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Investors' footsteps: an empirical study of herd behaviour in the stock exchanges of Bosnia and Herzegovina, Serbia and Ukraine

Meltem Keskin[1+]
Selma Ayture[2]

[1]*Ankara Yildirim Beyazıt University, SUBF, International Trade and Logistics, Turkey.*
Email: meltemkeskin@aybu.edu.tr
[2]*Bartin University, Faculty of Economics and Administrative Sciences, International Trade and Logistics, Turkey.*
Email: selma_ayture@hotmail.com


(+ Corresponding author)

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ABSTRACT

Herding behaviors can distort the Capital Asset Pricing Model (CAPM) and lead to deviations of assets from their real values, thus resulting in purchases and sales at incorrect prices. In this study, the existence of herding behaviors was examined in the stock exchanges of Bosnia and Herzegovina, Serbia, and Ukraine using three different and widely accepted models. These countries were selected due to their status as candidate countries for the European Union (EU). The study assesses the success of the structural reforms undertaken by these countries in the post-socialist period, the extent to which their market regulations align with those of the European Union, and whether market efficiency has been achieved during the accession process. Herding behavior is considered one of the indicators of market efficiency. The analysis utilized daily closing prices from January 2010 to October 2024. The results revealed no substantial indication of herding behavior in the stock markets of the three EU candidate countries when assessed through the models developed by Christie, Huang, Hwang, and Salmon. However, applying the approach of Chang, Cheng, and Khorana, statistically significant signs of sentiment-driven herding were detected exclusively in the stock market of Bosnia and Herzegovina.

Contribution/ Originality: This study uniquely investigates herding behavior in the stock markets of Bosnia-Herzegovina, Serbia, and Ukraine, three EU candidate countries, an area previously underexplored. By linking financial behavior to EU accession dynamics, it offers novel insights into market psychology during transitional economic and political integration processes.

1. INTRODUCTION

This research centers on Bosnia and Herzegovina, Serbia, and Ukraine, which were selected as the study sample due to their designation as candidate countries for European Union (EU) membership. At present, the list of official EU candidate countries comprises Albania, Bosnia and Herzegovina, Georgia, Moldova, Montenegro, North Macedonia, Serbia, Turkey, and Ukraine, while Kosovo holds the status of a potential candidate. The accession process to the EU follows a three-stage framework, each phase requiring unanimous consent from all existing member states. Only after the negotiations and the associated reforms are completed and mutually agreed upon by the EU and the candidate country can accession proceed. The final stage of membership necessitates ratification by every current EU member state.

Bosnia and Herzegovina was recognized as a potential EU candidate country, along with other Western Balkan nations, during the European Council Summit held in Thessaloniki in 2003. The country formally submitted its membership application in February 2016. In response, the European Commission issued its Opinion (Avis) in May

2019, outlining 14 key priorities that needed to be addressed before accession negotiations could commence. These priorities were subsequently endorsed by the EU Council in December 2019. The Opinion laid out a detailed reform roadmap in critical areas such as democratic governance, the rule of law, protection of fundamental rights, and public administration reform. After the Commission recommended granting candidate status in October 2022, the European Council conferred candidate country status to Bosnia and Herzegovina in December 2022. Later, in December 2023, the Council declared that accession negotiations could start once the country had aligned with EU membership criteria and requested a progress report from the Commission by March 2024. Following the Commission's recommendation on March 12, 2024, the European Council approved the initiation of accession negotiations with Bosnia and Herzegovina.

Serbia was designated as a potential EU candidate during the 2003 Thessaloniki Summit and formally submitted its application for membership in 2009. The country was granted candidate status in March 2012, and the Stabilization and Association Agreement came into effect in September 2013. Accession talks officially began in January 2014, following the European Council's endorsement of the negotiation framework in December 2013 and the subsequent intergovernmental conference held that same month. As of now, 22 out of the 35 negotiation chapters have been opened, with two of them having been provisionally closed.

Ukraine formally submitted its application for European Union membership on February 28, 2022. Subsequently, on June 17, 2022, the European Commission shared its opinions on the applications from Ukraine, Georgia, and Moldova, recommending that Ukraine be granted candidate status with a European outlook. This recommendation was endorsed unanimously by all 27 EU member states on June 23, 2022. In its roadmap, the Commission outlined seven essential steps Ukraine needed to undertake during its accession process, with these steps being further elaborated in an analytical report published on February 2, 2023. Ukraine was officially included for the first time in the EU Enlargement Package issued in November 2023. Following the Commission's suggestion to commence negotiations, the European Council agreed to open accession talks on December 14, 2023. The first intergovernmental conference marking the official beginning of negotiations was conducted on June 25, 2024 [1].

This study examines the success of the structural reforms undertaken by these countries in the post-socialist period, the extent to which their market regulations align with those of the European Union, and whether market efficiency has been achieved during the accession process. Lorgova and Ong [2] state that these countries have made special efforts to establish capital markets, implement pricing indicators, adopt modern laws and regulations, and construct a market structure that prioritizes perfect competition. Ivanov and Peleah [3] argue that the process of aligning with market regulations is time-consuming, costly, and painful.

While it is not possible to directly answer all questions related to market efficiency for the countries included in the study, this research analyzes investor behavior in the regional stock exchanges to test whether expected competition has developed in the markets and whether the return-risk balance has been achieved. For this purpose, the stock exchanges of Bosnia and Herzegovina, Serbia, and Ukraine have been examined over the period from January 2010 to October 2024.

As is well known, the most widely accepted theoretical framework for the return-risk balance is the "Capital Asset Pricing Model" (CAPM). However, certain market conditions give rise to "herding behaviour," which undermines the validity of this model. Herding behaviour can be defined as the tendency of investors to move together in the same direction, choosing particular stocks simultaneously rather than making independent decisions [4, 5]. Other definitions suggest that some investors mimic others for informational or strategic reasons [6, 7]. The famous quote by Isaac Newton, "I can calculate the movement of stars, but not the madness of men on financial markets" [8] strikingly illustrates the complexity of such behaviors. However, it can be stated that there is currently no comprehensive and widely accepted theoretical model to differentiate between rational behaviors that support market efficiency and irrational herding behaviors [9]. However, this study has some limitations. First of all, the capital markets of Bosnia and Herzegovina, Serbia, and Ukraine, which are among the analyzed countries, have very limited

depth and low trading volume compared to developed markets; this may limit the generalizability of the findings. In addition, the data used only covers the period 2010:1–2024:10; therefore, market behaviors related to previous structural transformation processes are not covered. Furthermore, investor behaviors are largely affected by macroeconomic, political, and geopolitical risks; the effects of these external factors are not directly analyzed in the study. Despite these limitations, the study provides an empirical analysis of the efficiency level of capital markets in EU candidate countries in the post-socialist transition process and opens the discussion of the existence of market anomalies, especially in the context of herd behavior. In this respect, the study not only provides evidence on the extent to which capital markets operate competitively and efficiently but also offers an opportunity to indirectly evaluate the extent to which these markets comply with the EU acquis. Contrary to herd behavior studies in the literature, which mostly focus on developed markets, this study analyzes investor behavior in developing and transition countries and makes an original contribution to the behavioral finance literature by considering regional and structural differences. It also suggests a new perspective on how the EU membership process affects not only institutional and legal reforms but also market efficiency at the level of investor behavior.

The structure of the study is organized as follows: Section II outlines the relevant literature, Section III details the methodologies and data employed, Section IV presents the empirical findings along with their interpretation, and Section V concludes the study by summarizing the results and offering policy implications.

2. LITERATURE REVIEW

Although various studies have been conducted on herding behaviour in markets outside the European Union, this research focuses on herding behaviour patterns in stock exchanges of EU candidate countries. Therefore, studies conducted outside the European Union will be discussed only to provide a general framework. For example, Solakoglu and Demir [10] examined the emotional herding behaviour exhibited by investors in Borsa Istanbul depending on their level of knowledge and revealed significant differences between informed and uninformed investors. Similarly, in a study conducted by Demir and M.N. Solakoglu [11] in frontier markets in the Middle East, the extent to which local and global factors affect herding behaviour was analysed. Although these studies provide important clues about how herding behaviour is shaped in markets outside the European Union, this research will focus more on the European Union stock exchanges.

Literature on European markets generally focuses on topics such as market integration, contagion between markets, and market efficiency, apart from herding behaviour [12-15]. One of the studies on herding behaviour, by Lipschitz, et al. [16] states that the intense capital flows into Central and Eastern European markets are a factor that drives the economies towards emotional market behaviour (Market Sentiment). Caparrelli, et al. [17] identified the presence of herding behaviour in the Italian Stock Exchange between 1988 and 2001 using the Christie and Huang [18] and CCK methods. Kizys and Pierdzioch [19] based on the state-space model, suggest that the expectations of EU membership in regional economies disrupt market expectations, create an environment of uncertainty, and ultimately lead investors to a state of indecision.

Research on herding behavior within the European Union region remains relatively scarce. Among the notable studies, Mobarek, et al. [20] analyzed daily stock market data from 2001 to 2012 for countries including Germany, France, Portugal, Italy, Ireland, Greece, Spain, Sweden, Norway, Denmark, and Finland. Although they did not detect significant herding at the individual country level, they identified substantial herding tendencies during periods of financial crisis and under specific market conditions.

Similarly, Angela-Maria, et al. [21] explored herding in Central and Eastern European (CEE) stock markets over the 2003–2013 period, particularly during crises, and concluded that investors exhibited a clear inclination towards herding.

Table 1. Investigations into non-stock market herding behavior within the EU.

Author(s)	Topic and study	Period	Model	Main findings
Scharfstein and Stein [22]	Study of flock behaviour.	1987-1990	Learning model.	They concluded that portfolio managers imitate each other by being influenced by each other's decisions.
Christie and Huang [18]	The impact of herding behavior on prices	1962-1988	The study employed the cross-sectional standard deviation (CSSD) of returns and utilized the model introduced by Christie and Huang (CH).	The CSSD results indicated that herding tendencies are more pronounced during bullish market conditions compared to bearish ones.
Chang, et al. [23]	Examining herd behaviour in stock markets.	1963–1995	CSAD, CH model and CCK model	Herding behaviour was identified in both the U.S. and Hong Kong stock markets, particularly during times of significant market fluctuations.
Hwang and Salmon [24]	Herd behaviour and stress in markets.	1993-2002	Hwang and Salmon (HS)	They detected signs of herding in both upward (bullish) and downward (bearish) market trends.
Tan, et al. [25]	Investor herding patterns in China's equity markets.	1994-2003	CH	Evidence of herding tendencies was identified in the Shanghai and Shenzhen stock exchanges.
Chiang and Zheng [26]	Analysis of herd behaviour in global stock markets	1988-2009	CCK	Herding behaviour has been confirmed in both advanced economies and various Asian stock markets, excluding the United States. In contrast, such behaviour has not been observed in Latin American stock markets, except during times of financial crises.
Angela-Maria, et al. [21]	An empirical analysis of herd behaviour in the stock markets of Central and Eastern Europe throughout the global financial crisis.	2003- 2013	CCK	Evidence of herding tendencies was observed in the stock exchanges of Croatia, Hungary, Latvia, Lithuania, and Slovenia during the global financial crisis.
Yousaf, et al. [27]	Evidence of investor herding in the Pakistani stock market during the holy month of Ramadan.	2004-2014	CH and CCK	There is no clear evidence of herding behavior during bullish or bearish market phases, nor during times of low or high volatility; however, signs of herding were observed specifically during the Eid al-Fitr holiday.
Júnior, et al. [28]	Examination of herding tendencies within commodity markets.	2018-2020	CCK	In the U.S., the S&P and GSCI indices have indicated the presence of herding behavior across fifteen different commodity markets.

Author(s)	Topic and study	Period	Model	Main findings
Kanojia, et al. [29]	Effect of herd behaviour on stock returns in the Indian equity market.	2009-2018	CCK	Some findings suggest a lack of herding behavior altogether.
Jiang, et al. [30]	Investor herding patterns in Asian financial markets throughout the COVID-19 pandemic.	2020- 2021	CH, CCK, HS and MS	Strong herding tendencies have been observed among stocks with high volatility. Additionally, it has been concluded that herding behaviour intensified during the market decline in 2020.
Li, et al. [31]	Influence of social media in detecting irrational herding behavior in stock trading.	2019–2021	HS CCK Ren and Wu	In the Chinese market, herding behavior has been documented, and it has been found that social media significantly influences investors' irrational herd-like decisions.
Keskin [32]	Fan herd behaviour after wins and losses of publicly traded football teams.	2013-2024	Logistic Regression	AFC Ajax's match-winning is significantly related to the increase in its stock price.

Fang, et al. [33] applying the Christie and Huang [18] approach, found that herding behaviour intensified in Eastern European stock markets during the COVID-19 outbreak. Ferreruela and Mallor [34] examined herding patterns throughout the 2008 Global Financial Crisis and the COVID-19 pandemic in the Spanish and Portuguese markets. Using daily data and the Chang, Cheng, and Khorana (CCK) methodology, their results revealed the presence of herding before the 2008 crisis. Although this behaviour diminished post-crisis, it reappeared later. Notably, during the COVID-19 period, herding was absent in Spain's stock market but resurfaced afterwards. Conversely, in Portugal, herding behaviour was observed during the pandemic, but evidence for such behaviour faded in the post-pandemic phase.

Examined the effects of influencer marketing strategies on Generation Z consumers on social media platforms, investigating how these strategies shape group-based consumption behaviors of this generation. The study highlighted that the characteristics of influencers, such as credibility and authenticity, create common brand preferences and loyalty trends among Generation Z individuals. These findings are similar to the herding behavior frequently observed in financial markets, as individuals tend to follow the behavior of the group rather than making independent, rational decisions. In this respect, the research demonstrates that consumer behaviors shaped by social media influence align with the psychological patterns of investor behavior.

A summary of literature on the identification of herding behavior outside of EU stock exchanges is presented in Table 1.

Keskin and Aytüre [35] analyzed investor herding tendencies in Eastern European stock markets over the 2013–2023 period using three distinct methodological approaches.

3. MODELS AND DATA

In this study, the stock exchanges of Bosnia and Herzegovina, Serbia, and Ukraine were examined over the period from January 2010 to October 2024. The selection of this time frame is primarily based on the fact that it corresponds to a phase in which these countries made significant progress in their European Union (EU) accession processes and underwent notable transformations in their market structures. The post-2010 period marks the deepening of these countries' relations with the EU, during which they either submitted official membership applications, obtained candidate status, or initiated accession negotiations. Specifically, Bosnia and Herzegovina applied for membership in

2016 and was granted candidate status in 2022; Serbia became an official candidate in 2012 and started accession talks in 2014; and Ukraine applied for EU membership in 2022 and received candidate status in the same year. The commonality among these three countries lies in their shared experience as post-socialist economies pursuing EU membership through similar political, economic, and financial reforms. This makes them suitable for a comparative analysis of how alignment with EU norms may have influenced the development and efficiency of their capital markets.

In this study, traces of herding behavior in the stock markets of Bosnia and Herzegovina, Serbia, and Ukraine, which are among the candidate countries for the European Union, were examined. Daily closing price data were used in the analysis covering the period between January 2010 and October 2024. The data were obtained from the website [36].

Researchers in the second group on herd behavior have defined herd behavior toward the market as "market-wide" and have conducted their empirical studies based on hypotheses that are essentially the same but vary according to their assumptions. Among the studies in this group, Christie and Huang [18] have taken the cross-sectional standard deviations (CSSD) of stock returns as the basic indicator for empirical applications. The hypothesis suggests that during periods of extreme market conditions or stress, investors tend to align their actions with overall market expectations, exhibiting herding behavior. As a result of this collective movement, the returns of individual stocks or portfolios converge, leading to a reduction in the dispersion of returns, i.e., a decrease in their standard deviations. The model they propose to test this hypothesis is as follows:

$$CSSD_t = \alpha + \beta_1^L D_t^L + \beta_2^U D_t^U + \varepsilon_t \qquad (1)$$

In this relation

$CSSD_t$ = On date (month) t, the cross-sectional standard deviation among all stock returns is,

D_t^L = Dummy variable showing the bottom 1% or 5% returns when market returns are ranked from smallest to largest (D_t^L=1 if not ^{DtL} =0).

D_t^U = is a dummy variable showing the top 1% or 5% returns (D_t^U =1, if not D_t^U = 0).

The error term εt is assumed to have a normal distribution with a mean of zero and a constant variance. The condition that proves herd behaviour is that the coefficients of the dummy variables are $\beta_1^L < 0$ ve $\beta_2^U < 0$, both have a (-) sign, and are also statistically significant.

The second model builds on the hypothesis proposed by Chang, et al. [23]. Unlike the use of CSSD, their approach relies on examining cross-sectional standard deviations (CSAD) derived from the absolute values of stock returns. For this purpose, they grouped the market (stock market) returns into two groups as winners $CSAD_t^{UP}$ and losers $CSAD_t^{Down}$ and applied a multiple regression for each as follows:

$$CSAD_t^{UP} = \alpha + \gamma_1^{UP} \rightleftarrows |r_{mt}^{UP}| + \gamma_2^{UP}(r_{mt}^{UP})^2 + \varepsilon_t$$
$$CSAD_t^{Down} = \alpha + \gamma_1^{Down} \rightleftarrows |r_{mt}^{Down}| + \gamma_2^{Down}(r_{mt}^{Down})^2 + e_t \qquad (2)$$

In this context, $CSAD_t^{UP}$ is the cross-sectional Absolute Deviations (CSAD) of the absolute values of returns for the winning periods, $CSAD_t^{Down}$ is the cross-sectional standard deviation of the absolute values of returns for the losing periods, $\rightleftarrows |r_{mt}^{UP}|$ is the return of the winners, and the second term (γ_1^{UP}) is the square of the returns.

In the second equation, $\rightleftarrows |r_{mt}^{Down}|$ denotes the absolute return values observed during the losing periods, while the second component corresponds to the squared returns. The error terms are presumed to follow a normal distribution with a mean of zero and constant variance. Chang, et al. [23] hypothesized that the coefficient related to the linear return variable should be $\gamma_1 > 0$ and significant, and the coefficient related to the quadratic return variable should be $\gamma_2 < 0$ and significant as an indicator of herd behaviour. Because in this case, the linearity assumption of the CAPM hypothesis will be invalid, and at the same time, the cross-sectional standard deviations of the returns will decrease both from above (For winners) and below (For losers), and thus, it will be revealed that investors act together and approach the market average return.

The third model related to herding behaviour is the hypothesis proposed by Hwang and Salmon [24] and takes the cross-sectional distribution of stock betas as the basic indicator, not market returns. Hwang and Salmon [24] introduced a new concept and argued that herding behaviour in the stock market cannot be observed, but can be revealed econometrically, and they named this behaviour "Sentimental Herding". In this study, the Hwang and Salmon [24] hypothesis was also tested for the stock markets of Serbia, Bosnia-Herzegovina and Ukraine. The assumptions and relations of this model are given below;

Hwang and Salmon [24] assumed that the empirical beta estimated for stock i in market m, for period t, is biased in the short term by (β^{b}_{imt}), The expected return $E_t(r_{it})$, of such a stock according to CAPM would be as follows;

$$E_t(r_{it}) = \beta_{imt}\, E_t\,(r_{mt}) \text{ and so } \frac{E^b_t(r_{it})}{E_t(r_{mt})} = \beta^b_{imt} \qquad (3)$$

In this relation, in the short term, for stock i, the conditional expectation of return at time t and the corresponding beta are both biased. According to the Hwang and Salmon [24] hypothesis, the latent and unobservable herd behaviour parameter "h_{mt}" is a proportional difference between the true beta β_{imt} and the market value of "1". Thus, the biased beta is obtained by subtracting the herd behaviour parameter estimate from the true beta:

$$\beta^b_{imt} = \beta_{imt} - h_{mt}(\beta_{imt} - 1) \qquad (4)$$

If there is no herding behaviour, it is h_{mt}=0. Thus, the observed beta is equal to the true beta, $\beta^b_{imt} = \beta_{imt}$. . If it is h_{mt} = 1, it is $\beta^b_{imt} = 1$, so the biased beta is equal to the market beta, "1". So all betas are equal to the market beta, which means perfect herding. However, if the result is $0 \le h_{mt} \le 1$, this indicates that there is some herding behaviour in the stock market. The intensity of herding behaviour depends on $h_{mt} \to 1$. Finally, if the model gives a result of $h_{mt} < 0$ for certain periods, this means adverse herding behaviour for that period. The cross-sectional standard deviation (CSBD) of Equation 2 is as follows;

$$SD_c\,(\beta^b_{imt}) = SD_c\,(\beta_{imt})\,(1 - h_{mt}) \qquad (5)$$

Here, the subscript c means the horizontal section. If it is assumed that $SD_c(\beta_{imt})$ will not change or will not undergo a significant change in the short term, $SD_c(\beta^b_{imt})$ the deviations that occur are attributed to herd behaviour. If the logarithm of the above Equation 3 is taken, the following equation is obtained:

$$ln\,[SD_c\,(\beta^b_{imt})] = ln\,[SD_c\,(\beta_{imt})] + ln\,(1 - h_{mt}) \qquad (6)$$

If it is assumed that the term $\ln [SD_c(\beta_{imt})]$ in this relation will remain constant, this term will be a constant coefficient μm and will be defined as $\ln(1- h_{mt}) = H_{mt,\text{ and}}$ if it is also assumed that H_{mt} is generated by an autoregressive AR(1) process with a one-term lag, the system will transform into a state-space model as follows.

Signal equation

$$H_{mt} = \varphi\, H_{mt-1} + \eta_{mt} \quad \text{State equation.} \quad (7)$$

Here $v_{mt} \sim iid\ (0,\sigma^2_{mv})$ and $\eta_{mt} \sim iid\ (0,\sigma^2_{m\eta})$ are. This system of equations is easily solved with the Kalman filter. Two parameters are very important in this model:

The first is η_{mt}; the variance associated with the error term is $\sigma^2_{m\eta}$.

Secondly, the persistent parameter φ related to the AR(1) process must be statistically significant. The significant variance ($\sigma^2_{m\eta}$) indicates that the herd behaviour indicator Hmt is different from zero, that is, $H_{mt} \neq 0$. In addition, it requires the absolute value of the persistence parameter φ to be smaller than "1", that is, $|\varphi| \le 1$. This situation guarantees that the herd behaviour path continues in a controlled manner, not in an exploding manner. However, to provide stronger evidence for herd behaviour, it is necessary to obtain a new solution by adding the stock market returns and the standard deviations of these returns to the signal relation of model (7). This process is meant to re-test the model. The reason is as follows. While the solutions of model (7) above indicate that there may be herd behaviour, the H_{mt} obtained from this solution may have been caused not only by the emotional herd behaviour effect but also by the dynamics in the national stock market index. If the stock market returns and the standard deviations

of these returns added to the signal relation are found to be significant with the new solutions, and if the two key parameters mentioned above (variance varyans $\sigma^2_{m\eta}$ and persistent parameter φ) are still found to be significant, this is an important finding and test showing that the herd behavior finding is strong [24]. Accordingly, the new model used for testing will be as follows;

$$\ln\left[Std_c\left(\beta^b_{imt}\right)\right] = \mu_m + H_{mt} + \theta_{c1} ln\, \sigma_{mt} + \theta_{c2} r_{mt} + v_{mt}$$
$$H_{mt} = \varphi_m H_{mt-1} + \eta_{mt} \quad (8)$$

Here, the two error terms are white-noise, $\ln\sigma_{mt}$ is the standard deviation (Log) of the national index returns and r_{mt} is the returns of the national index. Finally, the cross-sectional standard deviations of the betas are found with the following formula:

$$Std(\beta)_t = \sqrt{\frac{\sum_{i=1}^{n}(beta_{it} - \overline{beta}_t)^2}{n-1}}$$

Thus, in summary, in the stock exchanges of the three important countries of the CEE region, Serbia, Bosnia and Herzegovina, and Ukraine, herd behaviour searches were conducted based on two different hypotheses that are most valid today, and the results are presented in the following sections.

3243 daily and 162 monthly closing price data covering the period from January 2011 to June 2024 were used for stocks traded on the Serbian BELEX, Bosnia and Herzegovina BIRS, and Ukraine PFTS stock exchanges. From these data, observations were obtained on both a daily and a monthly basis as log-returns. Both monthly returns and beta coefficients were calculated for each month and each stock from the daily data. Volatility in stock exchanges is shown in Figure 1. In Figure 1, which expresses the monthly change compared to the previous month's closing, it is seen that volatility was generally low, but the Ukrainian stock exchange had more volatility than Bosnia and Herzegovina and Serbia until the war period.

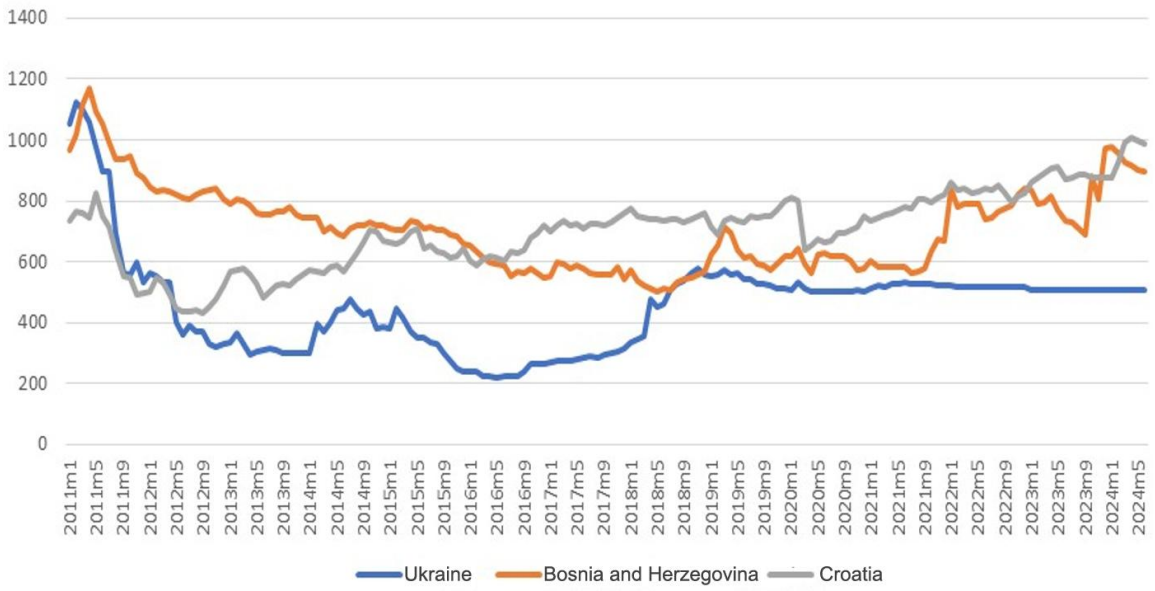

Figure 1. Volatility in stock indices.

4. FINDINGS AND DISCUSSION

The findings obtained for herd behaviour searches in the Ukrainian, Bosnian-Herzegovinian and Serbian stock exchanges are given in Table 2 for the Christie and Huang [18] hypothesis, in Table 3 for the Chang, et al. [23] hypothesis and in Table 4 for the Hwang and Salmon [24] hypothesis, respectively.

In the hypothesis of Christie and Huang [18] it was found that the conditions of, $\beta_1^L < 0$ and $\beta_2^U < 0$, which are put forward as evidence of herding behavior, are met only in the BIRS stock exchange of Bosnia and Herzegovina,

but in the three stock exchanges, both coefficients are not statistically significant (p>0.05). Considering that the coefficients are not significantly different from zero and do not have a negative sign, it can be said that there is no evidence of herding behavior under extreme market conditions (maximum return and minimum return) in the three stock exchanges (Table 2).

Table 2. Testing of herd behavior with Christie and Huang [18] hypothesis, stock exchanges of Ukraine, Bosnia and Herzegovina, and Serbia, 2011–2024.

Country stock exchanges	Ukraine PFTS		Bosnia-Herzegovina BIRS		Serbia BELEX	
	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic
Constant coefficient	2.634	1013.41**	2.740	1384.22**	2.635	1013.64**
D^L %5 least	0.030	1787n	-0.007n	-0.495n	0.030n	1.791n
D^U %5 most	0.005	0.266n	-0.004n	-0.275n	0.012n	0.658n
R-squared corrected	0.001		0.000		0.001	

Note: **Significant at α=0.01, *Significant at α=0.05 n=Insignificant.

According to the findings related to the hypothesis of Chang, et al. [23] (Table 3), herding behaviour patterns were not observed in the stock markets of both countries. As stated above, the conditions for evidence of herding behaviour were put forward as follows: the coefficient of the return variable being $\gamma_1 > 0$ and being significant, and the coefficient of the variable, which is the square of the returns (quadratic), being $\gamma_2 < 0$ and being significant.

As seen in Table 3.

- On the Ukrainian and Serbian stock markets, during the losing periods, the linear term is found to be positive, while the squared term is negative and statistically significant. A similar pattern is observed during the winning periods, with a positive linear term and a negative, significant squared term. These results indicate that the necessary conditions for detecting herding behavior are present in both market phases for Ukraine and Serbia.
- At the Bosnian-Herzegovinian stock exchange, the coefficient is negative during the losing period and positive during the winning period; however, both terms lack statistical significance. This indicates that the necessary conditions to confirm herding behaviour are not satisfied in either market phase. Therefore, based on the test results derived from the Chang, et al. [23] model, there is no indication of herding behaviour in the Bosnian-Herzegovinian stock exchange.

Table 3. Testing the herd behavior with the Chang, et al. [23] hypothesis, stock exchanges of Ukraine, Bosnia and Herzegovina, and Serbia, 2011–2024.

	Ukrainian PFTS		Bosnia and Herzegovina BIRS		Serbia BELEX	
Losing periods	**Coefficient**	**t-statistic**	**Coefficient**	**t-statistic**	**Coefficient**	**t-statistic**
Constant coefficient	2.573	352.95**	2.739	540.71*	2.574	352.08*
R^{down} Linear term	0.054n	**4.778****	-0.004n	-0.447n	0.054n	**4.829****
R^{down} Squared term	-0.006n	**-2.627****	0.0005n	0.343n	-0.007n	**-2.832****
R-squared	0.033		0.000		0.031	
Winning periods	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic
Constant coefficient	2.577	403.79**	2.736	598.77*	2.578	396.75*
R^{up} Linear term	0.030	**4.839****	0.003n	0.704n	0.031n	**4.833****
R^{up} Squared term	-0.001	**-3.344****	-0.0002n	-0.768n	-0.001n	**-3.362****
R-squared	0.022		0.000		0.022	

Note: **Significant at α=0.01, *Significant at α=0.05 n=Insignificant.

The third approach to investigating herding behavior relies on the hypothesis proposed by Hwang and Salmon [24]. Unlike methods based on market returns, this hypothesis focuses on the cross-sectional distribution of asset betas. In the empirical analysis, the logarithm of the cross-sectional standard deviations of betas serves as the dependent variable. Both the baseline state-space model described by Equation 7 and the robustness-checked state-space model outlined in Equation 8 are employed in the analysis. The estimations are carried out using the Kalman filter technique.

The findings obtained based on the Hwang and Salmon [24] hypothesis for the stock exchanges of Ukraine, Bosnia and Herzegovina, and Serbia are summarized in Table 4.

It was determined that two parameters (state relation and related error term variance σmη) are significant in the base model for the Ukrainian stock market, while the other two parameters (persistent coefficient (φm) estimate related to AR(1) process and φm) are not significant. Consequently, the results of the base model (7) do not offer strong evidence supporting the existence of emotional herding behavior in the Ukrainian stock market. The persistence parameter estimate for Ukraine in the base model is φ = 0.900 and statistically significant, indicating that investors in this market tend to exhibit stable behavior.

This suggests that participants in the Ukrainian stock market are able to return to equilibrium relatively quickly, adhering to the fundamental principles of the market mechanism. When the full model is analyzed, it becomes apparent that two parameters previously significant in the base model lose their significance, while two others that were not significant in the base model become statistically meaningful. Regarding the volatility of returns (standard deviation) in the Ukrainian stock market, the coefficient in the full model is 0.129, which does not meet the α = 0.05 significance threshold. In other words, an increase in return risk does not lead to a statistically significant change in the cross-sectional beta standard deviation for the Ukrainian market. This elasticity coefficient shows that $\ln[Std_c(\beta^b_{imt})]$ it is not affected as the stock market risk increases in Ukraine. This situation (although borderline) indicates that there is no herding behaviour in the Ukrainian stock market, and investors pay attention to return rather than volatility (risk).

In the case of the Bosnian-Herzegovinian stock market, none of the parameters in the base model were found to be statistically significant. Therefore, the findings from the base model (7) do not offer any indication of emotional herding behaviour in this market. The persistence parameter estimate for Bosnia and Herzegovina is φ = -0.567, which is also not statistically significant, suggesting that investors in this market demonstrate lower persistence compared to those in the Ukrainian stock market.

When the full model is assessed, a similar pattern emerges, with none of the parameters showing statistical significance, just as in the base model. Specifically, the coefficient related to return volatility (standard deviation of returns) in the Bosnian-Herzegovinian stock market is -0.095 in the full model and fails to reach significance at the α = 0.05 level. This implies that changes in return risk in this market do not lead to a statistically significant change in the cross-sectional beta standard deviation. This elasticity coefficient shows that $\ln[Std_c(\beta^b_{imt})]$ it is not affected as the stock market risk increases in Bosnia and Herzegovina. This situation shows that there is no herd behaviour in the Bosnian-Herzegovinian stock market and investors pay attention to return rather than volatility (risk).

In the Serbian stock market, none of the parameters in the base model were found to be statistically significant. As a result, the outcomes of the base model (7) do not offer any evidence supporting the presence of emotional herding behaviour in this market. The persistence parameter estimate for Serbia is φ = 0.175 and is not statistically significant, indicating that investor behaviour in the Serbian market is less persistent than in the Ukrainian market but more persistent than in the Bosnian-Herzegovinian market.

An evaluation of the full model reveals a similar outcome none of the parameters reach statistical significance, consistent with the base model results. The coefficient associated with return volatility (standard deviation of returns) for the Serbian stock market in the full model is 0.148, which does not achieve significance at the α = 0.05 level. This suggests that fluctuations in return risk do not have a statistically significant effect on the cross-sectional beta standard deviation in the Serbian market.

This elasticity coefficient shows that $\ln[Std_c(\beta^b_{imt})]$ it is not affected as the stock market risk increases in Serbia. This finding indicates that herding behavior is absent in the Serbian stock market, and investors tend to prioritise returns over volatility (risk).

Table 4. Herd behavior findings from State-Space models for the stock exchanges of Ukraine, Bosnia and Herzegovina and Serbia.

	Ukrainian PFTS		Bosnia and Herzegovina BIRS		Serbia BELEX	
	Base model	Full model	Base model	Full model	Base model	Full model
μ	-0.005n	-0.004n	-0.0005n	-0.005n	1.573n	1.570n
φ_m	0.900**	0.126n	-0.567n	-0.623n	0.175n	0.243n
σ_{mv}	0.0001n	0.004**	0.003n	0.0002n	621.53n	437.05n
$\sigma_{m\eta}$	0.003**	-0.00001n	0.0018n	0.0018n	121.36n	298.47n
Ln (σof return)	-	0.129n	-	-0.095n	-	0.148n
Return	-	-0.004n	-	-0.0005n	-	1.573n
$\sigma_{m\eta/SD(ln\beta)}$	-	0.004	-	0.0022	-	0.242
Log-Likelihood	220.996	-187.908	263.244	-79.427	-760.949	-990.629
Schwartz criterion	-	2.475	-	1.119	-	12.509

Note: Coefficients with ** are significant at α=0.01. The intercept of the signal equation is μ, ϕm is the autoregressive (degree one) persistency parameter associating the one-lag herd indicator Ht of the state equation with Ht-1, σmv is the standard deviation of the signal equation error, and σmη is the standard deviation of the state equation error. Schwarz IC is for model selection: the lower values indicate that the …….. market fit is better.

5. CONCLUSION

Herding behavior is a problem worth researching because it can lead to inefficient markets in stock exchanges and can result in incorrect determination of capital asset pricing. In this case, CAPM becomes invalid.

This study focuses on the stock markets of Ukraine, Bosnia and Herzegovina, and Serbia, three nations currently holding candidate status for European Union membership. The presence of herding behavior in these markets has been analyzed using the methodologies developed by Christie and Huang [18]; Chang et al. (2000) and Hwang and Salmon [24].

In the Christie and Huang [18] method, it is found that there is no evidence of herding behaviour in all three stock exchanges and that investors exhibit herding behaviour in extreme market conditions, whether upward or downward.

Using the method proposed by Chang, et al. [23], no evidence of herding behaviour was detected in the Bosnian-Herzegovinian stock exchange. Therefore, based on this approach, it cannot be concluded that investors in this market engage in herding behaviour. In contrast, the same method indicates that herding behaviour is present among investors in the Ukrainian and Serbian stock markets.

However, the Hwang and Salmon [24] approach leads to a different conclusion. According to this method, there is insufficient evidence of herding behavior across all three stock exchanges. It suggests that emotional herding does not occur during periods of extreme market movements, whether in upward or downward trends.

According to these findings, attention should be paid to an important question that needs to be examined:

"Why do the first two hypotheses show herd behaviour, while the Hwang and Salmon [24] hypothesis provides statistical support for the absence of emotional herd behaviour?" The reason for this lies in the perspective of investors on the risks in the market in both stock exchanges. Players who buy/sell capital assets may not care about the total risk in the market, but only about the market risk. As is known, CAPM is in the form of Rit = αt + βit Rmt + eit as the market version. The variance expression of this model is σ2it = β2it σ2mt+ σ2it. Here, the variance on the left side of the equation is the total risk of the capital asset (which can be a stock or a portfolio). The overall risk is composed of two separate components on the right-hand side of the equation. The first is the systematic risk known as β2it σ2mt market risk, and the second is the risk of institutions that put capital goods on the market, i.e., the non-systematic (idiosyncratic) risk. Both Christie and Huang [18] and Chang, et al. [23] models take into account total risk (i.e., the risk built into the return). In other words, they take into account both market risk and institutional risk at the same time. Investors may know that they cannot predict the behavior of the institutions that mediate them and foreign investors, and that institutional risk is important, and that this particular risk (unsystematic risk) will asymptotically approach zero, especially in portfolio investments, consciously or through feelings that they must conform to the behavior of others.

In short, it can be said that Hwang and Salmon [24] hypothesis is less suitable for the behavioural patterns of Ukrainian, Bosnian, and Serbian investors, indicating that they do not consider only betas, which are indicators of market risk, when making decisions.

Although the results of the study could not be compared with other studies due to the lack of such a study in the literature, similar results were reached with Angela-Maria, et al. [21] studies in one respect, while opposite results were reached with the findings of Filip, et al. [37] and Keskin and Aytüre [35]. The limitations of the study are that herd behaviour in the Ukrainian, Bosnian, and Serbian stock exchanges was attempted to be explained over the period covering the years 2010-2024. Additionally, among the limitations of this study is that cultural habits, sociological structures, and other elements that may cause investors to make irrational investment decisions were not evaluated. When the findings of the study are assessed, the stock exchanges of all countries that are candidates for the European Union were not included. Increasing the number of companies listed on stock exchanges in countries that are candidates for the European Union may be important in testing the existence of herd behaviour. Future studies could consider herd behaviour in different countries within the Central and Eastern European region and in large-capital stock exchanges in Northern European countries. It is believed that these studies will also contribute to the literature.

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