INVESTORS' BEHAVIOR AND MARKET SENTIMENT

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Abstract - This paper examines the effects of extreme investors' sentiments on herding behavior in five Central and Eastern European (CEE) stock markets. Our empirical research is designed to assess the asymmetric effects of two sentiment indicators, the ARMS Index and the RSI Index on herding behavior in specific industrial sectors from Poland, Hungary, Croatia, Romania, and Bulgaria. As extreme sentiments are more likely to induce herding behavior in overheated markets, we also test the impact of high optimism/pessimism on herding under excessive volatility. We report strong evidence in favor of extreme sentiment-enhanced herding. Estimation results are slightly sensitive to the choice of the sentiment indicator. During the global financial crisis, our findings indicate that high pessimism has induced herding behavior at an extensive scale in CEE stock market industries. Moreover, if investors are extremely optimistic or pessimistic when the market is characterized by high volatility, the herding effects are more pronounced. Our results are relevant both for investors, as herding behavior is likely to affect the portfolio optimization process, and for the CEE markets regulators as herd behavior is likely to prevent capital markets from achieving financial stability.

Keywords- Herding Behavior, Investors' Sentiments, Financial Crisis, High Volatility

I. INTRODUCTION

During the last decades, numerous empirical and experimental studies have revisited the conventional financial theory, providing overwhelming evidence on its shortcomings. The standard theory of efficient capital markets and rational investors with homogenous expectations fails to explain common market anomalies and behavioral biases accompanying trading strategies and causing the deviation of stock prices from their fundamental values. Stock markets' reality reveals systematic errors associated to the decision-making process. These errors cast a shadow on the assumption of perfect rationality and lead to inefficiency on the markets. In this paper, we address herding behavior, one of the most significant behavioral biases, considering its impact on market efficiency and asset pricing. Moreover, we are interested in analyzing the relationship between investors' sentiments and herding behavior. Herding behavior is associated to an irrational acceptance of the prevailing beliefs of a certain group. Pioneer studies on this phenomenon are attributed to mastermind psychologists such as Le Bon (1895) and Pavlov (1906). The development of cognitive psychology inspired financial researchers to also integrate behavioral factors into traditional financial decision models. Supporters of behavioral finance paradigm (Grossman and Stiglitz (1980), De Bondt and Thaler (1985), Shiller (2003)) emphasize the major impact of investors' behavioral biases on the dynamics of stock markets and on the occurrence of market crashes. Christie and Huang (1995) associate herding behavior to the ignorance of personal beliefs and the adoption of the market consensus. Shiller (2000) highlights that herding behavior occurs as investors fail to estimate the fundamental values of assets.

Empirical literature on herding behavior identifies two categories of models developed to assess mimicking actions on stock markets. The first category highlights investors' mimicry towards the strategies of other market participants (Lakonishok et al. (1992), Wermers (1999)), while the second branch of models makes reference to investors' tendency to follow the market consensus (Christie and Huang (1995), Chang et al. (2000), Hwang and Salmon (2004, 2007)). Previous studies on herding behavior are mainly focused on the developed and emerging capital markets of Asia and on the global stock markets and to a lesser extent on European markets. Demirer et al. (2010) investigate herding behavior at industry level on the Taiwanese stock market by using the cross-sectional standard deviation (CSSD) method developed by Christie and Huang (1995), the cross-sectional absolute deviation (CSAD) method developed by Chang et al. (2000) and the state space model of Hwang and Salmon (2004). The results obtained are mixed. The CSSD method provides weak evidence of herding behavior, only for two sectors, rubber and electronics. On the other hand, the CSAD method highlights the presence of herding behavior in almost all sectors, except for tourism and automobile, with a more pronounced occurrence during periods of market decline. In the same direction, the results provided by the state space model emphasize that the presence of investors' mimicry is more powerful during periods of market stress and high volatility in plastics, electrical, chemicals, pulp, steel, automobile, tourism and retailing sectors. Yao et al. (2014) examine herding behavior in Chinese stock markets, both Shanghai Stock Exchange (SHSE) and Shenzhen Stock Exchange (SZSE), by using the CSSD methodology. They fail to detect herding at the market level, but they identify intensive herding activity in 15 out of 21

analyzed sectors. Demirer et al. (2015) study the connection between industry herding and return momentum for the Chinese stock market, by using the CSSD and the CSAD methods. The analysis is performed on 50 industries, grouped in winners and losers, according to the value of their past six month returns. The results highlight that the level of herding influences the performance of the momentum strategies within specific industries. An asymmetric effect of herding on momentum returns was identified for loser industries. Loser industries with low level of herding outperformed loser industries with high level of herding.

Chen (2013) investigates investors' tendency to follow the market consensus on a sample of 69 stock markets, including development, emerging, and frontier markets. The results differ depending on the employed methodology. The findings of CSSD method provides no evidence of herding behavior, while the CSAD method shows that herding effect is more pronounced for developed markets, followed by frontier and emerging markets. By applying the state space model the author detects herding behavior towards the market consensus.

Although the investors' herding behavior is an actual topic in the literature, due to its impact on the stock market dynamics, there is weak evidence of herding in European markets. Economou et al. (2011) examine herding behavior in the PIGS countries for the period January 1998–December 2008. By using the CSAD methodology, they discover the existence of herding mainly in the Greek and the Italian markets. For the Portuguese market, the evidence are mixed, while for the Spanish one, there are no proves of herding. Mobarek et al. (2014) investigate herding behavior among European countries (continental, Nordic and the PIIGS) during 2001-2012. This phenomenon is pronounced in most continental countries and in the PIIGS during the global financial crisis. The Nordic countries were more affected by the Eurozone sovereign crisis than PIIGS. This might be due to the bailout packages offered to the PIIGS during the Eurozone crisis. Andrikopoulos et al. (2017) study herding on the Euronext at intraday level and they provide evidence that support the presence of herding in the Euronext as a group. Herding is identified on the Euronext market before, during and after the global financial crisis, being the weakest during the crisis. When investigating the country effect, the authors find that herding is significant in Belgium, France, and Portugal, but not in the Netherlands. A possible explanation is that on the Dutch market activate mainly foreign investors, who are more sophisticated and take investment decisions related to the international context, rather to the local one. In what concerns the CEE region, Pochea et al. (2017) study investors herding behavior toward the market consensus in ten countries. They are also interested in the impact of different market conditions such as up or down market, high or low volatility, and high or low trading volume on herding behavior. The only country that doesn't exhibit herding is, surprisingly, Romania. Also, Filip et al. (2015) analyze herding behavior at industry level in Poland, the Czech Republic, Hungary, Romania, and Bulgaria during 2008-2010 and they report week evidence of herding in several industries.

Considering that mimicking behavior is likely to be induced by extreme market sentiments, we aim to identify the relationship between them. Market sentiment encompasses investors' beliefs about future returns and risks, and it is proxied through the movements of prices and trading volumes. There are several studies that analyze the relationship between investors' sentiment and different stock market variables such as: market liquidity, stock returns, trading volume, and volatility (Corredor et al. 2013, Debata et al. 2018, Siganos et al. 2014, Chau et al. 2016, Dash and Maitra, 2017). The relationship between herding behavior and market sentiment is poorly explored in the literature. For measuring the impact of market sentiment on herding behavior, Bekiros et al. (2017) use two implied volatility indices, VXO and VXD, respectively. Their findings show that market sentiments, such as fear, play a key role in increasing irrational behavior.

Considering the limited research on the impact of investors' sentiments on herding behavior, our paper fills a gap in the existing literature. Moreover, our paper extends the existing studies by providing industry level evidence of the impact of extreme sentiments on herding behavior in periods of market stress. For this reason, our database encompasses time series before, during and after the global financial crisis. We use firm level data on stock prices (from January 2, 2003 to December 31, 2013) for 218 CEE companies listed in Poland, Hungary, Croatia, Romania, and Bulgaria. It is expected that herding behavior is more accurately detected at industry level, due to common characteristics in terms of knowledge and information inside a group. Therefore, in order to provide a deeper analysis we estimate herding behavior at the level of seven economic sectors including four industries such as Agriculture, Constructions, Financial, Manufacturing and three groups of mutually dependent industries such as Electronics, oil and chemicals, Health and pharmaceutical, Hotels and services.

Most empirical studies focused on herding refer to large time spans. Given that investors' irrational behavior is more likely to occur during periods characterized by extreme market conditions, such as crisis or high volatility, we aim to identify herding when investors are highly pessimistic during financial crisis. The empirical evidence on herding behavior documents that under market stress investors are more likely to abandon private information and to

exhibit herding behavior. We assume that extreme sentiments are more likely to induce herding behavior in an overheated market characterized by high volatility. Therefore, we test the impact of high optimism/pessimism on herding under high market volatility.

In line with the above-mentioned aims, we formulate some research questions, and we summarize the results as follows. 1. Is there evidence of herding behavior at industry level on the CEE stock markets? Herding behavior is detected in Agriculture (Bulgaria), Constructions (Croatia), and Electronics, oil and chemicals (Hungary). Romania and Poland exhibit no herding behavior at industry level on our sample period. 2. Does investors' sentiments such as optimism or pessimism impact herding behavior? Our findings show that all countries faced herding behavior in some industries under extreme sentiments. 3. Are the results sensitive to the use in the model specification of different sentiment indicators? The Relative Sentiment Indicator (RSI) is constructed only based on closing prices, while the ARMS is focused on trading volumes and number of price advancing /declining stocks. The use of the RSI as a proxy for market sentiment, provides evidence of herding behavior especially when investors are pessimistic, while the ARMS indicator fails to detect herding under extreme pessimism. On the contrary, when using the ARMS indicator, the results show that investors are more prone to follow the market when they are optimistic. 4. Did investors' sentiments during the global financial crisis have an impact on herding behavior? We tested the impact of investors' pessimism on herding behavior during the crisis, using both the ARMS and RSI as proxies for market sentiment. Our results confirm the impact of extreme pessimism on herding behavior in all countries, except for Poland. 5. Do investors' sentiments induce herding behavior under high volatility? Our findings confirm that herding behavior is an extended phenomenon in overbought/oversold volatile markets.

The paper is structured as follows: Section 2 highlights the methodology used to investigate herding behavior at industry level over the entire period, herding behavior under extreme market sentiments, the impact of extreme sentiments on herding during the global financial crisis and the impact of extreme sentiments on herding under high volatility; Section 3 describes the datasets; Section 4 outlines the empirical results and the last section concludes.

II. METHODOLOGY

To assess the impact of investors' sentiments on herding behavior, we will adapt the methodologies developed by Christie and Huang (1995) and Chang et al. (2000). Christie and Huang (1995) were the first to develop a methodology (CH) aiming to assess herding behavior towards the overall market. The authors argue that investors are more likely to abandon their private information during periods of market stress. They propose a regression model that relates the stocks returns dispersion to extremely high/low market returns through two dummy variables:

$$D_t=\alpha+\beta_1 \cdot H_t+\beta_2 \cdot L_t+\varepsilon_t \quad (1)$$

where H and L are dichotomous variables which equal 1 if the market return in day t lies in the 1% (5%) upper tale (H), respectively lower tale (L) of the market returns distribution, and 0 otherwise.

The coefficients β_1 and β_2 are expected to be positive and statistically significant if rational asset pricing models prevail. In this case, extreme market fluctuations induce an increase in stocks' dispersion. Statistically negative coefficients indicate a decrease in dispersion during periods of market stress, signaling the presence of herd behavior.

Chang et al. (2000) argue that under herding behavior, during periods of relatively large market price movements, the relationship between return dispersions of individual stocks (D) and market return (R_M) is expected to be nonlinear. They propose the following equation (CCK) to detect herding behavior towards the market:

$$D_t=\gamma_0+\gamma_1 \cdot \left|R_{M,t}\right|+\gamma_2 \cdot R_{M,t}^2+\varepsilon_t \quad (2)$$

If the tendency to follow the market consensus increases under extreme market conditions, the dispersion between individual returns and the market is expected to decrease or to increase at a lower rate with the market return. This is captured by a negative γ_2 coefficient.

2.1 Herding behavior at industry level

We use the cross-sectional absolute deviation of stock returns as a measure for stocks' returns dispersion and we examine herding behavior based on the following empirical specifications, adapted to also capture the impact of investors' sentiment on herding behavior in specific industrial sectors:

$$D_{j,t}=\beta_{j0}+\beta_{j1}\left|R_{S_j,t}\right|+\beta_{j2}\left(R_{S_j,t}-\overline{R_{S_j}}\right)^2+\beta_{j3}D_{j,t-1}+\varepsilon_{j,t} \quad (3)$$

where $D_{j,t}$ is the cross-sectional deviation in sector j at time t, $R_{S_j,t}$ measures the cross-sectional daily return of sector j at time t, $\overline{R_{S_j}}$ is the average return in sector j.

In our regression, the coefficient β_{j1} captures the sensitivity of the dispersion to the magnitude of the sector returns. We introduced the 1-day lag dispersion to correct for the autocorrelation within the D series

and we centered the quadratic term in order to avoid multicollinearity between the absolute and the quadratic value of the sector returns.

Under extreme market conditions investors are expected to abandon their private beliefs and expectations and to follow the overall trend. As a consequence, individual stock returns are expected to cluster around the average return, resulting in a decrease of the returns dispersion. While rational asset pricing models predict a linear relationship between stocks' return dispersion and the market return (β_{j2}=0), in the presence of herding behavior the relationship is expected to be nonlinear with a negative and statistically significant β_{j2} coefficient.

2.2 Market sentiment and herding behavior

Empirical financial and psychological studies provide evidence that investors' sentiments are likely to influence the decision-making process (De Long et al., 1990; Lee et al., 2002; Baker and Wurgler, 2006). In this paper we assess the asymmetric effects of two sentiment indicators, the ARMS Index and the RSI Index, on herding behavior.

The ARMS sentiment measure (also known as TRIN from Trading Indicator) was proposed by Richard Arms in 1970 and it is a technical analysis indicator used to identify overbought/oversold securities. The index is computed by dividing the up-down ratio to the advance-decline volume ratio:

$$ARMS_t = \frac{Nup_t/Ndown_t}{Voladv_t/Voldec_t} = \frac{Voldec_t/Ndown_t}{Voladv_t/Nup_t} \quad (4)$$

where, N_{up_t} is the number of stocks in the index that closed up on the day t, Vol_{adv_t} is the total volume of advancing stocks, N_{down_t} is the number of stocks in the index that closed down on the day t, Vol_{dec_t} is the total volume of declining stocks. Thus, if the ARMS Index is above 3, the market is oversold (investors are pessimistic), and if the ARMS Index is below 0.5 the market is overbought (investors are optimistic).

The second market sentiment measure, used in this paper is the RSI, developed by J. Welles Wilder in 1978. RSI is a technical indicator assessing the magnitude of price movements and detecting the momentum (values below/above 30/70 indicate that the security is undervalued/overvalued). The index is computed in two steps. In the first step the relative strength is calculated by dividing the modified moving averages (exponentially smoothed over a period of 14 days) of the upward and downward price changes:

$$RS=\frac{MMA(U)}{MMA(D)} \quad (5)$$

where,U indicates an upward trend $U_t=P_t-P_{t-1}$; D_t=0 if the closing price in a certain day t is higher than the closing price of the previous day t-1, and D indicates a downward trend $D_t=P_{t-1}-P_t$; U_t=0 if the closing price in a certain day t is below the closing price of the previous day t-1.

In the second step the RSI is determined according to the following formula:

$$RSI=100-\frac{100}{1+RS} \quad (6)$$

For highlighting the relationship between investors' sentiments and their tendency to imitate other investors' strategies, we estimate the following regression:

$$D_{j,t} = \beta_{j0}+\beta_{j1}\left|R_{S_j,t}\right| +\beta_{j2}\cdot P_{j,t}\cdot\left(R_{S_j,t}-\overline{R_{S_j}}\right)^2 +\beta_{j3}\cdot O_{j,t}\cdot\left(R_{S_j,t}-\overline{R_{S_j}}\right)^2+\beta_{j4}D_{j,t-1}+\varepsilon_{j,t} \quad (7)$$

where, P and Oare dummy variable indicating that investors are either pessimistic (the market is oversold) or optimistic (the market is overbought). We roll the above regression model for both sentiment indicators, ARMS and RSI. If coefficients β_{j2} and β_{j3} are negative and statistically significant, we can conclude that investors' sentiments influence herding behavior towards the consensus of the analyzed sector, the phenomenon being consistent with an oversold, respectively an overbought market.

2.3 Impact of extreme pessimism on herding behavior during the global financial crisis

Given Christie and Huang (1995) fundamental assumption that herding behavior is more pronounced during periods characterized by market stress, we analyze the impact of extreme pessimism on herding behavior during the global financial crisis based on the following regression model:

$$D^C_{j,t}=\beta_{j0}+\beta_{j1}\cdot\left|R^C_{S_j,t}\right| +\beta_{j2}\cdot\left(R^C_{S_j,t}-\overline{R^C_{S_j,t}}\right)^2 +\beta_{j3}\cdot P_{j,t}\cdot\left(R^C_{S_j,t}-\overline{R^C_{S_j,t}}\right)^2+\beta_{j4}\cdot D^C_{j,t-1}+\varepsilon_{j,t} \quad (8)$$

where, P is a dichotomous variable which equals1 under extreme pessimism.

As sentiment indicators we use both the ARMS and the RSI. The dummy variableP equals 1 if the ARMS indicator is above 3, respectively if the RSI is below 30 indicating an oversold market and pessimistic investors' perspectives with respect to its evolution.

A negative and statistically significant β_{j2} coefficient confirms the presence of herding behavior during the

global financial crisis. As generally accepted in the literature, the starting point of the global financial crisis is associated to Lehman Brother's bankruptcy on September 2007. Beginning with January 2010, the CEE stock markets started to recover as reflected in the evolution of the main indices (SOFIX, CROBEX, BUX, WIG, and BET). Therefore, we analyze the impact of the crisis on herding behavior between September 2007 and December 2009.

A negative and statistically significant β_{j3} coefficient captures herding behavior in periods of extreme pessimism during the global financial crisis. It suggests that this behavior is not a prolonged phenomenon, but it occurs in turbulent markets associated to investors' worsening sentiments.

2.4 Herding behavior under high volatility and extreme market sentiment

Our approach is based on the intuition that unusual excitement among investors associated with high volatility is likely to induce herding behavior. We consider that the volatility in a specific sector is high when one day volatility is higher than the average volatility over the previous 30 days. The standard deviation of stocks returns is used as a volatility measure. In our analysis we are only interested in high-volatility data. The impact of investors' sentiment on herding behavior under high volatility is tested based on the following regression models:

$$D_{j,t}=\beta_{j0}+\beta_{j1}\left|R_{S_j,t}\right|+\beta_{j2}\cdot P_{j,t}^{HV}\cdot\left(R_{S_j,t}-\overline{R_{S_j}}\right)^2 +\beta_{j3}\cdot O_{j,t}^{HV}\cdot\left(R_{S_j,t}-\overline{R_{S_j}}\right)^2+\beta_{j4}D_{j,t-1}+\varepsilon_{j,t} \quad (9)$$

A negative and significant β_{j2}/β_{j3} indicate the presence of herding behavior under high volatility and pessimistic/optimistic investors' sentiment. It suggests that herding is rather a short-lived phenomenon arising in volatile markets when investors' projections are excessively somber/bright.

In order to check the robustness of our results, we also adapt the methodology developed by Christie and Huang (1995) to investigate for the impact of investors' sentiment on herding behavior:

$$D_{j,t}=\beta_{j0}+\beta_{j1}\cdot P_{j,t}+\beta_{j2}\cdot O_{j,t}+\varepsilon_{j,t} \quad (10)$$

where P and O are the dichotomous variables previously described which equal 1 under extreme market sentiments, i.e. if the market is oversold and investors are pessimistic (P), respectively if the market is overbought and investors are optimistic(O), and 0 otherwise. We use both the ARMS and the RSI as sentiment indicators, the thresholds being specified in subsection 2.2.

III. DATA

The data is represented by daily data on stock prices, on market indices quotations and trading volumes captured five years before, during and five years after the recession of 2008 from January 2, 2003 to December 31, 2013 and it is collected from Thomson Reuters Datastream. Our sample comprises 218 companies listed in five CEE countries: Bulgaria, Croatia, Hungary, Poland, and Romania.

For each market we built the ARMS and the RSI using historical daily data on the representative stock market indices, SOFIX, CROBEX, BUX, WIG, and BET. For robustness assessments, a third sentiment indicator was used, i.e. the Fear and Greed Index, computed by Bloomberg.

Our initial database comprised all CEE countries, but due to historical data scarcity at industry level we focused only on the five countries mentioned above. They have a common history as members of the former communist bloc. Nowadays, Poland is the most developed CEE country, being promoted to Developed Market status by FTSE Russell, while Hungary is classified as Advanced Emerging, and the other three markets are included into the Frontier Markets category.

Logarithmic daily returns are computed for each stock based on the following relation:

$R_{i_j,t}=\ln\left(\frac{P_{i_j,t}}{P_{i_j,t-1}}\right)$ where $P_{i_j,t}$ represents the closing price of day t for stock i from sector j.

As suggested by Chang et al. (2000), we use the cross-sectional absolute standard deviation for each industrial sector $D_{j,t}$ in order to investigate herding behavior:

$$D_{j,t}=\frac{1}{n_j}\sum_{i_j=1}^{n_j}\left|R_{i_j,t}-R_{S_j,t}\right| \quad (11)$$

$D_{j,t}$ is the cross-sectional standard deviation in sector j at time t, n_j represents the number of companies within sector j, $R_{i_j,t}$ is the return of stock i from sector j at time t, $R_{S_j,t}$ the average return of sector j at time t.

Further, we will roll the above-mentioned regression models in order to identify herding behavior in the most representative industrial sectors on CEE markets and to assess the impact of extreme sentiments on herding.

As proxies for the industry sector portfolios we use historical daily data for listed companies within each sector from January 2, 2003 to December 31, 2013.

$$R_{S_{j,t}}=\frac{1}{n_{j,t}}\sum_{i_j=1}^{n_{j,t}} R_{i_j,t} \quad (12)$$

where $R_{S_{j,t}}$ the average return of sector j at time t, $n_{j,t}$ represents the number of companies within sector j at time t, $R_{i_j,t}$ is the return of stock i from sector j at time t.

IV. EMPIRICAL RESULTS

4.1 Evidence of herding behavior at industry level

We begin our analysis by investigating herding behavior at industry level without considering the impact of investors' sentiments. In Bulgaria we detect herding behavior in two important sectors, Agriculture and Constructions. In Croatia we find evidence of herding in Constructions, while in Hungary herding is recorded in Electronics, oil and chemicals. We notice that herding is likely to occur in Constructions and we explain this by the volatility of the Real Estate sector during the global financial crisis. In Poland and Romania there is no evidence of herding during the entire sample period. These findings are in line with Filip et al. (2015) who didn't find herding behavior on Romanian and Polish markets during 2008-2010. Given that Poland is the largest market in terms of capitalization, we believe that investors are less prone to this behavioral bias.

4.2 Impact of investors' sentiments on herding behavior

Further, we examine the impact of investors' sentiments on herding by the rolling regression model (7). For this purpose, two sentiment indicators are employed, the ARMS and the RSI, respectively. Negative and statistically significant β_{j2} and β_{j3} confirm that herding behavior is induced by extreme market sentiments.

The use of the ARMS indicator shows that the occurrence of herding is more likely when investors' sentiments are high. Moreover, we notice that the analysis of herding under extreme sentiments increases the estimates accuracy by identifying the presence of herding behavior in new industries. For example, if initially, in Poland we didn't detect herding, when we use the ARMS, we find evidence of herding in most sectors under extreme sentiments. In Bulgaria, herding behavior is a common phenomenon when investors exhibit intense emotions. We also discover new evidence of herding in Hungary and Croatia. The RSI indicator reveals investors' tendency to herd, mainly when they are optimistic.

For checking the robustness of our results, another sentiment indicator, namely Bloomberg's Fear and Greed Index is employed. The results are similar to the ones obtained by using the RSI for Bulgaria, Croatia, and Romania, with small differences for Poland and Hungary.

To conclude, we underline that the results seem slightly sensitive to the indicator used as a proxy for investors' sentiments. The differences in the construction of these indicators lead to varying signals of extreme market conditions.

4.3 Impact of extreme pessimism on herding behavior during the global financial crisis

The global financial crisis offers the suitable context for testing whether the degree of herding is affected by extreme sentiments. In Romania, investors adopted a herding behavior in two important sectors during the crisis (as reflected by β_{j2}): Financial and Constructions. Romanian financial companies are, in general, very liquid and, therefore, they are likely to induce a mass behavior. The construction industry was the most affected by the crisis. Thus, herding behavior in this sector can be explained through a sell mass behavior generated by the decline of Real Estate companies. Herding is also detected during the crisis within Agriculture, Constructions, and Electronics, oil and chemicals in Bulgaria. In Hungary we detect herding during 2007-2009 in two sectors: Electronics, oil and chemicals and Hotels and services. Poland is the only country in which the β_{j2} coefficient doesn't reveal herding over the crisis period (yet, we show below that herding was present even in Poland during the crisis in moments of extreme pessimism). A possible explanation for this result is that the Polish economy had better performances during the global financial crisis.

Under the hypothesis that during the crisis, panic and fear could lead to herding behavior, we analyze the interaction between crisis and extreme pessimism. The results offer new interesting findings, in the sense that we find more sectors in which herding is detected (β_{j3}). For example, when RSI is employed as proxy for high pessimism, we provide evidence of herding as follows: in Poland for Constructions and Electronics, oil and chemicals; in Croatia for Agriculture, Financial, Hotels and services, and Manufacturing; in Romania for Electronics, oil and chemicals, Health and pharma, Hotels and services, and Manufacturing; in Hungary for Constructions. When we run the estimations considering the extreme pessimism proxied by ARMS, the evidence for herding is a bit weaker compared to the RSI, the coefficients not being statistically significant in some cases.

4.4 Herding behavior under high volatility and extreme market sentiment

Previous studies documented that investors are more prone to herding behavior in overheated markets, characterized by high volatility. Our claim that

investors' sentiments are more likely to induce herding behavior when the market is characterized by high volatility is supported by the estimated results of regression (9).

Our results show that herding is an extensive phenomenon at industry level in volatile markets when investors experience extreme sentiments as reflected by coefficients β_{j2} and β_{j3} coefficients.

By using the ARMS indicator as a sentiment measure, we don't detect herding behavior in Romania, under high volatility. In Poland, the phenomenon is sporadic, and it occurs when investors are pessimistic in the Financial sector, Hotels and services and Manufacturing and in Constructions when they are optimistic.

In Bulgaria, β_{j2} is negative and significant in Agriculture, Electronics, oil and chemicals, Financial and Hotels and services. In Croatia, the coefficient reveals mimicking behavior in Electronics, oil and chemicals, Health and pharma and Hotels and services. The phenomenon is not present in Hungary under high volatility and extreme pessimism. The β_{j3} indicates herding behavior in three sectors in Bulgaria (Agriculture, Constructions, and Health and pharma), four Croatian sectors (Agriculture, Financial, Health and pharma and Hotels and services) and in three sectors in Hungary (Constructions, Electronics, oil and chemicals, and Hotels and services).

Although all countries exhibit herding behavior in important sectors in both market states (pessimism and optimism), in Hungary the phenomenon is more prevalent when the market is overbought.

By using the RSI as a sentiment indicator, herding is detected even in Romania, mainly when investors are optimistic (Electronics, oil and chemicals, Financial, Health and pharma and Manufacturing). In Poland, the phenomenon is present when investors are optimistic in Electronics, oil and chemicals, Hotels and services and Manufacturing). To check the robustness of our results we also run the estimations by adapting the methodology developed by Christie and Huang (1995). The empirical findings are not relevant, confirming the methodology weakness as it is showed in the literature (Chang et. al., 2000; Chen, 2013).

V. CONCLUSION

Investors imitating the crowd are likely to disrupt the market stability by creating excess volatility and impacting stocks' equilibrium prices. Extant empirical literature provides evidence on herding behavior under different market conditions. Nevertheless, industry level herding is less explored than market-wide herding.

Our study brings a valuable contribution to the financial literature by analyzing the impact of investors sentiments on herding behavior at industry level based on CCK's and CH's methodologies. We adapted the methodologies to analyze whether investors' perceptions of the market evolution, i.e. pessimism or optimism, induce herding behavior under periods of market stress. Both methodologies focus on herding behavior towards de market consensus. Bikhchandani and Sharma (2001) argue that failing to detect herding behavior based on these methodologies is not evidence against other forms of herding behavior, such as group-wide herding.We provide extensive evidence of herding behavior at industry level, in most countries, except for Poland and Romania, where the phenomenon seems to sporadically affect few sectors. An explanation for this result is that the Warsaw Stock Exchange (WSE) and the Bucharest Stock Exchange are the most developed CEE markets, the WSE aiming to become the financial center of this area. Furthermore, during the global financial crisis, the Polish stock exchange reinforced its position in Europe through a high proportion of foreign institutional investors.

The inclusion of sentiment indicators, i.e. the RSI and the ARMS, in modeling herding behavior offers essential insights into the phenomenon, improving the accuracy of the results. Our estimates show that investors' sentiments are related to herding behavior when the market is extremely turbulent as observed during the global financial crisis or under high volatility conditions. It must be highlighted that the empirical results differ to some extent according to the indicator employed for investors' sentiments. The evolution of the two indicators is not always in tandem, offering different bullish and bearish signals and failing to similarly indicate extreme investors' sentiments.

Considering that herding effects are likely to prevent capital markets from achieving financial stability, the results revealed through this study may raise genuine concerns for the CEE region regulators. For more insightful findings in this line, future research should analyze the relationship between investors' herding behavior and stock markets co-movements. Given the increasing concentration of institutional investors on regional portfolio diversification, it would be interesting to see if herding behavior contributes to the contagion phenomenon between markets and, consequently, to the emergency of a crisis. From the assets allocation perspective, our results are relevant for investors, as herding behavior is likely to affect the portfolio optimization process.

To conclude, this study provides evidence that herding behavior is frequently short-lived and needs to be deeper investigated in overheated markets in correlation with extreme market sentiments.

Otherwise, under typical market conditions, the empirical evidence is inconclusive, herding behavior appearing as an isolated phenomenon.

We argue that many studies on herding behavior fail to detect this bias due to the difficulty of isolating extreme market conditions. Sentiment indicators are convenient and relevant tools that can successfully indicate periods of overheated markets.

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