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Article

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Abstract
This paper uses the theory of behavioral finance to examine the effects of investors' psychology on price formation in the Greek stock market. Modern financial theory draws attention to the ability of some concepts of psychology to explain the behavior of stock market participants and their resulting effect on stock prices in order to provide plausible explanations for "unexplained" phenomena existing in financial markets. Recently, in 2017 Richard H. Thaler awarded the prize in economic sciences for his research in behavioral finance where he incorporated psychologically realistic assumptions into the analysis of economic decision-making. By exploring the consequences of limited rationality, social preferences, and lack of self-control, he has shown how these human traits systematically affect individual decisions as well as market outcomes. Herd behavior in financial markets, that is, a tendency of investors to base decisions on the actions of other investors, is a special case of behavioral finance that starts to raise more interest of both practitioners and academic researchers. Such interest arises from the impact that herd behavior of stock market participants causes on financial markets' stability and efficiency. In this paper, we examine herding behavior in the Greek stock market using eight of the most commonly used models in the extant literature. We use daily log returns data of eighty-five traded stocks in the Athens Stock Exchange during a period of nineteen years from January 1999 till November 2017. The consensus result of the models utilized in this study reveals strong herding behavior for 1999 and 2000 and mixed results for all other years.

Keywords: Behavioral finance, Investor psychology, Herding, Cross-sectional correlation, Greek stock market.

JEL classifications: G24, G4, C25, C01.

Indroduction

Within the social interaction, the herding phenomenon is observed. It is perhaps the most significant behavioral bias of investors and professional portfolio managers emerging from the study of international capital markets and can be defined as the mutual imitation of investment choices, which ultimately leads to convergence of actions (Hirshleifer & Hong Teoh, 2003).

In Behavioral Finance, the term Herding is used to describe the correlation of investor behaviors resulting from their interaction. Such behavior is considered to be rational for less sophisticated investors trying to imitate financial experts or pursuing the activities of successful investors since using their own knowledge and information may be more costly. The result of this behavior is that a group of investors is trading in the same direction over a period of time (Nofsinger & Sias, 1999). This can lead to common behaviors among individuals and this can cause systematic and erroneous decisions by whole populations (Bikhchandani, Hirshleifer, & Welch, 1992). Therefore, investors need a larger portfolio to achieve the same degree of diversification as more experienced investors. In addition, if market participants follow the investment behavior of the herd, the trading behavior of investors is likely to lead to significant overvaluations or undervaluations of stocks.

Lakonishok, Shleifer, & Vishny, (1992) define herding as the "simultaneous purchase (sale) of the same shares". According to Banerjee (1992), herding occurs when each person does what the others do, although private/personal information indicates a different way of action. Yet another definition concerns the existence of correlated behavior among individual investors (Devenow & Welch, 1996).

The study of herding has accumulated over time the scientific interest of researchers due to its serious impact on market efficiency. One of the first surveys on the subject was carried out by Scharfstein and Stein, (Scharfstein & Stein, 1990), who examined herding in professional Mutual Fund managers. According to their findings, under specific circumstances, managers simply imitate the investment choices of other managers, ignoring important private information. Although this behavior is inefficient from an economic and social point of view, it may be logical for the managers who are interested in maintaining their good reputation, as their performance greatly determines their remuneration. Even a wrong investment strategy is not as painful financially and emotionally when the other managers are making the same mistake. At the level of the private investors, when they do not trust their personal information, they focus on the herd, believing that other investors know something that they ignore and thus they follow public opinion. This is particularly the case where individuals have little investment experience or do not trust their knowledge and information.

Relevant Literature

The study of investor herding behavior is a very active topic of research. Christie & Huang (1995) used cross-sectional standard deviation of returns to examine the existence of herding in times of market stress. Using daily returns, they examined the existence of herding in the US stock market during periods of extreme change, without however identifying the existence of the phenomenon.

According to Caparrelli, D’Arcangelis, & Cassuto (2004), it is particularly important to distinguish between the intentional and the spurious behavior of the herd, as the latter is not against the efficient market hypothesis. If individual investors face the same investment choices, having the same level of information available, they adopt similar investment behavior by creating a fictitious behavior but without disturbing the efficient operation of the stock market. On the contrary, the deliberate behavior of the herd results from the voluntary imitation of the investment behavior of other investors, ignoring any personal information. Nevertheless, the cost of moving against the herd can be great. In fact, this behavior causes fear or even pain in individuals (Eisenberger, Lieberman, & Williams, 2003).

Graham (1999) also dealt with this phenomenon. Based on his research, an investor can imitate the behavior of others, whether he has a good reputation or minimal skills, or whether there is public information that is inconsistent with his or her own.

Wermers (1999) conducted one of the most important American Fund Surveys in 1975-1994. They examined the existence of herding using the same methodology of Lakonishok, Shleifer and Vishny (1992, and found herding at a slightly higher rate than the original paper.

Chang, Cheng & Khorana (2000) presented two models for testing the herd and investors' behavior in various international markets (USA, Taiwan, South Korea, Hong Kong, Japan) was examined for the period 1964-1997. They found herding in Japan, South Korea, and Taiwan.

Herding usually occurs on the market in situations of excessive fluctuations when investors are extremely prone to creepy behaviors. Caparrelli et al., (2004) examined the Italian stock market for the period 1988-2001 using daily data. Their results support herding behavior during periods of market pressure and especially in upward periods.

Boyer, Kumagai, & Yuan (2006) found that in emerging equity markets, there is a greater shift in times of great instability, suggesting that the crisis spreads to the shares controlled by international investors mainly due to the transmission rather than the change in the equity values of the shares.

In the Greek stock market, previous studies have highlighted the strong presence of herding during the 1999-2000 stock market bubble (Caporale, Economou, & Philippas, 2008).

Measures of Return Dispersion

Most of the empirical models of herding in the equity market are based on Christie & Huang (1995) and Chang et al.,(2000)model. The rationale behind these models stems from the standard capital asset pricing model, which predicts a wider dispersion in returns across securities with an increase in absolute value of the market return. Christie & Huang, (1995) proposed cross-sectional standard deviations (CSSD) method, which is expressed as:

$$CSSD = \sqrt{\frac{\sum_{i=1}^{n}(R_i - \bar{R})^2}{(N-1)}} \tag{1.1}$$

Where $R_{i,t}$ is the observed stock return on the firm i at time t and $R_{m,t}$ is the Cross-Sectional average of the N returns in the aggregate market portfolio at time t. This dispersion measure quantifies the average proximity of individual returns to the realized average returns.

Chang et al., (2000), assume, that herding in the market place would imply a non-linear relationship between dispersions of individual asset returns and the return on the market portfolio. This means that the cross-sectional absolute deviation will decrease or at least increase at a less-than proportional rate with the market return. They use the Cross Sectional Absolute Deviation (CSAD) as a measurement of dispersion:

$$CSAD = \frac{1}{n}\sum_{i=1}^{n}\left|R_{i,t} - R_{m,t}\right| \quad (1.2)$$

Where N is the number of stocks in the sample is, $R_{i,t}$ is the observed stock return of stock i at time t, and $R_{m,t}$ is the cross-sectional average stock of N returns in the portfolio at time t.
Bhaduri & Mahapatra, (2013) proposed an alternative test for herding based in absolute mean–median difference (CSMMD).

$$CSMMD_t = | R_{mean,t} - R_{median,t} | \quad (1.3)$$

Where $R_{mean,t}$ and $R_{median,t}$ are the observed cross-sectional average and median of the N returns, respectively, of the aggregate market portfolio at the time t.
In a symmetric distribution, the mean coincides with the median and therefore, the difference between the cross-sectional mean and median can be exploited to capture the extent of convergence of individual belief towards the common market behavior. By construct, the symmetry in the cross-sectional distribution would imply that $CSMMD_t$ would tend to zero. In the presence of herding, we expect that cross-sectional return dispersions will decrease with an increase in the market return.

Models of Herd Behavior

Christie & Huang, (1995) is the first study that proposed an approach to detect whether the herd behavior is present in the market-wide sense. In order to examine whether the herd behavior is present in the particular market, authors used the following model:

$$CSSD = a + b^L D_t^L + b^U D_t^U + \varepsilon_t \quad (1.4)$$

Where $D_t^L = 1$, if the market return on day t lies in the extreme lower tail of the distribution, and equal to zero otherwise, and
$D_t^U = 1$ if the market return on day t lies in the extreme upper tail of the distribution; and equal to zero otherwise. The dummy variables are designed to capture differences in investor behavior in extreme up or down versus relatively normal markets. The presence of negative and statistically significant b^L and b^U coefficients would be indicative of herd behavior.
Chiang, Li, & Tan, (2010) tested the existence of herding in the Chinese stock market using the following empirical specification:

$$CSAD = \gamma_0 + \gamma_1 | R_{m,t} | + \gamma_2 R_{m,t}^2 + \varepsilon_t \quad (1.5)$$

Where $R_{m,t}$ is the equally weighted average stock return. During periods of relatively large price swings, in which market participants are more likely to herd around indicators such as the average consensus of all market opinions, the relation between CSAD and the average market

return is more likely to be nonlinear. For this reason, a nonlinear market return, $R_{m,t}^2$, is included in the test equation. Thus, a significantly negative coefficient γ_2 in the empirical test will indicate the occurrence of herding behavior, since it reflects the phenomenon that during periods of market stress, a negative, nonlinear relationship between return dispersion and $R_{m,t}^2$ exists.
In order to capture the asymmetric effects arising from market risings or falls they developed the following model:

$$CSAD = \gamma_0 + \gamma_1(1-D)R_{m,t} + \gamma_2 DR_{m,t} + \gamma_3(1-D)R_{m,t}^2 + \gamma_4 DR_{m,t}^2 + \varepsilon_t \quad (1.6)$$

D = A dummy variable that equals one when market return is negative and zero otherwise. A negative and statistically significant γ_3 would be consistent with herding during up-market days and a negative and statistically significant γ_4 would be consistent with herding during down-market days, Chiang and Zheng (2010).

An alternative empirical specification for testing the degree of asymmetric herding proposed by (Chang et al., 2000). They developed two models to test the possibility that the degree of herding may be asymmetric in the up-versus the down-market. The used the following empirical specification:

$$CSAD_t^{UP} = \alpha + \gamma_1^{UP} | R_{m,t}^{UP} | + \gamma_2^{UP} (R_{m,t}^{UP})^2 + \varepsilon_t \quad (1.7)$$

$$CSAD_t^{DOWN} = \alpha + \gamma_1^{DOWN} | R_{m,t}^{DOWN} | + \gamma_2^{DOWN} (R_{m,t}^{DOWN})^2 + \varepsilon_t \quad (1.8)$$

If during periods of relatively large price swings, market participants do indeed herd around indicators such as the average consensus of all market constituents, a non-linear relation between $CSAD_t$ and the average market return would result. The non-linearity would be captured by a negative and statistically significant γ_2 coefficient.
Bhaduri & Mahapatra, (2013) used the cross-sectional absolute mean-median difference (CSMMD) to capture the symmetry of return distribution.

$$CSMMD = \alpha_0 + \alpha_1 | R_{m,t} | + \alpha_2 R_{m,t}^2 + \varepsilon_t \quad (1.9)$$

The relationship between CSMMD and the average market return $R_{m,t}$, should to be positive under CAPM. The lack of linearity between CSMMD and $R_{m,t}$ is considered as evidence of herding.
With herding behaviour, the individual investor's belief converges towards the average consensus of all market participants. Hence, a non-linear relation will be captured by a negative and significant α_2 coefficient, (Bhaduri & Mahapatra, 2013).
To incorporate the asymmetries in herding behavior during a market rise or fall, following equations are estimated separately for positive and negative market returns:

$$CSMMD_t^{UP} = \alpha + \alpha_1 | R_{m,t}^{UP} | + \alpha_2^{UP} (R_{m,t}^{UP})^2 + \varepsilon_t \quad if\ R_{m,t} \geq 0 \quad (1.10)$$

$$CSMMD_t^{DOWN} = \alpha + \alpha_1 | R_{m,t}^{DOWN} | + \alpha_2^{DOWN} (R_{m,t}^{DOWN})^2 + \varepsilon_t \quad if\ R_{m,t} < 0 \qquad (1.11)$$

Where, $R_{m,t}^{UP}$ and $R_{m,t}^{DOWN}$ are equal-weighted portfolio return at a time t during the uptrend and down trend in the market respectively. A significant negative α_2 would indicate the evidence of herding.

Data

We use stock prices of eighty-five (85) firms} with an uninterrupted presence in the Greek Stock Market during the period 1999-2017. We created a geometric stock market proxy index, proposed by value line, as $Index_t = index_{t-1} \times \sqrt[n]{\prod \left(1 + \frac{P_{i,t}}{P_{i,t-1}}\right)}$ where $index_{t-1}$ is the value of the index as time t - 1.

$P_{i,t}$ is the price of i stock included in the index at the time t

n is the number of stocks in the index

$\prod$ is the product

Individual stock and market log returns calculated as:

$$R_t = 100 \times (ln(P_t) - ln(P_{t-1})) \qquad (1.12)$$

Where ln is the Natural logarithm, and P_t is the price of the stock at time t.

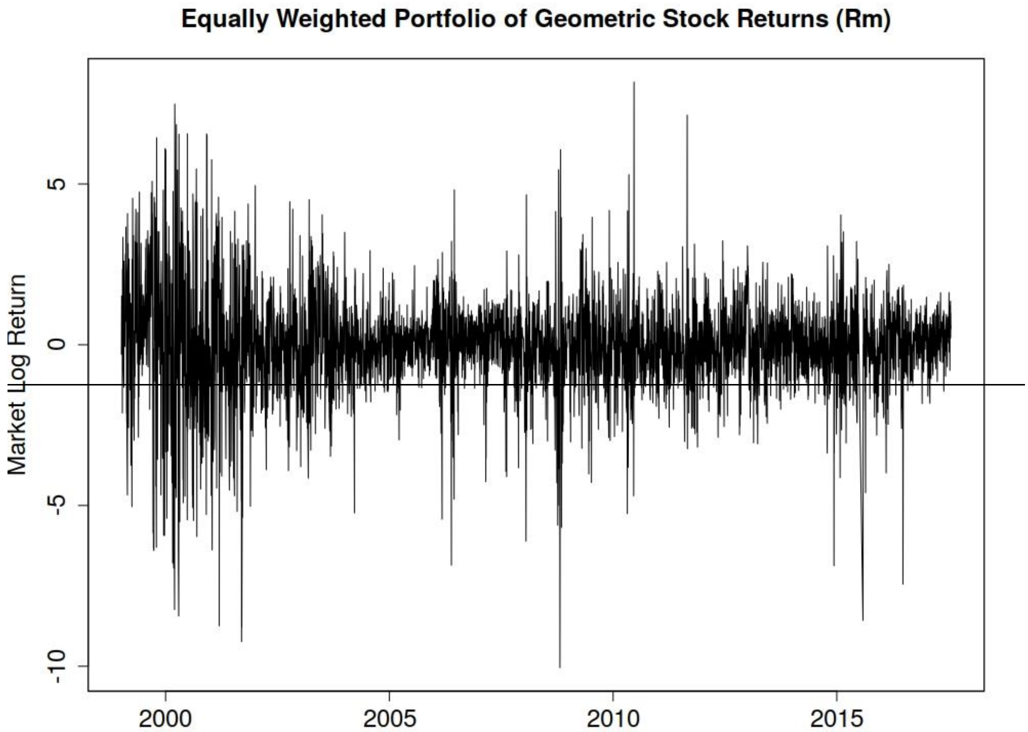

Figure 1: Daily log returns of a geometric Stock Market Proxy Index for the Greek Stock Market

In order to further illustrate the magnitude of the non-linearity in the CSAD-market relation, we plot the CSAD measure for each day and the corresponding equally-weighted market return. For 1999 and 2000 the non-linear CSAD-market relation is evident. Moreover, the slightly steeper slope in the up than in the down market for both countries can also be visualized. Therefore, for this simple graphical representation between CSAD-market is evident

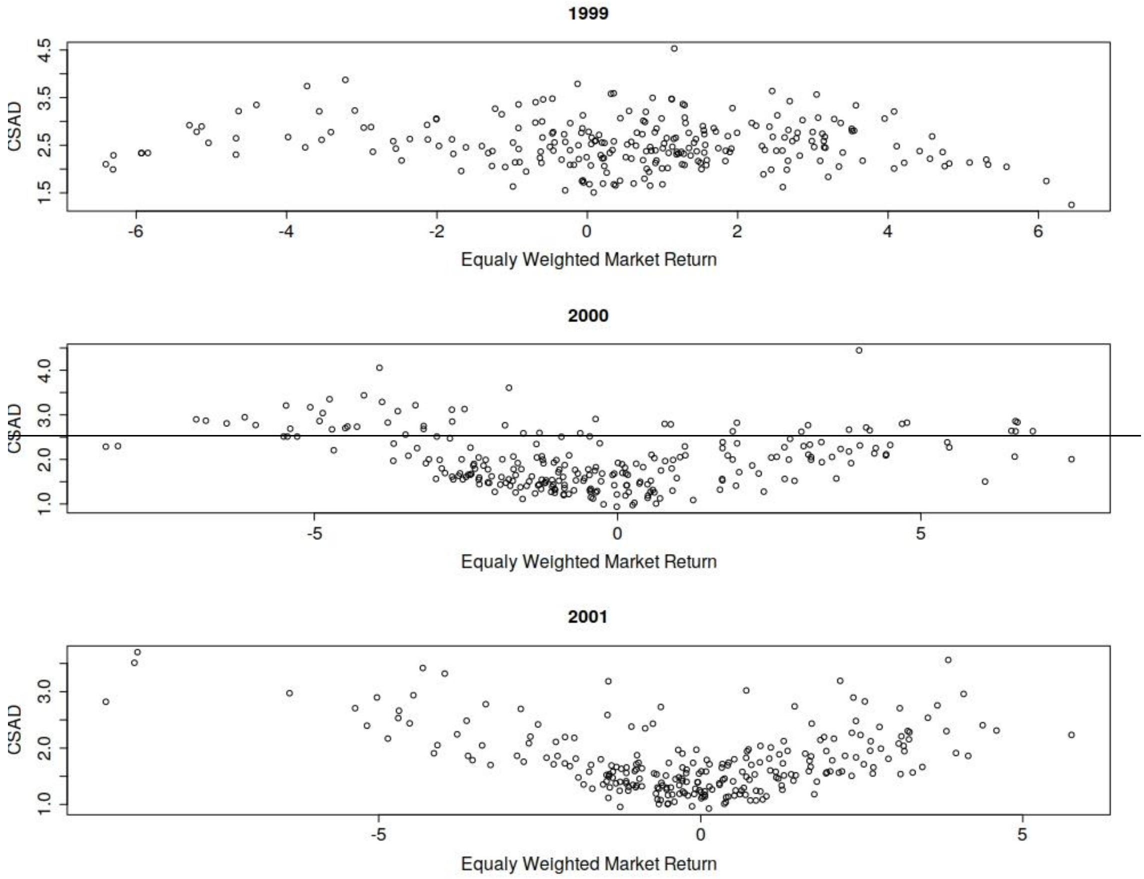

Figure 2: Relationship between the daily cross-sectional absolute deviation $\left(CSAD_t\right)$ and the corresponding equally-weighted market return $\left(R_{m,t}\right)$ for Greece (1999, 2000 and 2001)

Empirical results

In this study, we examine 95 companies of the Athens Stock Exchange with uninterrupted trading for the period 1999-2017 (19 years). Stock prices obtained from Effect Company which is one of the leading providers of Greek financial data.

Herd investment behavior examined by the models described by Eq.1.4 to Eq.1.11. Each model is estimated for both the whole period (1999-2017) and on an annual basis for the whole of the above period. One hundred and sixty regressions were run and the results reveal strong herding for 1999 while the results for other years are mixed. The detailed results of the models can be obtained from the authors upon request.

In summary, the following table shows the existence of the herd phenomenon for the years 1999-2017 according to the models described by Eq.4 to Eq.11.

ETH	***Eq.4***	***Eq.5***	***Eq.6***	***Eq.7***	***Eq.8***	***Eq.9***	***Eq.10***	***Eq.11***
1999								
2000								
2001								
2002								
2003								
2004								
2005								
2006								
2007								
2008								
2009								
2010								
2011								
2012								
2013								
2014								
2015								
2016								
2017								

Conclusions

In our research, we identified the intense presence of herding in the Greek stock market during the stock bubble of 1999-2000 (based on the consensus of the seven models used). Therefore, our work supports the findings of (Caporale et al., 2008).

It should be noted that, for the period examined the results among the herding models used are not consisted. This raises the following interesting research question: “What should be the underlying characteristics of the real data in order of the herding models to provide consisted results?” We will try to answer that question in a future research.

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Appendix

Representative results for one herding model (see Eq. 1.5).
The detailed results of all the models used in this work can be obtained from the authors upon request.

$CSAD = \gamma_0 + \gamma_1 \lvert R_{m,t} \rvert + \gamma_2 R^2_{m,t}$					
	γ_0	γ_1	γ_2	**Adjusted R2**	**p-value**
1999	2.34819 (< 2e-16 ***)	0.24704 (8.02e-05 ***)	**-0.04575** (4.05e-05 ***)	0.05879	0.0002143
2000	1.366869 (< 2e-16 ***)	0.349777 (3.77e-11 ***)	**-0.023221** (0.00208 **)	0.3803	< 2.2e-16
2001	1.290524 (< 2e-16 ***)	0.301012 (6.87e-14 ***)	**-0.008012** (0.153)	0.4965	< 2.2e-16
2002	1.18601 (< 2e-16 ***)	0.20675 (1.07e-06 ***)	0.03218 (0.00582 **)	0.5845	< 2.2e-16
2003	1.41235 (< 2e-16 ***)	0.25482 (0.000108 ***)	0.01346 (0.470588)	0.4322	< 2.2e-16
2004	1.29884 (< 2e-16 ***)	0.27160 (6.78e-09 ***)	0.01414 (0.295)	0.4381	< 2.2e-16

2005	1.3788589 (< 2e-16 ***)	0.3090270 (4.25e-05 ***)	-0.0006011 (0.986)	0.2969	< 2.2e-16
2006	1.455768 (< 2e-16 ***)	0.346260 (5.07e-14 ***)	0.000643 (0.943)	0.5578	< 2.2e-16
2007	1.41767 (< 2e-16 ***)	0.16828 (0.00333 **)	0.02673 (0.11305)	0.3159	< 2.2e-16
2008	1.573061 (<2e-16 ***)	0.393878 (<2e-16 ***)	0.006407 (0.331)	0.6712	< 2.2e-16
2009	1.91000 (< 2e-16 ***)	0.02822 (0.741)	0.14557 (1.64e-08 ***)	0.562	< 2.2e-16
2010	1.841098 (< 2e-16 ***)	0.283980 (8.55e-11 ***)	0.057655 (4.03e-13 ***)	0.7619	< 2.2e-16
2011	1.8086517 (< 2e-16 ***)	0.6155506 (8.49e-14 ***)	-0.0001794 (0.992)	0.4688	< 2.2e-16
2012	2.04079 (< 2e-16 ***)	0.51504 (4.26e-05 ***)	0.08653 (0.0809)	0.5604	< 2.2e-16
2013	2.31307 (< 2e-16 ***)	0.44633 (0.00822 **)	0.07288 (0.26182)	0.3463	< 2.2e-16
2014	1.95263 (< 2e-16 ***)	0.56312 (1.6e-15 ***)	0.03514 (0.0124 *)	0.6266	< 2.2e-16
2015	2.11708 (<2e-16 ***)	0.75601 (<2e-16 ***)	0.02817 (0.015 *)	0.746	< 2.2e-16
2016	1.87032 (<2e-16 ***)	0.93729 (<2e-16 ***)	-0.01479 (0.344)	0.6057	< 2.2e-16
2017	2.06447 (<2e-16 ***)	0.49408 (0.161)	0.09036 (0.685)	0.1962	1.317e-07
*** represent significance level 1%, **10%,*5%					