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HERDING IN FINANCIAL MARKETS: EVIDENCE FROM THE ATHENS STOCK EXCHANGE

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ABSTRACT

This paper examines the existence of herding behavior in the Athens Stock Exchange. Moreover, it estimates the implications of herding behavior in terms of market returns, volume of transaction and volatility. In addition, it tests whether herding effects become more intense during the recent period of the Greek debt crisis. The results indicate that herding is not a dominant behavior in the Greek equity market over the whole 2002-2012 period. However, when herding is examined in certain sub-periods, strong evidence of herding effects can be found. In these periods herding behavior is more pronounced under conditions of declining market returns, high trading volume and low volatility, while the recent debt crisis does not induce a more intense herding activity. Capitalization appears to play a particular role, since herding effects are usually attributed to small stocks.

Keywords: herding behavior, cross-sectional absolute deviation, ASE

INTRODUCTION

As the economic environment is constantly changing and experiencing periods of economic uncertainty, so do the influences on the decision-making process of investors change. One such influence that has received particular attention in the last decade is the concept of ‘herding’. While herd behavior itself pertains to the instinct of animals to follow the herd, a diverse set of theoretical approaches have allowed the concept to be applied to many domains. Relating to the field of behavioral finance, herding behavior is generally characterized by mimicking the actions of other investors, which constitute the market consensus (Bikhchandani and Sharma, 2001). Even though the motivations behind the phenomenon are explained from several perspectives, there is a general conformity concerning its effect in financial markets, referring to substantial movements in asset prices and increasing price volatility (Chang, Cheng and Khorana, 2000).

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On the other hand, it has been suggested that the presence of herd behavior is most likely to occur during periods of extreme market movements, as investors would then be more triggered to follow the market consensus (Demirer, Kutan and Chen, 2010). In addition, Lao and Singh (2011) provided evidence for asymmetric effects of herd behavior patterns. This implies that investors tend to herd more intensively during either an upward movement or a downward movement of the market. According to recent experience, this result is also relevant for the effect of a financial crisis on the extent of herding, since extreme return movements persistently occur in such periods (Chiang and Zheng, 2010). Finally, previous studies show that herd behavior is more profound among smaller stocks compared to heavily-followed larger cap stocks (Bikhchandani and Sharma, 2001).

At the same time the economic environment in Greece has changed dramatically since 2008. In late 2009, fears of a sovereign debt crisis developed among investors concerning Greece's ability to meet its debt obligations due to strong increase in government debt levels. This led to a crisis of confidence, indicated by a widening of bond yield spreads and the cost of risk insurance on credit default swaps compared to the other countries in the Eurozone, most importantly Germany. The downgrading of Greek government debt to junk bond status in April 2010 created alarm in financial markets, with bond yields rising so high, that private capital markets were practically no longer available for Greece as a funding source. On May 2, 2010 the Eurozone countries and the International Monetary Fund (IMF) agreed on a €110 billion bailout loan for Greece, conditional on compliance with the following three key points: (a) implementation of austerity measures to restore the fiscal balance, (b) privatization of government assets worth €50bn by the end of 2015 to keep the debt pile sustainable and (c) implementation of outlined structural reforms to improve competitiveness and growth prospects. The debt crisis did not leave the Athens Stock Exchange (ASE) unaffected. During the period 2010-2011 the Athex Composite Share Price Index experienced a 70% decline, while the capitalization of ASE shrank from €83.5bn to €26.8bn. This makes it interesting to test whether herd behavior is more profound in an environment of such economic depression and stock price decline. Therefore, the contribution of this research is of academic relevance, since it provides more insight into the effect of herd behavior on asset prices in the Greek stock market, while also investigates the several influences on the extent of herding.

MEASURES OF HERDING

Generally speaking, in economics and finance, with the term herding or herd behavior we mean the process where economic agents are imitating each other actions and/or base their decisions upon the actions of others. (see for example, Nofsinger and Sias, 1999; Banerjee, 1992; Avery and Zemsky, 1998; Welch, 2000; De Bondt and Forbes, 1999; Hirshleifer and Teoh, 2003; Hwang and Salmon, 2004; among others). Herding among investors can be divided into intentional herding and spurious herding (Bikhchandani and Sharma, 2001). The former is the result of the intent by market participants to imitate the actions of other's. Spurious herding on the other hand is a situation where groups face similar information sets and decision problems. This in turn makes them make similar decision. The literature on herding is voluminous and a literature review is beyond the scope of this paper; we will discuss, however, measures of herd behavior that have been proposed in the literature (for a detailed review on herding see Spyrou, 2013).

Lakonishok, Shleifer and Vishny (1992) (hereafter LSV) defined and measured herding as the average tendency of a group of investors (money managers) to disproportionately buy or sell particular stocks at the same time, relative to what would be expected if investors traded independently. This measure thereby aims at identifying correlation in trading patterns for a particular group of traders. They compute herding as the proportion of net buyers (investors who increase their holdings in a stock during a given period) relative to the total number of investors who trade that stock minus an adjustment factor that declines, as the number of investors active in that stock, rises. If no herding exists the expected value of this metric should not vary from period to period; in the presence of herding there should be significant cross-sectional variation in this measure.

Let $B(i,t)$ and $S(i,t)$ be the number of investors in the group who buy and sell respectively stock i at time t. The measure of herding $H(i,t)$ used by LSV is defined as follows:

$$H(i,t) = \left| p(i,t) - p(t) \right| - AF(i,t)$$

where $p(i,t) = \dfrac{B(i,t)}{B(i,t)+S(i,t)}$ and $p(t)$ is the average of $p(i,t)$ over all stocks i traded by at least one of the investors in the group at time t. The adjustment factor is $AF(i,t) = E\left[\left| p(i,t) - p(t) \right|\right]$ where the expectation is calculated under the null hypothesis of no herding. LSV point out that, for any stock, *AF* declines as the number of investors active in that stock rises. The method has been criticized for disregarding the amount of stock traded, while focusing on the number of investors, and for its shortcomings in identifying intertemporal trading patterns (Bikhchandani & Sharma, 2001).

Wermers (1999) introduced a new method of measuring herding, the so-called portfolio-change measure (PCM) of correlated trading. The model defined herding by the extent to which portfolio-weights, assigned to the various stocks by different investors, move in the same direction. The intensity of beliefs is captured by the percent change of the fraction accounted for by a stock in a fund portfolio. The cross-correlation PCM of lag τ between portfolio I and J is defined as follows:

$$\hat{\rho}_{t,\tau}^{I,J} = \frac{\frac{1}{N_t}\sum_{n=1}^{N_t}(\Delta\tilde{\omega}_{n,t}^{I})(\Delta\tilde{\omega}_{n,t-\tau}^{J})}{\hat{\sigma}^{I,J}(\tau)}$$

where:

$(\Delta\tilde{\omega}_{n,t}^{I})$: the change in portfolio *I*'s weight of n during the period $\left[t-1,t\right]$

$(\Delta\tilde{\omega}_{n,t-\tau}^{J})$: the change in portfolio *J*'s weight of n during the period $\left[t-\tau-1,t-\tau\right]$

N_t: the number of stocks in the intersection of the set of tradable securities in portfolio I during period $[t-1,t]$ and the set of tradable securities in portfolio J during period $[t-\tau-1,t-\tau]$, and

$$\hat{\sigma}^{I,J}(\tau)=\frac{1}{T}\sum_t \frac{1}{N_t}\sqrt{\sum_{n=1}^{N_t}(\Delta\tilde{\omega}_{n,t}^{I})^2\sum_{n-1}^{N_t}(\Delta\tilde{\omega}_{n,t-\tau}^{J})^2}$$

is the time-series average of the product of the cross-sectional standard-deviations. PCM improves the LSV model in respect of the amount of stock traded, while it receives criticism for yielding results based on spurious herding, as weights of stocks that increase (decrease) in price tend to go up, even without any buying (selling).

Christie and Huang (1995) (CH hereafter) argue that during periods of large price movements, individual investors may ignore their own information about stock prices and instead base their trading decisions on the behavior of the market. If investors herd, stock returns will tend to be clustered closely to the return of the market. CH (1995) use the cross-sectional standard deviation (CSSD) of individual stock returns as a measure of the degree of clustering around the market aggregate. Rational asset pricing suggests that an increase in market returns will be associated with an increase in the cross sectional standard deviation of stock returns given the exposure of individual stock returns to the market portfolio. In contrast, in the presence of herding, CSSD is expected to increase at a decreasing rate or it might even fall if herding is severe. CH (1995) argue that herding will be stronger during the periods of extreme up or down market movements. To test herding during extreme market conditions CH (1995) regress $CSSD_t$ over a constant and two dummy variables that equal 1 when the market return at day t lies in the extreme lower (upper) x percent of observations, and 0 otherwise. x is defined as 1%, 5% and 10% of observations. In the absence of herding, during extreme market movements, individual stock returns exhibit high volatility and the estimated coefficients of the dummy variables are positive. In contrast, negative estimates of the coefficients are consistent with the presence of herding behavior.

Chang, Cheng and Khorana (2000) (CCK hereafter) suggest a variant of the CH (1995) methodology which although similar in spirit could detect herding behavior in less extreme market movements. In place of the $CSSD_t$, CCK (2000) use the average cross-sectional absolute deviation ($CSAD_t$) and show that under the CAPM assumptions, $CSAD_t$ should be a linear function of market returns. Any evidence that the relation is not linear could be interpreted as evidence in favor of herding behavior. So CCK (2000) regress $CSAD_t$ over the absolute value of market return (linear factor) and the square of the market return (non-linear factor). If herding occurs, the coefficient of the non-linear term is expected to be negative indicating that after a market move, *CSAD* might be increasing at a decreasing rate or even falling if the absolute market return is large enough. (A deeper insight of the dispersion-based measures of herding (CH and CCK), together with an alternative proposed by Chiang and Zheng (2010) and Chiang et al. (2010) is provided in the next section, since these methods are the foundation of this study). Bikhchandani and Sharma (2001) argue that these methods of herd behavior are statistics-based, focusing on clustering of decisions. It therefore lacks in recognizing the direct linkages between the types of herding, intentional and spurious, and the empirical design used to test for herding. Their explanation behind this is that it is difficult to assert the true fundamentals of herding, and that it is difficult to measure and quantify them.

A pioneer study in this field is the one of Christie and Huang (1995). They examine security returns from the NYSE and Amex firms during the period 1962-1988 but the results from both daily and monthly returns were inconsistent with the presence of herding during periods of high price volatility. Chang, Cheng and Khorana (2000) extended their empirical study around the CH model and examined herding behavior in USA, Hong Kong, Japan, South Korea and Taiwan, using a method based on cross-sectional absolute deviation (CSAD). The authors find a marked increase in stock return deviations during periods of extreme price up movements when compared to extreme price down days. They reveal significant herding behavior in South Korean and Taiwan markets, do not find any evidence of herding behavior in US and Hong Kong markets and identify partly herding behavior in Japan. Henker, Henker and Mitsios (2003), using high frequency intraday prices for 200 stocks listed on the Australian stock exchange during the period 2000-2002, find no evidence of herding towards the market portfolio and, even in extreme market conditions, participants seem to have a high level of firm specific information and hence no need to base their trading decisions on the overall market consensus.

Gleason, Mathur and Peterson (2004) use intraday data to examine whether traders herd during periods of extreme market movements using sector Exchange Traded Funds (ETFs). The results from analyzing up and down markets in aggregate show no evidence of herding. However, they also report a weak presence of asymmetric reaction to news during periods of stress in up markets and down markets. Caparrelli, D'Arcangelis and Cassuto (2004) focus on Italian stock market and support the finding that herding is present in extreme market conditions.

Hwang and Salmon (2005) apply their proposed herding measure to US and South Korean equity markets and their results indicate significance movements and persistence of herding in the direction of the market independently from and given market conditions and macro factors. They find evidence of herding towards the market portfolio in both bull and bear markets and also report that market crises seem to reduce herding behavior. Demirer and Kutan (2006) examine herding behavior in Shanghai and Shenzhen stock markets over the period 1999-2002, obtaining no evidence of the presence of herding behavior in both markets. Demirer, Gubo and Kutan (2007) conduct a study covering six geographical regions and the period between 1998 and 2004, in which they empirically test herding behavior. They examine the movements of returns in African, Asian, Eastern-Western-Central European, Central Asian, and Latin American markets according to S&P 500 and MSCI indices and oil prices. They fail to find any evidence of herding behavior in all of the markets, except for Asian and Middle Eastern markets.

Tan et al. (2008) examine the existence of herding behavior in dual-listed Chinese A-shares and B- shares markets from 1996 to 2003, as well as they test for potential asymmetries in herd behavior related to market returns, trading volume, and volatility. The results, reveal herding within both the Shanghai and Shenzhen A-share markets that are dominated by domestic individual investors, and also within both B-share markets, in which foreign institutional investors are the main participants. Caporale, Economou and Philippas (2008), by using daily, weekly and monthly data on the Athens Stock Exchange listed firms, provide evidence of market wide herding during the period 1998-2007. This evidence is much stronger for daily time intervals, revealing the short-term nature of this phenomenon, as also shown by Tan et al. (2008). In a study investigating the presence of herding in the Istanbul Stock Exchange between 1997 and 2008, Altay's (2008) results reveal the existence of herding behavior. The study also concludes, as a result of a research by sector, that herding behavior is a common tendency in all sectors in the market, but the periods and the tendency of recovery from herd influence varies among sectors. Tessaromatis and Thomas (2009) find strong evidence of herding on the Athens Stock Exchange for the 1998-2004 periods in both up and down markets. In addition, the empirical evidence suggests that firm size plays no role in herding behavior.

Kallinterakis and Lodetti (2009) investigate in their study the influence of low trading volume on herding behavior in Montenegro New Securities Exchange for the period between 2003 and 2008. Their analysis, utilizing the non-linear model, reveals no evidence suggesting that low trading volume leads to herding behavior. Further evidence about global markets is provided by Chiang and Zheng (2010) who, by using a sample of 18 countries for the period 1988-2009, find significant evidence of herding in each market, except US and Latin America. Additionally, they show that most investors herd with the US market in addition to their domestic market and that herding is present both in up and down markets. Demirer, Kutan and Chen (2010) test the existence of investor herds to the Taiwanese stock market at the sector level by using firm level data. The linear model based on the cross-sectional standard deviation testing methodology yields no significant evidence of herding. However the non-linear CCK (2000) model and the state space based models of Hwang and Salmon (2004) lead to consistent results indicating strong evidence of herd formation in all sectors. In addition, they demonstrate that the herding effect is more prominent during periods of market losses. Tran and Huy (2011) examine the existence of herding behavior in the Vietnamese stock market and the asymmetric effects of herding that are conditional on the direction of market movements. The evidence supports the presence of herding with respect to different market periods and indicates that upward market have less dispersions than downward markets, meaning that investors in the Vietnamese stock market perform more uniformly in rising markets than in declining markets.

Philippas et al. (2011) provide comprehensive evidence for the existence of herding effects in the US REITs market for the 2004-2009 period. However, the financial crisis of 2008 does not seem to contribute to this phenomenon. They also conclude that no asymmetric herding effects are documented during days of negative market returns. Al-Shboul (2012) investigates whether Australian stock investors do herd, using a sample of the largest 251 Australian listed firms during the period 2003-2010 on daily and monthly basis. As proxy of the market return the AOI and S&P300 indices are selected. Evidence of herding is found for both indices.

Herding is not asymmetric in the up and the down markets or in terms of fundamentals. It is, however, asymmetric with respect to financial crisis and in high volume state both indices returns. In high volatility state, evidence of asymmetric herding is found for only the AOI monthly returns. Galariotis, Rong and Spyrou (2013) examine herd behavior towards the consensus using daily data between October 1989 and April 2011 for the US and UK equity markets.

The findings indicate that when the full sample period and all stocks are used no evidence of herding can be found for either the US or the UK market. Evidence of herding can be found during the global financial crisis for value, growth, large and small stocks for the US market only. Herding due to changes in fundamental factors is suggested only for the US market and during 1992-2000 and after the crisis (2009-2012). For the US during the crisis herding is intentional.

For the US there seems to be intentional herding for growth stocks for the period between 1997 and 2006. For the UK market the findings indicate that investors herd as a reaction to changes in fundamental factors for the period between 2000 and 2009.

DATA AND METHODOLOGY

In order to examine herd behavior in the Athens Stock Exchange (ASE), daily data on closing price, previous closing price, trading volume, trading value and market capitalization are collected for all stocks traded over the period from January 1, 2002 to December 31, 2012. 430 stocks traded during that period. All data are provided by the Information Services Department of Hellenic Exchanges S.A.

Previous studies indicate that herding is more pronounced in smaller capitalization stocks (Lakonishok, Shleifer and Vishny, 1992 and Wermers, 1999; among others). So each year all stocks are ranked on their market capitalization (based on daily average capitalization) and the first twenty stocks are used to create the portfolio of "large" stocks and the rest to create the portfolio of "small" stocks. Large stocks for each year represent approximately 59% to 74% of the ASE total capitalization.

The daily return for the stock i traded at time t is calculated as follows:

$$R_{i,t} = 100 \cdot \log\left(\frac{cp_{i,t}}{pcp_{i,t}}\right)$$

where $cp_{i,t}$ and $pcp_{i,t}$ are the closing price and previous closing price respectively of the stock i traded at time t ($pcp_{i,t}$ is not always equal to $cp_{i,t-1}$ because it is adjusted to possible corporate actions).

The intuition underlying the CSSD and CSAD herding measures of Christie and Huang (1995) and Chang et al. (2000) respectively, is that low dispersion of returns around their cross-sectional average indicates that market participants ignore their prior heterogeneous beliefs and information to follow correlated trading patterns around the "market consensus". The cross-sectional standard deviation (CSSD) at time t of stock returns with respect to market return introduced by Christie and Huang (1995), is calculated as:

$$CSSD_t = \sqrt{\frac{\sum_{i=1}^{N_t} (R_{i,t} - R_{m,t})^2}{N_t - 1}} \qquad (1)$$

where $R_{m,t}$ is the equal-weighted cross-sectional average return of the N_t number of stocks traded at time t, which is calculated as: $R_{m,t} = \frac{\sum_{i=1}^{N_t} R_{i,t}}{N_t}$.

Although CSSD is a quite intuitive measure of cross-sectional returns' dispersion, it is considerably affected by the existence of outliers. That is why Christie and Huang (1995) as well as Chang, Cheng and Khorana (2000) proposed the use of the cross-sectional absolute deviation, (CSAD), as a better measure of dispersion:

$$CSAD_t = \frac{\sum_{i=1}^{N_t} \left| R_{i,t} - R_{m,t} \right|}{N_t} \tag{2}$$

Value-Weighted Market Return

Instead of using the equal-weighted average of the N_t stock returns traded at time t as a proxy of the market return, one can use the value-weighted average market return ($vwR_{m,t}$) where the weights $w_{i,t}$ are the trading value of stock i traded at time t to the total trading value at time t [1]. Thus:

$$vwR_{m,t} = \sum_{i=1}^{N_t} w_{i,t} \cdot R_{i,t}$$

The value-weighted CSSD and CSAD are then defined as[2]:

$$vwCSSD_t = \sqrt{\sum_{i=1}^{N_t} w_{i,t} \cdot (R_{i,t} - vwR_{m,t})^2} \text{ and } vwCSAD_t = \sum_{i=1}^{N_t} w_{i,t} \left| R_{i,t} - vwR_{m,t} \right|$$

Christie and Huang (1995) (CH) argue that, when investors suppress their own beliefs in favor of herding to market consensus, security returns would not disperse far from the overall market return. In addition, it states that the security return is more volatile during periods of market stress, thus, herding is more likely to be present. Therefore, this method examines whether equity return dispersions are significantly lower than average during periods of extreme and normal market conditions.

[1] Many researchers use as weights the market capitalization of stock *i* traded at time *t* to the total market capitalization at time *t*.

[2] In this analysis the terms of dispersion $(R_{i,t} - vwR_{m,t})^2$ and $\left| R_{i,t} - vwR_{m,t} \right|$ are also weighted. Other researchers prefer only to substitute $R_{m,t}$ with $vwR_{m,t}$ in specifications (1) and (2).

The CSSD of returns is regressed against a constant and two dummies in order to identify the extreme market phases, with $D_t^L = 1$ if the market return on day t lies in the extreme 1% and 5% lower tail of the distribution of market returns (and zero otherwise), and $D^U = 1$ if it lies in the extreme 1% and 5% upper tail of the same distribution (and zero otherwise):

$$CSSD_t = a + \beta_1 D_t^L + \beta_2 D_t^U + \varepsilon_t \tag{3}$$

where the a coefficient denotes the average dispersion of the sample excluding the regions corresponding to the two dummy variables. According to this model, statistically significant negative values of the estimated coefficients β_1 and β_2, indicate the presence of herd behavior. In other words, when the CSSD of stock returns is low under large price movements, herding is detected. This contradicts the CAPM theory which suggests that, in periods of market stress, large dispersions should be expected because individual securities may have a different degree of sensitivities to market return.

As mentioned before, the cross-sectional standard deviation can be considerably affected by the existence of outliers, that is why the CH model is suggested to be used with the cross-sectional absolute deviation (CSAD) as the dependent variable, thus:

$$CSAD_t = a + \beta_1 D_t^L + \beta_2 D_t^U + \varepsilon_t \tag{4}$$

Christie and Huang (1995) approach however, suffers from a major drawback which originates from the proposed definition of extreme returns. The cut-off points (one and five percent) used to assign observations to the upper and lower tails in the distribution of stock returns are rather arbitrary. It appears that Christie and Huang (1995) only captures herding characteristics under the conditions of extreme returns. Additionally, herding behavior may emerge to some extent over the entire return distribution, becoming more prevalent under abnormal market changes (Tan et al., 2008). Furthermore, Tan et al. (2008), argue that the approach used by Christie and Huang (1995) is actually a stringent test, since it requires a greater magnitude of non-linearity before determining that herding evidence can be found.

Chang, Cheng and Khorana (2000) (CCK) propose an alternative approach to the one suggested by Christie and Huang (1995) using the entire distribution of market returns, as in the following equation:

$$CSAD_t = a + \gamma_1 \left| R_{m,t} \right| + \gamma_2 R_{m,t}^2 + \varepsilon_t \tag{5}$$

It should be noted that both the absolute value of market returns at time t and its squared term are included as independent variables in Equation (5).

The economic meaning behind this model specification is that, a linear relationship between the dispersion in individual stock returns and the market returns is expected under a rational asset pricing model. It follows that an increase in the absolute value of market returns will result in a rise in the dispersion of individual stock returns. Thus, a positive and statistically significant coefficient of γ_1 will be in line with the predictions of the rational asset pricing model.

Investors might also have a tendency to react in the same manner during periods of relatively large market price movements which leads to a higher correlation among the stock returns. In turn, the dispersion among returns is liable to decrease or at least increase at a decreasing rate, with an increase in the absolute value of the market return reflecting this increase in correlation (Chang et al., 2000). In other words, a non-linear relationship is expected. For this reason, the square term of the market return is included in the model. This argument also implies that a statistically significant negative coefficient γ_2 indicates the presence of herding behavior. In that case, it is implied that investors in days of extreme market movements are inclined to act in line with the consensus of the market and suppress their own predictions in respect with asset price, so the cross-sectional dispersion of stock returns is expected to decrease or increase considerably less than proportionally with market return.

Asymmetric Herding Behavior

Potential asymmetries in herding behavior can be examined when the trading environment is characterized by different states of market returns, trading volume and volatility. So an analyst must examine whether the returns' dispersion behaves differently in up and down markets, in periods of high or low trading activity as well as in periods of high or low volatility.

Christie and Huang (1995) and Chang, Cheng and Khorana (2000) note that herding behavior may be more pronounced during periods of market distress; excess trading activity (i.e. high volume) and high volatility are common indicators of such periods. We would expect that the cross-sectional dispersion of stock returns would be reduced during days with negative market returns, high volatility and high trading volume. A series of existing studies in the literature have made similar conjectures. With respect to the asymmetric impact of market return sign, Christie and Huang (1995), Chang et al. (2000), Demirer et al. (2010) and Chiang and Zheng (2010) have argued that herding effects are expected to be more pronounced during periods of market losses. With respect to trading volume and volatility, Gleason et al. (2004) argue that the tendency to herd may be strongest during periods of abnormal information flows and volatility, exactly when individual investors seek the "comfort" of the consensus opinion. Similar is the conjecture of Tan et al. (2008) who argue that herding effects are more prevalent during periods of high trading volume and high volatility. Nevertheless, it should be mentioned that the findings in prior studies are rather mixed, depending on the particular market examined and the specific sample period considered.

Since the direction of the market return may affect investor behavior, possible asymmetries can be examined in herd behavior conditional on whether the market is rising or falling. Instead of splitting the sample in positive and negative market returns and estimating the model (3) separately as in Tan et al. (2008), we can follow the more robust approach of Chiang and Zheng (2010) and Chiang et al. (2010) who utilize a dummy variable approach in a single model. In particular, to examine the asymmetric effect of market return sign, the following model is estimated:

$$CSAD_t = a + \gamma_1 D^{up}\left|R_{m,t}\right| + \gamma_2(1-D^{up})\left|R_{m,t}\right| + \gamma_3 D^{up} R_{m,t}^2 + \gamma_4(1-D^{up})R_{m,t}^2 + \varepsilon_t \quad (6)$$

where D^{up} is a dummy variable taking the value 1 on days with positive market returns and the value 0 on days with negative market returns.

In the absence of herding effects, we expect $\gamma_1 > 0$ and $\gamma_2 > 0$ in model (6). If herding effects are prevailing, we expect $\gamma_3 < 0$ or $\gamma_4 < 0$, with $\gamma_3 < \gamma_4$ if these effects are more pronounced during days with positive market returns.

Asymmetric Effects of Trading Volume

The level of herding behavior may be associated with trading volume, so possible asymmetric effects during periods of high or low volume must be examined. Trading volume V_t is characterized as high if on day *t* it is greater than the previous 30-day moving average. Trading volume is regarded as low if it is less than the previous 30-day moving average. Again, instead of estimating two models, one for the days with high trading volume and one for the days with low trading volume, we can estimate a single model with the use of a dummy variable. So the following model is estimated:

$$CSAD_t = a + \gamma_1 D^{V-high}\left|R_{m,t}\right| + \gamma_2(1-D^{V-high})\left|R_{m,t}\right| + \gamma_3 D^{V-high} R_{m,t}^2 + \gamma_4(1-D^{V-high})R_{m,t}^2 + \varepsilon_t \quad (7)$$

where D^{V-high} is a dummy variable taking the value 1 on days of high trading volume and the value 0 on days of low trading volume.

In the absence of herding effects, we expect $\gamma_1 > 0$ and $\gamma_2 > 0$ in model (7). If herding effects are prevailing, we expect $\gamma_3 < 0$ or $\gamma_4 < 0$, with $\gamma_3 < \gamma_4$ if these effects are more pronounced during days with high trading volume.

Asymmetric Effects of Volatility

Similar to the analysis of trading volume, volatility is defined to be high when the observed volatility exceeds the moving average of volatility over the previous 30 days. Volatility is characterized as low when it is below the 30-day moving average. Following Tan et al. (2008), volatility σ_t of day *t* is calculated as the square of the market return. The asymmetric effects are examined using the following model:

$$CSAD_t = a + \gamma_1 D^{\sigma-high}\left|R_{m,t}\right| + \gamma_2(1-D^{\sigma-high})\left|R_{m,t}\right| + \gamma_3 D^{\sigma-high} R_{m,t}^2 + \gamma_4(1-D^{\sigma-high})R_{m,t}^2 + \varepsilon_t \quad (8)$$

where $D^{\sigma-high}$ is a dummy variable taking the value 1 on days of high volatility and the value 0 on days low volatility.

In the absence of herding effects, we expect $\gamma_1 > 0$ and $\gamma_2 > 0$ in model (8). If herding effects are prevailing, we expect $\gamma_3 < 0$ or $\gamma_4 < 0$, with $\gamma_3 < \gamma_4$ if these effects are more pronounced during days of high market volatility.

Herding Behavior during Periods of Crisis

Recent experience suggests that the movements of extreme returns occur continuously in times of crisis. So based the intuition that the effects of herding may be more intensive during periods of market stress it is relevant to consider whether the financial crises, could alter the course of the degree of herding. To do this, the following model is estimated:

$$CSAD_t = a + \gamma_1 \left|R_{m,t}\right| + \gamma_2 R_{m,t}^2 + \gamma_3 D^{crisis} R_{m,t}^2 + \varepsilon_t \tag{9}$$

where D^{crisis} is a dummy variable that takes the value 1 on the days during the crisis and the value 0 otherwise. A statistically significant negative coefficient γ_3 indicates that herding behavior is more intense during the period of crisis.

5. Results

Descriptive Statistics

Table 1 reports the descriptive statistics for the average market return, the CSSD and CSAD measures, calculated using both equal weights (Panel A) and trading value weights (Panel B) for the whole sample of stocks, the large and the small stocks. The data series of all these variables are stationary as the ADF tests show.

When equal weights are employed the average daily market return of the Athens Stock Exchange over the period studied is -0.11% while those of large and small stocks are -0.05% and -0.11% respectively. The equity market return in Greece exhibits a magnitude of volatility with a standard deviation of 1.50% per day for the entire market and with 1.87% and 1.49% for the large and small stock respectively. In addition, the maximum and minimum values of the market return in this table show that its largest increase is 9.06% while its largest decline is 12.04% in one day. For the large and small stocks the largest increase in one day are 16.55% and 8.23% respectively, while the largest decline are 10.23% and 12.18%. The average level of dispersion using the CSSD measure in the overall market return is 3.68% a day, with a standard deviation of 1.38%. The large stocks display less dispersion than the small ones (2.02% and 3.78%, respectively) with lower volatility (1.14% and 1.45% respectively). When the CSAD measure is used the average level of dispersion in the overall market return is 2.47% per day, with a standard deviation of 0.91%. Again, the large stocks display less dispersion than the small ones (1.52% and 2.54%, respectively) with lower volatility (0.87% and 0.95% respectively). When value weights are used the picture is quite different. The average daily market return of the ASE is positive (0.10%) while those of large and small stocks are -0.03% and 0.33% (positive) respectively. The market return exhibits a higher magnitude of volatility as the standard deviation is 2.59% per day for the entire market with 2.61% and 2.60% for the large and small stock respectively. The market return expresses higher range of daily returns between -12.82% and 19.19%, the large stocks' range is between -13.04% and 19.55% while the small ones is between -14.80% and 22.21%. The dispersion measure of CSSD is lower on average level; 2.77% per day in the overall market return, 1.96% and 3.58% for large and small stocks respectively.

The dispersion measure of CSAD is lower on average for the overall market (2.01%) but higher for both the large and the small stocks (1.58% and 2.64% respectively). Once again however, the large stocks display less dispersion than small ones as the CSSD and CSAD measures indicate with lower volatility in the dispersion (standard deviations for CSSD are 1.26% and 2.02 respectively and for CSAD are 1.11% and 1.64%). Possible explanations of the higher volatility of small stock could be that they have less information, fewer analysts covers them, tend to be preferred by private rather than institutional investors and most of their shares tend to be held by the founding shareholders (small free float).

Table 1. Descriptive Statistics

	Mean	Median	Std. Dev	Minimum	Maximum	ADF-test
Panel A: Equally weighted						
All Stocks						
Rm	-0,1058	-0,0367	1,5016	-12,0439	9,0555	-44.61***
CSSD	3,6758	3,2984	1,3821	1,6727	12,6813	-4.68***
CSAD	2,4678	2,2015	0,9121	1,1446	7,1534	-5.22***
Stocks traded - Maximum: 373 Minimum: 107						
Large						
Rm	-0,0549	0,0183	1,8748	-10,2280	16,5505	-37.88***
CSSD	2,0195	1,7114	1,1368	0,5400	11,6483	-10.39***
CSAD	1,5219	1,2836	0,8699	0,3749	10,0255	-9.16***
Stocks traded - Maximum: 20 Minimum: 17						
Small						
Rm	-0,1088	-0,0478	1,4884	-12,1869	8,2319	-25.74***
CSSD	3,7719	3,3686	1,4499	1,7004	13,1072	-4.56***
CSAD	2,5387	2,2582	0,9532	1,1633	6,8750	-4.98***
Stocks traded - Maximum: 353 Minimum: 88						
Panel B: Value weighted						
All Stocks						
Rm	0,1011	0,1989	2,5941	-12,8202	19,1925	-37.68***
CSSD	2,7696	2,4020	1,6722	0,5198	36,1128	-6.61***
CSAD	2,0139	1,7069	1,3045	0,1969	25,0528	-10.93***

Table 1. (Continued)

Stocks traded - Maximum: 373 Minimum: 107						
Large						
Rm	-0,0346	0,0464	2,6062	-13,0395	19,5457	-38.50***
CSSD	1,9565	1,6279	1,2637	0,2902	12,4255	-10.63***
CSAD	1,5843	1,2880	1,1136	0,0512	10,5360	-9.89***
Stocks traded - Maximum: 20 Minimum: 17						
Small						
Rm	0,3333	0,3726	2,6010	-14,7955	22,2124	-45.79***
CSSD	3,5800	3,1442	2,0207	0,5696	40,1591	-7.59***
CSAD	2,6147	2,2711	1,6357	0,1146	33,9801	-14.35***
Stocks traded - Maximum: 353 Minimum: 88						

The table reports the daily descriptive statistics of market return ($R_{m,t}$), cross-sectional standard deviation ($CSSD_t$) and cross-sectional absoloute deviation ($CSAD_t$) for the Athens Stock Exchange (ASE). The examined period is January 2002-December 2012 (2745 daily observations). In addition, the test-statistics of the Augmented Dickey-Fuller test (includes constant and trent) are reported. ***, ** and * represent statistical significance at the 1%, 5% and 10% level respectively. Panel A contains the descriptive statistics when equal weights are employed for the calculations while Panel B contains the corresponding statistics when trading value weights are used instead.

Table 2. Regression Results for CSSD – Christie and Huang (1995)

Coefficient	All Stocks		Large		Small	
	Criterion	*Criterion*	*Criterion*	*Criterion*	*Criterion*	*Criterion*
	1%	*5%*	*1%*	*5%*	*1%*	*5%*
Panel A: Equally weighted						
α	3,6415	3,5704	1,9436	1,8204	3,7434	3,6805
	(49.89)***	(50.66)***	(47.58)***	(93.40)***	(48.23)***	(48.21)***
β_1	2,0628	1,0847	3,4753	1,9193	1,5994	0,9335
	(5.90)***	(6.97)***	(8.54)***	(22.66)***	(4.54)***	(6.04)***
β_2	1,2924	1,0107	3,9717	2,0413	1,2034	0,8857
	(5.36)***	(6.99)**	(11.39)***	(24.10)***	(5.35)***	(6.10)***
Adjusted R^2	0,0303	0,0514	0,2149	0,2743	0,0183	0,0349
Panel B: Value weighted						
α	2,6729	2,5494	1,8724	1,7372	3,4547	3,3036
	(61.79)***	(67.20)***	(45.47)***	(50.05)***	(71.79)***	(79.79)***
β_1	3,5155	1,8034	4,2447	2,3018	4,2784	2,3434
	(8.41)***	(9.01)***	(10.46)***	(11.28)***	(5.28)***	(7.78)***

β_2	5,9651	2,5781	3,9986	2,0608	8,0061	3,1551
	(4.08)***	(5.49)***	(11.35)***	(11.59)***	(3.85)***	(5.85)***
Adjusted R^2	0,1710	0,1601	0,2123	0,2699	0,2015	0,1709

This table reports the estimated coefficients of the regression model developed by Christie and Huang (1995), i.e. model (3), where $CSSD_t$ is the cross-sectional standard deviation of the N_t stocks traded in the Athens Stock Exchange (ASE) at time t , D_t^L (D_t^U) equals one, if the market return on day t lies in the extreme 1% and 5% lower (upper) tail of the distribution of market returns (and zero otherwise). The sample period is January 2002-December 2012 (2745 daily observations). Panel A contains the estimated coefficients when equal weights are used for the calculations, while Panel B contains the corresponding coefficients when trading value weights are employed instead. Numbers in parentheses are t-statistics calculated using Newey-West (1987) heteroscedasticity and autocorrelation consistent standard errors. ***, ** and * represent statistical significance at the 1%, 5% and 10% level, respectively.

CH Method

Table 2 and 3 report the regression results for the Christie and Huang (2005) models (3) and (4). For both the criteria (1% and 5%) used, the coefficients β_1 and β_2 of the lower and upper extreme variable are positive and statistically significant, regardless the type of stocks selected (all, large and small) and the method of calculating $R_{m,t}$, $CSSD_t$ and $CSAD_t$ (equally weighted or value weighted). This suggests no evidence of herding since equity return dispersion tend to increase rather than to decrease in periods of extreme price movements, which is consistent with rational asset pricing models. The values for the adjusted R^2 are quite low when equal weights are used for all and small stock and considerably higher for large stocks. When value weights are employed, the estimated regression models have higher values for the adjusted R^2 for all type of stocks, not only the large ones. Adjusted R^2 values however, are low in general for all cases, since the number of observations being considered as extreme market return movements only account a small portion of the whole sample.

Table 3. Regression Results for CSAD – Christie and Huang (1995)

Coefficient	All Stocks		Large		Small	
	Criterion 1%	*Criterion 5%*	*Criterion 1%*	*Criterion 5%*	*Criterion 1%*	*Criterion 5%*
Panel A: Equally weighted						
α	2,4348	2,3650	1,4594	1,3567	2,5102	2,4462
	(51.45)***	(52.76)***	(46.76)***	(54.33)***	(49.65)***	(49.89)***
β_1	1,9254	1,0814	2,8894	1,6087	1,5461	0,9689
	(7.61)***	(9.66)***	(8.09)***	(9.68)***	(6.11)***	(8.90)***
β_2	1,3140	0,9639	3,2367	1,6765	1,2537	0,8723
	(6.96)***	(9.61)***	(10.87)***	(12.20)***	(7.28)***	(8.74)***

Table 3. (Continued)

Adjusted R^2	0,0647	0,1135	0,2481	0,3222	0,0429	0,0840
Panel B: Value weighted						
α	1,9258	1,8126	1,5087	1,3923	2,5043	2,3686
	(57.15)***	(64.07)***	(43.60)***	(48.51)***	(69.98)***	(76.38)***
β_1	3,4445	1,7711	3,8673	2,0548	4,0833	2,1196
	(8.44)***	(9.51)***	(9.58)***	(10.56)***	(4.89)***	(7.97)***
β_2	5,1887	2,2332	3,5412	1,7645	6,7399	2,7760
	(4.97)***	(6.60)***	(10.71)***	(11.19)***	(4.07)***	(6.40)***
Adjusted R^2	0,2275	0,2157	0,2211	0,2672	0,2317	0,2061

This table reports the estimated coefficients of the regression model developed by Christie and Huang (1995) (see notes to Table 2), where $CSAD_t$ is the cross-sectional absolute deviation of the N_t stocks traded in the Athens Stock Exchange (ASE) at time *t*, D_t^L (D_t^U) equals one, if the market return on day *t* lies in the extreme 1% and 5% lower (upper) tail of the distribution of market returns (and zero otherwise). The sample period is January 2002-December 2012 (2745 daily observations). Panel A contains the estimated coefficients when equal weights are used for the calculations, while Panel B contains the corresponding coefficients when trading value weights are employed instead. Numbers in parentheses are t-statistics calculated using Newey-West (1987) heteroscedasticity and autocorrelation consistent standard errors. ***,** and * represent statistical significance at the 1%, 5% and 10% level, respectively.

CCK Method

Table 4 reports the results of estimating the benchmark regression model (5) developed by Chang, Cheng and Khorana (2000).

Table 4. Estimates of Herding Behavior in the Full Sample Period

Coefficent	All Stocks	Large	Small
Panel A: Equally weighted			
α	2,0746	1,0236	2,1693
	(45.52)***	(35.65)***	(42.96)***
γ_1	0,3681	0,3677	0,3553
	(10.42)***	(10.79)***	(10.17)***
γ_2	-0,0011	0,0106	-0,0048
	(-0.20)	(2.00)**	(-1.04)
Adjusted R^2	0,1751	0,4894	0,1318

Panel B: Value weighted			
α	1,5225	1,0313	1,9444
	(24.05)***	(27.87)***	(18.44)***
γ_1	0,1906	0,2887	0,2488
	(2.56)**	(8.74)***	(2.16)**
γ_2	0,0239	0,0086	0,0321
	(2.02)**	(2.38)**	(1.87)*
Adjusted R^2	0,3801	0,4204	0,4706

This table reports the estimated coefficients of the regression model developed by Chang, Cheng & Khorana (2000), i.e. model (5), where $CSAD_t$ and $R_{m,t}$ are the cross-sectional absolute deviation and market return of the N_t stocks traded in the Athens Stock Exchange (ASE) at time *t*. The sample period is January 2002-December 2012 (2745 daily observations). Panel A contains the estimated coefficients when equal weights are used for the calculations, while Panel B contains the corresponding coefficients when trading value weights are employed instead. Numbers in parentheses are t-statistics calculated using Newey-West (1987) heteroscedasticity and autocorrelation consistent standard errors. ***,** and * represent statistical significance at the 1%, 5% and 10% level, respectively.

The first observation one can make is that cross-sectional returns' dispersion, regardless if the stocks are large or small, increases with the magnitude of the market return (coefficient γ_1 is positive and statistically significant), a feature that is consistent with standard asset pricing models. Incorporating the squared market return in the model, allows us to test whether this cross-sectional dispersion increases at a decreasing rate during extreme market movements. Such evidence cannot be found since the coefficient γ_2 is either insignificant (all stocks and small stocks for equal weights) or positive and statistically significant (large stocks for equal weights and all cases using trading value weights) suggesting no sign of herding. The positive and statistically significant value of the coefficient γ_2 means that investors seem to diverge rather than converge to the market average (anti-herding).

As mentioned before finding evidence of herding depends on the specific sample period considered. So the model (5) is estimated for different sub-periods. The full sample period of 2002-2012 (11 years) is split in 2 sub-periods of 10 years, 3 sub-periods of 9 years, 4 sub-periods of 8 years and so on (the convention is that the starting point of each sub-period is January 1 and the ending point is December 31[3]).

Table 4b reports the estimated model (5) for sub-periods where there is evidence of herding behavior (coefficient γ_2 is negative and statistically significant). For the overall market, herding is detected in the periods 2004-2012, 2005-2012 and 2006-2012. Estimating the regression model (5) of Chang, Cheng and Khorana (2000) for the large stocks for all sub-periods the coefficient γ_2 is either insignificant or positive and statistically significant (anti-herding).

However, there is evidence of herding for the small stocks for five sub-periods: 2003-2012, 2004-2012, 2005-2012, 2006-2012, and 2007-2012.

When the value weighted approached is used, the coefficient γ_2 that indicates potential herding behavior can be found negative and statistically significant only in one sub-period

[3] With this convention the total number of sub-periods is 65.

(2007) and only in the case of small stocks. In most of the rest cases it is positive and statistically significant.

Table 4b. Estimates of Herding Behavior in Sub-Periods

Period	α	γ_1	γ_2	*Adjusted* R^2
Panel A: Equally weighted				
All stocks				
2004-2012	2,1369	0,4593	-0,0114	0,2021
Obs: 2251	(43.53)***	(11.89)***	(-2.14)**	
2005-2012	2,2233	0,4618	-0,0132	0,2004
Obs: 1998	(40.95)***	(11.23)***	(-2.47)**	
2006-2012	2,3231	0,4319	-0,0114	0,1827
Obs: 1748	(37.13)**	(9.90)***	(-2.07)**	
Small				
2003-2012	2,2251	0,3857	-0,0089	0,1401
Obs: 2498	(41.29)***	(10.33)***	(-1.84)*	
2004-2012	2,2357	0,4506	-0,0150	0,1555
Obs: 2251	(40.98)***	(11.11)***	(-2.92)***	
2005-2012	2,3273	0,4553	-0,0171	0,1537
Obs: 1998	(38.49)***	(10.27)***	(-3.03)***	
2006-2012	2,4361	0,4230	-0,0150	0,1368
Obs: 1748	(35.07)***	(8.94)***	(-2.59)***	
2007-2012	2,5575	0,4144	-0,0130	0,1326
Obs: 1499	(32.89)***	(8.31)***	(-2.34)**	
Panel B: Value weighted				
Small				
2007	1,2988	0,6123	-0,0145	0,4274
Obs: 252	(6.93)***	(3.22)***	(-1.85)*	

This table reports the estimated coefficients of the regression model developed by Chang, Cheng & Khorana (2000), i.e. model (5), where $CSAD_t$ and $R_{m,t}$ are the cross-sectional absolute deviation and market return of the N_t stocks traded in the Athens Stock Exchange (ASE) at time *t* for certain periods. Panel A contains the estimated coefficients when equal weights are used for the calculations, while Panel B contains the corresponding coefficients when trading value weights are employed instead. Numbers in parentheses are t-statistics calculated using Newey-West (1987) heteroscedasticity and autocorrelation consistent standard errors. ***,** and * represent statistical significance at the 1%, 5% and 10% level, respectively.

The conclusion that one can make from Table 4b is that herding effects in the Greek equity market can be found when equal weights are employed, they are present mainly during the period 2004-2012 and these effects are the result of the reduced cross-sectional dispersion around the market portfolio of the small cap stocks. Tessaromatis and Thomas (2009) find strong evidence of herding behavior in the ASE for the period 1998-2003 but capitalization does not appear to play a particular role, while Economou, Kostakis and Philippas (2011) find such evidence for the period 1998-2008, regardless of the way market returns and the CSAD measure are calculated. Both these researches include in their sample the stock market bubble of the 1998-2000 period, where the sharp upward and downward movements in returns could be attributed to herd behavior, reflecting the massive trading of new, inexperienced and uniformed individual investors.

Asymmetric Herding Behavior

The next set of results reported in Table 5 examine whether there is an asymmetric relationship between CSAD and market returns, distinguishing between rising and declining days. Such an asymmetry is captured using the relevant dummy variable in model (6). In addition a Wald test for the null hypothesis that the herding coefficients are equal on days with rising and falling market prices is presented. The results do not show that there is a differential behavior of the cross-sectional returns' deviation for the full sample period. None of the coefficient γ_3 and γ_4 is negative and statistically significant. Once again model (6) is estimated for all the sub-periods and the estimations where the asymmetric relationship between rising and declining days is justified (γ_3<0 or γ_4<0 and the difference γ_3-γ_4 is statistically significant) are reported in Table 5b.

Table 5. Estimates of Herding Behavior in Days with Rising and Declining Prices for the Full Sample Period

Coefficent	All Stocks	Large	Small
Panel A: Equally weighted			
α	2,0761	1,0274	2,1699
	(45.10)***	(38.72)***	(42.14)***
γ_1	0,3745	0,3999	0,3642
	(7.50)***	(12.66)****	(6.38)***
γ_2	0,3537	0,3221	0,3428
	(9.43)***	(8.51)***	(8.79)***
γ_3	0,0033	0,0069	-0,0029
	(0.35)	(1.47)	(-0.24)
γ_4	-0,0013	0,0176	-0,0043
	(-0.24)	(2.06)**	(-0.89)
Adjusted R^2	0,1754	0,4911	0,1316
Wald Test for equality of herding coefficients (H_0: $\gamma_3=\gamma_4$)			
γ_3-γ_4	0,0046	-0,0107	0,0014
Chi-square	[0.20]	[1.52]	[0.01]

Table 5. (Continued)

Panel B: Value weighted			
α	1,4992	1,0417	1,9368
	(26.61)***	(29.46)***	(23.69)***
γ_1	0,1978	0,2729	0,2687
	(2.35)**	(9.16)***	(2.35)**
γ_2	0,2442	0,2801	0,2376
	(5.01)***	(6.95)**	(3.66)***
γ_3	0,0272	0,0079	0,0318
	(1.77)*	(2.26)**	(1.61)
γ_4	0,0119	0,0122	0,0305
	(1.97)**	(2.18)**	(3.24)***
Adjusted R^2	0,3857	0,4221	0,4712
Wald Test for equality of herding coefficients (H_0: $\gamma_3=\gamma_4$)			
γ_3-γ_4	0,0153	-0,0043	0,0014
Chi-square	[1.16]	[0.53]	[0.01]

See Notes to Table 4.

Table 5b. With Rising and Declining Prices for Sub-Periods

Period	γ_3	γ_4	γ_3-γ_4
Panel A: Equally weighted			
All stocks			
2005-2012	0,0028	-0,0167	0,0194
Obs:1998	(0.32)	(-2.90)***	[3.84]**
2005-2011	0,0173	-0,0083	0,0256
Obs:1749	(2.34)**	(-1.94)*	[9.60]***
2006-2012	0,0055	-0,0151	0,0205
Obs:1748	(0.60)	(-2.54)**	[3.96]**
2006-2011	0,0202	-0,0075	0,0277
Obs:1499	(2.54)**	(-1.64)*	[9.89]***
Small			
2004-2011	0,0168	-0,0075	0,0243
Obs:2002	(1.90)*	(-1.71)*	[6.65]***
2005-2011	0,0189	-0,0108	0,0298
Obs:1749	(2.05)**	(-2.04)**	[8.76]***
2006-2012	0,0040	-0,0182	0,0221
Obs:1748	(0.35)	(-2.35)**	[2.92]*
2006-2011	0,0225	-0,0100	0,0326
Obs:1499	(2.26)**	(-1.78)*	[9.19]***

Panel B: Value weighted			
Small			
2003-2007	-0,0084	0,0256	-0,0340
Obs: 1251	(-1.80)*	(1.68)*	[4.98]**
2004-2007	-0,0097	0,0295	-0,0392
Obs:1004	(-2.22)**	(1.89)*	[6.46]**
2004-2011	-0,0081	0,0219	-0,0300
Obs:2002	(-1.69)*	(1.58)	[4.71]**
2005-2007	-0,0102	0,0428	-0,0530
Obs:751	(-2.43)**	(3.18)***	[16.14]***
2005-2011	-0,0081	0,0246	-0,0327
Obs:1749	(-1.73)*	(1.70)*	[5.18]**
2006-2007	-0,0105	0,0469	-0,0574
Obs:501	(-2.17)**	(3.56)***	[21.17]***
2006-2011	-0,0081	0,0259	-0,0339
Obs:1499	(-1.74)*	(1.76)*	[5.38]**
2007-2011	-0,0098	0,0209	-0,0307
Period	γ_3	γ_4	γ_3-γ_4
Obs:1250	(-2.32)**	(1.19)	[3.12]*
2010-2011	-0,0141	0,0725	-0,0867
Obs:503	(-2.95)**	(2.18)**	[7.03]***
2011	-0,0143	0,0734	-0,0876
Obs:251	(-2.74)***	(1.72)*	[4.43]**

See Notes to Table 4.

The results show that when using equal weights for the returns, there is a differential behavior of the overall market in four sub-periods: 2005-2012, 2005-2011, 2006-2012 and 2006-2011. The Wald tests show that in these periods the difference γ_3-γ_4 is positive and statistically significant, meaning that the herding effects are more pronounced during days with negative market returns. In other words, investors in these periods display the so-called ‘loss aversion’ behavior. According to this belief, investors may fear potential losses in the downward market price swing more than they enjoy the potential gain in the upward market which leads them to be likely to follow ‘herds’, the consequence being a reduction in return dispersion (Gleason et al, 2004). Estimating the model (6) using data only for the large stocks does not provide any evidence of asymmetric behavior during periods of up and down price movements in any sub-period. For the small stocks, the estimations show the presence of herding in four sub-periods: 2004-2011, 2005-2011, 2006-2012 and 2006-2011 where the herding behavior is much stronger on days with declining market prices. The employment of trading value weights confirms the presence of herding for ten sub-periods and concerns only small stocks. However, the difference γ_3-γ_4 is now negative and statistically significant in all cases, meaning that the herding effects are more pronounced during days with rising market prices.

The conclusion is that in certain sub-periods there is evidence of asymmetric herding behavior due to the trades of small cap stocks. However the type of this asymmetry depends on the method used for the market return and CSAD. When equally weighted returns are employed herding behavior in the Greek market is much more likely to be encountered on days with negative market returns. When value weighted measures are used the results are reversed when this asymmetry is taken into account, meaning that herding behavior is much stronger on days with positive market prices. The study of Economou, Kostakis and Philippas (2011) shows the asymmetry is much stronger on days with rising market prices regardless the method used for the market return and CSAD) but for different period examined (1998-2008).

Table 6. High and Low Trading Volume in the Full Sample Period

Coefficent	All Stocks	Large	Small
Panel A: Equally weighted			
α	2,1035	1,0535	2,1881
	(45.97)***	(39.03)***	(43.16)***
γ_1	0,3944	0,4237	0,3794
	(9.21)***	(12.06)****	(9.17)***
γ_2	0,2894	0,2819	0,3222
	(4.46)***	(7.99)***	(4.84)***
γ_3	-0,0053	0,0052	-0,0074
	(-0.93)	(1.08)	(-1.39)
γ_4	0,0133	0,0139	-0,0067
	(0.76)	(1.62)**	(-0.42)
Adjusted R^2	0,1750	0,5003	0,1310
Wald Test for equality of herding coefficients (H_0: $\gamma_3=\gamma_4$)			
γ_3-γ_4	-0,0186	-0,0087	-0,0007
Chi-square	[1.04]	[0.94]	[0.00]
Panel B: Value weighted			
α	1,5534	1,0635	1,9363
	(23.32)***	(30.12)***	(36.12)***
γ_1	0,2672	0,3204	0,4101
	(5.46)**	(8.55)***	(6.63)**
γ_2	0,0497	0,2195	0,1141
	(0.39)	(6.63)***	(2.80)***
γ_3	0,0093	0,0058	0,0027
	(1.72)*	(1.52)	(0.28)
γ_4	0,0501	0,0142	0,0647
	(1.71)*	(2.48)**	(17.70)***

Adjusted R^2	0,3901	0,4230	0,5026
Wald Test for equality of herding coefficients (H_0: $\gamma_3=\gamma_4$)			
γ_3-γ_4	-0,0408	-0,0084	-0,0620
Chi-square	[2.18]	[1.85]	[43.48]***

This table reports the estimated coefficients for the regression model, where $CSAD_t$ and $R_{m,t}$ are the cross-sectional absolute deviation and market return of the N_t stocks traded in the Athens Stock Exchange (ASE) at time t and $D^{V\text{-}high}$ is a dummy variable that takes the value 1 on days characterized by high trading volume, as compared to a 30-day moving average, and the value 0 otherwise. The sample period is January 2002-December 2012 (2145 daily observations). Panel A contains the estimated coefficients when equal weights are used for the calculations, while Panel B contains the corresponding coefficients when trading value weights are employed instead. Numbers in parentheses are t-statistics calculated using Newey-West (1987) heteroscedasticity and autocorrelation consistent standard errors. In addition, the Chi-square statistics corresponding to the Wald test of the null hypothesis $\gamma_3=\gamma_4$ are reported. ***,** and * represent statistical significance at the 1%, 5% and 10% level, respectively.

Table 6b. Days of High and Low Trading Volume in Sub-Periods

Period	γ_3	γ_4	γ_3-γ_4
Panel A: Equally weighted			
All stocks			
2003-2007	-0,0097	0,0431	-0,0528
Obs:1251	(-1.98)**	(5.10)***	[32.2]***
2003-2006	-0,0111	0,0388	-0,0499
Obs:999	(-2.26)**	(4.51)***	[28.37]***
2004-2006	-0,0097	0,0412	-0,0509
Obs:752	(-1.67)*	(3.64)***	[20.12]***
2005-2007	-0,0113	0,0400	-0,0513
Obs:751	(-1.91)*	(3.85)***	[20.82]***
2005-2006	-0,0156	0,0237	-0,0393
Obs:499	(-2.73)***	(2.42)***	[16.36]***
2006	-0,0117	0,0295	-0,0411
Obs:249	(-1.78)*	(2.19)**	[10.16]***
Small			
2003-2007	-0,0127	0,0322	-0,0449
Obs:1251	(-2.46)**	(3.46)***	[22.12]***
2003-2006	-0,0125	0,0297	-0,0421
Obs:999	(-2.43)**	(3.14)***	[18.75]***
2004-2010	-0,0065	0,0158	-0,0222
Obs:1751	(-1.70)*	(1.52)	[4.30]**
2004-2009	-0,0070	0,0255	-0,0325
Obs:1499	(-1.68)*	(2.49)**	[9.22]***

Table 6b. (Continued)

Period	γ_3	γ_4	γ_3-γ_4
Panel A: Equally weighted			
All stocks			
2004-2007	-0,0127	0,0301	-0,0428
Obs:1004	(-2.22)**	(3.22)***	[20.11]***
2004-2006	-0,0137	0,0255	-0,0392
Obs:752	(-2.35)**	(2.67)***	[16.13]***
2005-2007	-0,0179	0,0220	-0,0399
Obs:751	(-2.80)***	(2.73)***	[19.43]***
2005-2006	-0,0196	0,0106	-0,0302
Obs:499	(-3.47)***	(1.61)	[17.72]***
2006-2007	-0,0130	0,0231	-0,0361
Obs:501	(-1.91)*	(2.61)***	[13.39]***
2006	-0,0158	0,0099	-0,0257
Obs:249	(-2.36)**	(1.30)	[10.93]***
2007	-0,0309	0,0490	-0,0799
Obs:252	(-2.48)**	(3.03)***	[19.11]***

See Notes to Table 6.

To examine further the impact of asymmetries on herding behavior, days with high and days with low trading volume are distinguished with the help of the dummy variable $D^{V\text{-}high}$. Table 6 presents the corresponding results using model (7) for the full sample period. Evidence that trading volume asymmetrically affects the cross-sectional dispersion of returns cannot be found. None of the coefficient γ_3 and γ_4 is negative and statistically significant. So model (7) is estimated for all the sub-periods and the estimations where the asymmetric relationship between days of high and low trading volume is justified (γ_3<0 or γ_4<0 and the difference γ_3-γ_4 is statistically significant) are reported in Table 6b.

The evidence from Table 6b suggests, when equal weights are used, herding for the overall market in six sub-periods (2003-2007, 2003-2006, 2004-2006, 2005-2007 and 2006) and for the small stocks in eleven sub-periods (2003-2007, 2003-2006, 2004-2010, 2004-2009, 2004-2007, 2004-2006, 2005-2007, 2005-2006, 2006-2007, 2006 and 2007). The difference γ_3-γ_4 is negative and statistically significant in all cases, meaning that the herding effects are more pronounced during days with high trading volume. Still there is no evidence of asymmetric herding behavior for the large stocks. With the employment of trading value weighted returns, two sub-periods (2007-2001 and 2010-2011) show evidence of herding effect only for the small stocks with negative difference for γ_3-γ_4. Therefore, robust evidence is found of asymmetric behavior of returns' dispersion with respect to trading volume for the Greek equity market in certain sub-periods. This asymmetry is the result of the investors' transactions with small capitalization stocks and it is more likely to occur in days with high trading volume. This evidence is inconsistent with the study of Economou, Kostakis and Philippas (2011) where such asymmetry cannot be found for the period 1998-2008, implying that herding effects are equally likely to be encountered regardless of the magnitude of trading volume.

Another potential source of asymmetric behavior for CSAD is volatility of market returns. Model (8) attempts to capture this asymmetry by distinguishing between days with high and days with low volatility relative to a 30-day moving average.

The results for the full sample period are reported in Table 7. When equal weights are used, the coefficient γ_4 is negative and statistically significant and the difference γ_3-γ_4 is positive and statistically significant meaning that herding behavior is more pronounced during days of low market volatility. For another time there is evidence that this asymmetry is the result of the trades of small stocks. Large stock once again display signs of antiherding behavior (the coefficient γ_3 is positive and statistically significant). When value weights are used, no evidence of herding asymmetry can be found for the full sample period.

To be consistent with the previous methodology, model (8) is estimated for all sub-periods and the estimations where the asymmetric relationship between days of high and low volatility is justified (γ_3<0 or γ_4<0 and the difference γ_3-γ_4 is statistically significant) are reported in Table 7b. This time there are much more sub-periods with evidence of herding behavior. This is logical since the estimation for the full sample period suggests the presence of herding. Using equal weight for the returns, eleven sub-periods for all stocks, one for the large stocks and eight for the small stock indicate asymmetric herding behavior. When trading value weights are employed, the number of sub-periods indicating herding, are nine, one and five respectively. But the most important finding is that the difference γ_3-γ_4 in every sub-period is positive. So the method of calculating the average market return and dispersion does not affect the type of asymmetry, i.e. herding behavior is more likely to be encountered on days of low volatility.

Table 7. Estimates of Herding Behavior on Days of High and Low Volatility in the Full Sample Period

Coefficent	All Stocks	Large	Small
Panel A: Equally weighted			
α	1,9998	0,9464	2,0906
	(41.75)***	(27.18)***	(38.56)***
γ_1	0,3726	0,3310	0,3659
	(9.48)***	(7.55)****	(9.59)***
γ_2	0,6303	0,5724	0,6411
	(6.50)***	(8.08)***	(5.75)***
γ_3	0,0013	0,0160	-0,0031
	(0.20)	(2.26)**	(-0.64)
γ_4	-0,0768	0,0044	-0,1024
	(-2.06)**	(0.17)	(-2.23)**
Adjusted R^2	0,1785	0,5123	0,1342

Table 7. (Continued)

Coefficent	All Stocks	Large	Small
Wald Test for equality of herding coefficients (H0: γ3=γ4)			
γ_3-γ_4	0,0781	0,0116	0,0993
Chi-square	[4.70]**	[0.23]	[4.97]**
Panel B: Value weighted			
α	1,4033	0,9523	1,8620
	(25.71)***	(21.46)***	(18.19)***
γ_1	0,2146	0,2472	0,2874
	(3.39)***	(6.08)***	(2.27)**
γ_2	0,3913	0,4484	0,3580
	(4.63)***	(5.74)***	(2.63)***
γ_3	0,0186	0,0129	0,0241
	(2.01)**	(2.86)***	(1.34)
γ_4	0,0017	0,0062	0,0242
	(0.07)	(0.28)	(0.63)
Adjusted R^2	0,3773	0,4380	0,4327
Wald Test for equality of herding coefficients (H0: γ3=γ4)			
γ_3-γ_4	0,0168	0,0067	-0,0001
Chi-square	[0.61]	[0.11]	[0.00]

See Notes to Table 6.

A possible explanation in the framework of behavioral finance could be that during periods characterized by absence of news (low volatility), investors in the Greek equity market ignore their own information about stock prices and prefer to base their trading decisions on the behavior of the market. Economou, Kostakis and Philippas (2011) do not find that volatility has an asymmetric impact on the returns' dispersion in the Greek market regardless of the way market returns are calculated but for the period 1998-2008.

We also examine whether herding effects are stronger during periods of financial crisis. The dept crisis of Greece provides an appropriate setup to test this hypothesis. Model (9) is used for this purpose. As crisis period the period November 2009-December 2012 is selected. It was November 2009 when fears of a sovereign debt crisis developed among investors concerning Greece's ability to meet its debt obligations that led to a crisis of confidence, indicated by a widening of bond yield spreads and the cost of risk insurance on credit default swaps.

The economic depression as a result of the implementation of severe austerity measures that followed characterizes the Greek economy until the end of 2012. The estimated coefficients for model (9) are reported in Table 8.

Table 8. Estimates of Herding Behavior during Financial Crisis Period

Coefficent	All Stocks	Large	Small
Panel A: Equally weighted			
α	2,1118	1,0070	2,2173
	(37.81)***	(32.12)***	(37.14)***
γ_1	0,2944	0,4182	0,2496
	(4.29)***	(10.08)***	(3.78)***
γ_2	-0,0168	-0,0244	-0,0119
	(-1.04)	(-2.50)**	(-0.78)
γ_3	0,1037	0,0347	0,1219
	(4.96)***	(4.76)***	(4.81)***
Adjusted R^2	0,2671	0,5149	0,2246
Panel B: Value weighted			
α	1,5486	1,0266	1,8986
	(29.20)***	(27.31)***	(20.98)***
γ_1	0,1296	0,2980	0,2913
	(1.97)**	(8.40)***	(2.91)***
γ_2	0,0575	0,0046	0,0352
	(2.92)***	(0.69)	(1.86)*
γ_3	-0,0367	0,0037	-0,0180
	(-2.43)**	(0.74)	(-1.41)
Adjusted R^2	0,4387	0,4208	0,4841

This table reports the estimated coefficients of the regression model, where $CSAD_t$ and $R_{m,t}$ are the cross-sectional absolute deviation and market return of the N_t stocks traded in the Athens Stock Exchange (ASE) at time *t* and D^{crisis} is a dummy variable that takes the value 1 during the period of financial crisis.The sample period is January 2002-December 2012 (2745 daily observations). The financial crisis period refers to the period November 2009-December 2012. Panel A contains the estimated coefficients when equal weights are used for the calculations, while Panel B contains the corresponding coefficients when trading value weights are employed instead. Numbers in parentheses are t-statistics calculated using Newey-West (1987) heteroscedasticity and autocorrelation consistent standard errors. ***,** and * represent statistical significance at the 1%, 5% and 10% level, respectively.

Overall, there is no evidence in favour of the hypothesis that cross-sectional return dispersion is further decreased during this crisis period when equal weights are used. The coefficient γ_3 is positive and statistically significant indicating that the cross-sectional dispersion actually increased during the financial crisis. When value weights are employed the results are reversed. The coefficient γ_3 is negative and statistically significant for all stocks, an evidence of herding behavior during the financial crisis.

The fact that coefficient γ_3 is not significant for the large and small stocks means that it is difficult to infer if this herding behavior is the result of the investors' transaction with large or small stocks. Economou, Kostakis and Philippas (2011) finds that financial crisis does not induce a more intense herding behavior in the Greek market regardless of the way market returns are calculated. However, it must be mentioned that this study uses a different sample period (1998-2008) and financial crisis period is selected differently (one alternative refers to the period August 2007-December 2008 and the other alternative refers to the period September 2008-October 2008).

CONCLUSION

This study tests whether herding characterizes the behavior of investors in the Athens Stock Exchange (ASE) over the 2002-2012 period. Rational asset pricing suggests that given the exposure of stock prices to systematic factors, large market price increases or decreases will be associated with a larger dispersion of individual stock returns around the market aggregate. In contrast, if herding occurs, stock prices will be tightly clustered around the market consensus.

Daily continuous compounded returns are used for all stock (430) traded on ASE during the examined period. To test if the company size plays a particular role in herding behavior, the sample is split in two size groups, large and small stocks, according to the daily average market capitalization of each year. The average market return and the two measures of dispersion, the cross-sectional standard deviation (CSSD) and the cross-sectional absolute deviation (CSAD) are calculated with two methods. The one is the commonly used of the equal-weighted market portfolio and the alternative is value-weighted market portfolio.

At first, the methodology applied is the one developed by Christie and Huang (1995). This method examines whether equity return dispersions are significantly lower than average during periods of extreme market conditions. As extreme market movements are considered the 1% and 5% of the observations in the lower or upper tail of the market return distribution. The empirical evidence using the CH approach suggests that herding behavior is not a driving force in the ASE over the entire 2002-2012 period.

The testing methodology suggested by Chang, Cheng and Khorana (2000) is then employed and the results support the linearity assumption implied by rational asset pricing models but do not provide evidence in favor of the presence of herding behavior in the ASE over the entire sample period. On the contrary, transactions involving only large stocks indicate that market movements cause more dispersion in stock returns than expected under rational pricing (anti-herding). The implementation of the value-weighted approach also captures evidence of anti-herding behavior for both the large and small stock in the full sample period. However, when the CCK model is estimated in sub-periods, clear evidence of herding behavior can be found in certain sub-periods as a result of the activity on small sized stocks.

A set of tests is then conducted to investigate whether the herding behavior is documented above varies with market conditions. For this purpose the approach of Chiang and Zheng (2010) and Chiang et al. (2010) is selected, where a dummy variable is utilized to capture the asymmetry of the behavior. The first asymmetric relationship that is examined distinguishes between days of rising and falling returns. As with the benchmark model CCK, no evidence of differential behavior can be found in the full sample period using both equally weighted and value weighted returns. However, in certain sub-periods strong evidence of herding effects are detected due to the trades of small stocks. When equally weighted returns are used herding is much stronger on days with falling market prices but when value weighted returns are employed herding seem to be more intense on days with positive market returns. As regards the impact of trading volume activity on herding, no such evidence can be found in the whole period of 2002-2012. But in certain sub-periods, an asymmetric relationship between dispersion and market return is captured, indicating the presence of herding effects. These effects are more likely to be encountered on days of high trading volume, they concern transactions of small stocks and are detected mainly when equal weights are used. The third source of asymmetry, volatility, is the only that can be found in the full sample period and implies that herding behavior is more pronounced during days of low market volatility. Many sub-periods show signs of low volatility asymmetry, even for large stocks, using both equally weighted and value weighted returns. Finally, a positive finding that herding effects are stronger during the ongoing dept crisis of Greece, is induced only when value weighted measures are employed.

GENERAL CONCLUSION

- The detection of the existence or absence of herding behavior depends largely on the specific sample period considered.
- The method of calculating market returns and cross-sectional dispersion (equally weighted or value weighted) affects the estimations about herding effects.
- When herding behavior is confirmed in the Greek equity market, it usually the result of investors' transactions with small stocks. Most of the times, large stock show evidence of anti-herding behavior.
- In general herding behavior is more pronounced under conditions of high trading volume and low volatility.

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