yield <1 year - monthly inflation (%)	-128.632	-54.578	2,090.149	-20,997.660	14,475.969	-119.891	35.752	197
Yield 3 years - monthly inflation (%)	11.332	-52.326	954.981	-7,261.934	6,361.082	-119.857	55.212	197
Yield 5 years - monthly inflation (%)	-86.388	-56.791	710.430	-3,918.666	4,275.865	-131.547	38.900	197
Yield 10 years - monthly inflation (%)	534.576	-58.875	5,734.076	-8,212.001	60,198.415	-128.872	35.996	197
ROTX return - monthly inflation (%)	-160.455	-105.533	1,530.372	-12,569.616	8,812.711	-222.491	-16.312	197
BET-XT return - monthly inflation (%)	39.659	-101.315	2,094.256	-15,376.953	20,317.556	-190.099	13.335	197
BET-NG return - monthly inflation (%)	-23.833	-97.125	1,916.825	-5,716.021	24,857.330	-192.075	8.830	197

Source: authors' calculations using JASP

Annex 1e

	Mean	Median	St.dev.	Minim	Maxim	Q1	Q3	Obs.
Descriptive statistics for the premiums of various rates/returns over T-bill avg. yield for Nov.2001-Dec.2023								
Robid overnight – T-bill yield (%)	-1.340	-0.995	2.004	-11.080	2.780	-1.792	-0.440	266
Robid 3M – T-bill yield (%)	-0.420	-0.385	1.085	-6.240	2.860	-0.780	-0.070	266
Robid 6M – T-bill yield (%)	-0.439	-0.380	1.043	-6.410	2.770	-0.728	-0.110	266
Robid 12M – T-bill yield (%)	-0.471	-0.360	1.122	-7.210	2.510	-0.710	-0.020	266
Robor overnight – T-bill yield (%)	-0.178	-0.440	1.841	-5.450	10.260	-1.010	0.282	266
Robor 3M – T-bill yield (%)	0.793	0.185	1.580	-2.320	9.150	-0.178	1.325	266
Robor 6M – T-bill yield (%)	0.925	0.395	1.392	-2.670	9.330	0.100	1.590	266
Robor 12M – T-bill yield (%)	0.926	0.480	1.306	-3.130	9.110	0.190	1.498	266
avg.Robid-Robor 3M – T-bill yield (%)	0.186	-0.100	1.133	-4.280	5.210	-0.480	0.493	266
avg.Robid-Robor 6M – monthly inflation (%)	0.243	0.055	0.962	-4.540	5.175	-0.264	0.446	266
credit rate - T-bill yield (%)	5.493	4.830	2.525	-0.375	15.710	3.910	6.459	266
savings rate - T-bill yield (%)	-1.267	-0.465	2.632	-12.300	5.245	-1.195	-0.016	266
T-bond rate - T-bill yield (%)	-0.425	0.710	5.422	-35.700	3.410	0.010	1.200	266
BET return - T-bill yield (%)	53.945	6.371	256.227	-112.288	3,282.719	-24.578	55.269	266
BET-C/Plus return - T-bill yield (%)	43.089	5.046	189.236	-112.283	2,067.414	-26.339	59.547	266
BET-Fi return - T-bill yield (%)	1,144.261	3.859	14,426.490	-127.328	230,168.050	-35.944	71.772	266
Descriptive statistics for the premiums of various rates/returns over T-bill avg. yield for Jul.2007-Dec.2023								
Robid overnight – T-bill yield (%)	-1.216	-1.020	1.034	-4.310	1.900	-1.477	-0.610	198
Robid 3M – T-bill yield (%)	-0.406	-0.405	0.671	-3.110	2.350	-0.740	-0.180	198
Robid 6M – T-bill yield (%)	-0.290	-0.310	0.565	-1.930	2.190	-0.610	-0.088	198
Robid 12M – T-bill yield (%)	-0.203	-0.260	0.561	-1.810	2.120	-0.538	0.017	198
Robor overnight – T-bill yield (%)	-0.742	-0.645	1.281	-3.940	10.260	-1.130	-0.230	198
Robor 3M – T-bill yield (%)	0.116	0.050	0.987	-1.740	9.150	-0.297	0.280	198
Robor 6M – T-bill yield (%)	0.359	0.240	0.929	-1.580	9.330	0.020	0.510	198
Robor 12M – T-bill yield (%)	0.452	0.360	0.901	-1.460	9.110	0.105	0.590	198
avg.Robid-Robor 3M – T-bill yield (%)	-0.145	-0.175	0.785	-1.890	5.210	-0.519	0.057	198
avg.Robid-Robor 6M – monthly inflation (%)	0.034	-0.028	0.704	-1.755	5.175	-0.304	0.180	198
credit rate - T-bill yield (%)	4.371	4.457	1.290	-0.375	8.240	3.569	5.033	198

savings rate - T-bill yield (%)	-0.271	-0.300	0.966	-2.820	5.245	-0.867	0.105	198
T-bond rate - T-bill yield (%)	0.865	0.855	0.846	-1.800	3.410	0.385	1.440	198
BET return - T-bill yield (%)	30.954	4.090	150.040	-112.288	1,449.022	-24.346	49.941	198
BET-C/Plus return - T-bill yield (%)	24.403	1.634	131.836	-112.283	1,267.380	-28.637	47.805	198
BET-Fi return - T-bill yield (%)	299.580	1.342	3,550.475	-112.997	49,862.687	-32.092	55.787	198
Yield <1 year - T-bill yield (%)	-0.303	-0.150	0.708	-4.880	1.880	-0.420	0.000	198
Yield 3 years - T-bill yield (%)	0.503	0.560	0.830	-2.470	2.800	0.193	0.945	198
Yield 5 years - T-bill yield (%)	0.738	0.770	1.068	-3.580	3.350	0.210	1.468	198
Yield 10 years - T-bill yield (%)	0.978	1.125	1.561	-5.020	3.880	0.253	2.095	198
ROTX return - T-bill yield (%)	43.865	4.195	272.627	-112.463	3,446.884	-25.004	49.532	198
BET-XT return - T-bill yield (%)	48.849	4.303	351.133	-112.826	4,471.493	-24.446	52.280	198
BET-NG return - T-bill yield (%)	22.967	-1.312	100.238	-112.869	745.962	-32.133	48.372	198
Descriptive statistics for the monthly variations of the premiums of various rates/returns over T-bill avg. yield for Nov.2001-Dec.2023								
Robid overnight – T-bill yield (%)	-15.777	-8.955	379.754	-3,672.727	2,055.556	-49.624	23.944	265
Robid 3M – T-bill yield (%)	-15.190	-7143	552.407	-3,100.000	7,300.000	-50.649	29.293	265
Robid 6M – T-bill yield (%)	-13.384	-4.000	221.563	-2,000.000	1,100.000	-45.790	26.190	265
Robid 12M – T-bill yield (%)	-53.002	-5.993	586.982	-9,000.000	1,600.000	-47.692	30.769	265
Robor overnight – T-bill yield (%)	24.667	-14.599	453.137	-1,643.750	4,614.286	-64.198	35.409	265
Robor 3M – T-bill yield (%)	6.590	-6.667	264.663	-2,209.091	1,600.000	-58.436	36.842	265
Robor 6M – T-bill yield (%)	-26.238	-4.217	573.595	-7,400.000	3.250.000	-47.126	21.094	265
Robor 12M – T-bill yield (%)	17.315	-3.982	198.598	-866.667	1,362.500	-37.255	28.571	265
avg.Robid-Robor 3M – T-bill yield (%)	-20.153	-11.940	315.879	-1,733.333	2,700.000	-78.261	27.273	265
avg.Robid-Robor 6M – monthly inflation (%)	-19.401	-13.043	269.161	-1,320.000	1,650.000	-76.667	25.000	265
credit rate - T-bill yield (%)	-1.188	-0.446	39.051	-520.000	175.439	-6.022	5.275	265
savings rate - T-bill yield (%)	49.580	-3.922	916.989	-2,000.000	14,000.000	-37.201	15.534	265
T-bond rate - T-bill yield (%)	-28.694	0.000	550.470	-6,800.000	5,500.000	-22.222	15.972	265
BET return - T-bill yield (%)	24.259	-94.062	2,679.936	-10,682.151	36,638.961	-174.877	23.085	265
BET-C/Plus return - T-bill yield (%)	996.649	-99.131	16,1997.760	-22,504.648	252,582.914	-198.527	9.967	265
BET-Fi return - T-bill yield (%)	11,861.628	-94.326	158,401.022	-30,109.349	2,495,000.000	-164.763	14.961	265

Descriptive statistics for the monthly variations of the premiums of various rates/returns over T-bill avg. yield for Jul.2007-Dec.2023

Robid overnight – T-bill yield (%)	3.221	-4.348	269.261	-1,154.545	2,055.556	-33.784	22.892	197
Robid 3M – T-bill yield (%)	-5.797	-7.143	618.011	-3,100.000	7,300.000	-43.243	25.714	197
Robid 6M – T-bill yield (%)	-12.226	-4.412	245.366	-2,000.000	1,100.000	-50.000	26.923	197
Robid 12M – T-bill yield (%)	-21.484	-9.677	211.902	-900.000	1,600.000	-61.538	29.730	197
Robor overnight – T-bill yield (%)	10.684	-14.912	479.566	-1,643.750	4,614.286	-61.468	28.767	197
Robor 3M – T-bill yield (%)	20.955	-15.385	260.823	-646.154	1,600.000	-81.250	48.387	197
Robor 6M – T-bill yield (%)	-40.324	-10.377	658.736	-7,400.000	3,250.000	-57.692	33.333	197
Robor 12M – T-bill yield (%)	10.696	-3.774	190.092	-866.667	1,183.333	-41.935	35.000	197
avg.Robid-Robor 3M – T-bill yield (%)	-28.153	-14.545	336.177	-1,733.333	2,700.000	-85.714	34.783	197
avg.Robid-Robor 6M – monthly inflation (%)	-14.163	-15.038	283.886	-1,320.000	1,650.000	-77.358	27.692	197
credit rate - T-bill yield (%)	-2.284	0.000	42.915	-520.000	175.439	-5.775	5.411	197
savings rate - T-bill yield (%)	73.392	-5.714	1,061.427	-2,000.000	14,000.000	-42.017	21.739	197
T-bond rate - T-bill yield (%)	-26.831	-2.439	625.878	-6,800.000	5,000.000	-20.455	18.571	197
BET return - T-bill yield (%)	-71.610	-91.155	1,145.806	-4,860.959	11,661.887	-181.016	24.413	197
BET-C/Plus return - T-bill yield (%)	1,511.749	-94.263	18,663.866	-4,317.575	252,582.914	-198.057	23.464	197
BET-Fi return - T-bill yield (%)	12,803.154	-94.864	177,800.869	-24,694.868	2,495,000.000	-163.933	6.046	197
Yield <1 year - T-bill yield (%)	-48.934	-8.696	363.493	-2,600.000	957.143	-97.297	15.464	197
Yield 3 years - T-bill yield (%)	40.397	-2.500	339.591	-684.615	3,300.000	42.500	29.762	197
Yield 5 years - T-bill yield (%)	38.724	0.000	380.163	-396.552	4,100.000	-25.676	26.131	197
Yield 10 years - T-bill yield (%)	15.658	0.000	186.347	-900.000	1,600.000	-20.567	19.632	197
ROTX return - T-bill yield (%)	-780.897	-103.203	9,005.248	-112,176.509	26,114.483	-211.650	-7.822	197
BET-XT return - T-bill yield (%)	90.449	-105.229	1,717.119	-5,679.811	13,418.170	-200.801	13.570	197
BET-NG return - T-bill yield (%)	-144.230	-96.195	1,112.717	-12,511.378	5,146.311	-194.819	3.818	197

Source: authors' calculations using JASP

Annex 1f

	Mean	Median	St.dev.	Minim	Maxim	Q1	Q3	Obs.
Descriptive statistics for the premiums of various rates/returns over Yield <1 year for Jul.2007-Dec.2023								
Robid overnight – Yield <1year (%)	-0.913	-0.890	1.049	-3.980	3.690	-1.415	-0.412	198
Robid 3M – Yield<1year (%)	-0.103	-0.255	0.846	-3.200	3.540	-0.580	-0.042	198
Robid 6M – Yield<1year (%)	0.012	-0.150	0.757	-1.200	3.290	-0.365	0.060	198
Robid 12M – Yield<1year (%)	0.100	-0.065	0.749	-1.180	3.270	-0.297	0.200	198
Robor overnight – Yield<1year (%)	-0.439	-0.495	1.381	-3.480	12.530	-1.027	-0.013	198
Robor 3M – Yield<1year (%)	0.418	0.170	1.207	-1.030	11.420	-0.158	0.385	198
Robor 6M – Yield<1year (%)	0.661	0.415	1.161	-0.850	11.600	0.170	0.688	198
Robor 12M – Yield<1year (%)	0.755	0.540	1.136	-0.780	11.380	0.283	0.847	198
avg.Robid-Robor 3M – Yield<1year (%)	0.158	-0.043	0.995	-1.550	7.480	-0.388	0.186	198
avg.Robid-Robor 6M – Yield<1year (%)	0.337	0.117	0.930	-1.025	7.448	-0.064	0.365	198
credit rate - Yield<1year (%)	4.674	4.820	1.293	0.975	9.005	3.779	5.241	198
savings rate - Yield<1year (%)	0.032	0.047	1.051	-2.415	6.05	-0.660	0.350	198
T-bill yield - Yield<1year (%)	0.303	0.150	0.708	-1.880	4.880	0.000	0.420	198
T-bond rate - Yield<1year (%)	1.168	1.095	0.884	-1.910	4.890	0.540	1.555	198
BET return - Yield<1 year (%)	31.257	4.350	149.945	-110.018	1,449.332	-24.001	50.109	198
BET-C/Plus return - Yield<1year (%)	24.706	1.927	131.704	-110.013	1,265.500	-28.598	47.871	198
BET-Fi return - Yield<1year (%)	299.883	1.427	3,550.469	-110.727	49,862.997	-31.450	56.562	198
Yield 3 years - Yield<1year (%)	0.806	0.750	0.754	-1.140	4.020	0.350	1.140	198
Yield 5 years - Yield<1year (%)	1.041	0.900	1.002	-2.680	5.260	0.490	1.600	198
Yield 10 years - Yield<1year (%)	1.281	1.325	1.415	-3.350	4.680	0.600	2.290	198
ROTX return - Yield<1year (%)	44.168	5.031	272.482	-111.319	3,445.004	-24.771	49.794	198
BET-XT return - Yield<1year (%)	49.152	4.228	351.068	-110.556	4,471.803	-24.485	52.382	198
BET-NG return - Yield<1year (%)	23.270	-1.272	100.199	-110.599	746.272	-31.633	49.120	198
Descriptive statistics for the monthly variations of the premiums of various rates/returns over Yield <1 year for Jul.2007-Dec.2023								
Robid overnight – Yield<1year (%)	-13.360	-2.308	217.201	-1.913.333	866.667	-38.158	18.182	197
Robid 3M – Yield<1year (%)	41.126	0.000	575.023	-1,600.000	7,300.000	-44.000	36.842	197
Robid 6M – Yield<1year (%)	-11.362	-2.542	387.050	-4,350.000	1,375.000	-54.054	48.241	197
Robid 12M – Yield<1year (%)	-29.084	-4.124	307.270	-2,550.000	1,375.000	-58.462	31.579	197

Robor overnight – Yield<1year (%)	-26.605	-4.839	355.907	-3,480.000	1,680.000	-62.500	34.615	197
Robor 3M – Yield<1year (%)	-4.774	-8.696	196.477	-800.000	1,150.000	-59.016	28.571	197
Robor 6M – Yield<1year (%)	19.674	-2.703	207.641	-650.000	1,900.000	-30.435	26.923	197
Robor 12M – Yield<1year (%)	-1.870	-1.170	203.073	-2,000.000	1,200.000	-24.638	21.622	197
avg.Robid-Robor 3M – Yield<1year (%)	-46.935	-9.055	649.473	-7,850.000	2,600.000	-80.000	36.986	197
avg.Robid-Robor 6M – Yield<1year (%)	24.533	-8.929	416.940	-1,144.444	4,000.000	-68.639	29.000	197
credit rate - Yield<1year (%)	1.177	-0.396	19.350	-73.918	191.282	-4.714	4.541	197
savings rate - Yield<1year (%)	34.440	-0.901	323.990	-1,525.000	2,866.667	-46.341	22.727	197
T-bill yield - Yield<1year (%)	-48.934	-8.696	363.493	-2,600.000	957.297	-97.297	15.464	197
T-bond rate - Yield<1year (%)	15.644	1.515	139.161	-790.909	1,075.000	-20.192	21.053	197
BET return - Yield<1year (%)	-144.712	-91.459	753.530	-4,883.502	4,217.169	-182.932	14.470	197
BET-C/Plus return - Yield<1year (%)	-74.661	-96.739	1,638.048	-4,317.575	20,724.655	-209.493	15.276	197
BET-Fi return - Yield<1year (%)	1,059.011	-94.069	11,566.575	-3,306.497	153,913.970	-161.007	13.889	197
Yield 3 years - Yield<1year (%)	-41.052	0.000	532.899	7,100.000	933.333	-32.000	24.051	197
Yield 5 years - Yield<1year (%)	-82.895	0.000	829.151	-9,033.333	1,950.000	-23.364	20.548	197
Yield 10 years - Yield<1year (%)	-30.840	0.000	444.125	-4,633.333	1,016.667	-19.008	17.391	197
ROTX return - Yield<1year (%)	737.697	-103.458	12,742.302	-31,062.165	173,957.154	-208.426	-5.617	197
BET-XT return - Yield<1year (%)	15.159	-106.160	1,516.572	-5,679.811	12,456.914	-216.995	8.361	197
BET-NG return - Yield<1 year (%)	-4,139.006	-94.512	56,835.213	-797,753.601	5,096.936	-190.941	3.312	197

Source: authors' calculations using JASP