Nonlinearities, Herd Behaviour and Market Illiquidity: Evidence from Montenegro?[*]

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ABSTRACT – *Research in Finance has shown that herd behaviour is associated with nonlinear dynamics in both developed and emerging stock markets. However the latter are characterized by thin trading which has been found to amplify nonlinearities in returns by enhancing their serial dependence. If so, then the association between herding and nonlinearities may be subject to the thin trading bias. As this issue has never explored before, we investigate this in the context of the New Securities Stock Exchange of Montenegro. Results indicate that correcting for thin trading bears a notable impact upon the observed nonlinearities, yet not the estimated herding, which appears insignificant in all test*

KEY WORDS: herding, thin trading, nonlinearities, Montenegro

Introduction

Research in Finance has produced widespread evidence in favour of herding being associated with nonlinear return dynamics in capital markets, both developed as well as developing (Lux, 1995; Lux and Marchesi, 1999; Wagner, 2002). However, emerging stock exchanges are typified by thin trading, which has been found to amplify nonlinearities (Solibakke, 2005; Saadi *et al.*, 2006) as it tends to enhance the serial dependence in the structure of the return-generation process (Lo and MacKinley, 1990; Miller et al, 1994; Antoniou et al, 1997; Siriopoulos, 2001; Solibakke, 2001). Despite the above mentioned association between thin trading and nonlinearities, the potential for thin trading producing a bias over nonlinear herding estimations has never been explored in Finance, even though many herding studies have been undertaken in emerging markets.

We aim at filling this gap by addressing this issue in the context of Montenegro's New Securities Stock Exchange (NEX) which is one of the most recently (2001) established markets in the world and which has never been the subject of any research in Finance before. Our study covers the period between March 2003 and May 2008 and is conducted on the premises of the NEX20 index which constitutes the market's main index. The rest of the paper is structured as follows: section 2 provides a brief overview of the herding literature,

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while section 3 delineates the evolution of Montenegrin capital markets; section 4 discusses the data (4.1), the methodology employed (4.2) and presents some descriptive statistics (4.3). Section 5 presents and discusses the results; section 6 concludes.

Herd behaviour: theory and empirical evidence

The notion of herding pertains to the behavioural similarity following from the interactive observation of opinions, information, actions or the payoffs of those actions (Hirshleifer and Teoh, 2003). If the individual chooses to align his/her mode of action to that suggested by others, then he/she will exhibit convergence in that direction. Under such circumstances, one's priors are expected to be sidelined in favour of the observed consensus, thus giving rise to phenomena of collective dynamics.

In psychological terms, imitation has often been assumed to be driven by the behavioural biases of the human nature itself. Hirshleifer (2001) noted how *conformity* can lead people to copy the actions of those around them. Such an imitative tendency may be explained through individuals' interactive communication, which could be described as either *explicit* (when people are conversing- Shiller, 1995) or *tacit* (when people observe others' choices, for example in fashion-Bikhchandani et al, 1992). Drawing from earlier findings of cognitive psychology, Prast (2000) demonstrated how the interplay of *congruity* and *cognitive dissonance* is capable of facilitating herding among individuals.

Investors, however, may resort to imitative behaviour due to sheer informational reasons; Devenow and Welch (1996) showed that a person might find herding appealing if she possesses no information, perceives her information less reliable compared to others' or considers others better informed. If an investor considers the actions of her peers highly informative, it is likely she will end up suppressing her private information and allow herself to be drawn into an informational cascade (Banerjee, 1992; Bikhchandani *et al.*, 1992), thus leading to a slower aggregation of information into the market and rendering the public information pool poorer.

Career/reputational considerations may prompt market participants to conform to the line implied by the perceived consensus. This has been found to be the case particularly among investment professionals (e.g. fund managers and financial analysts) who are subject to relative performance evaluation vis-à-vis their peers. As Scharfstein and Stein (1990) have shown, such a situation may encourage professionals to align their conduct in line with the perceived benchmark in order to avoid deviating largely from it and run a professional risk. The issue here is that "bad" professionals will find it more attractive to mimic the actions of their "good" peers so that they improve their image, thus jamming the evaluation process. However, "good" professionals might also resort to herding if they feel that the risk by going-it-alone exceeds the corresponding benefit, especially if they wish to protect their image and reputation (Graham, 1999). What is more, investment professionals are subject to a certain framework of conduct that may actually itself foster commonality in their behavior (De Bondt and Teh, 1997). Research (Olivares, 2003; Voronkova and Bohl, 2005; Kominek, 2006) has shown, for example, that funds in some cases may be restricted in the choice of stocks they are allowed to invest in by the regulatory authorities, thus ending up holding portfolios of similar composition.

A key finding surrounding much analytical as well as empirical research in herding is that herd behaviour is associated with nonlinearities in the structure of returns. These findings indicate that in the presence of herding, asset returns will deviate from the paradigm implied by rational pricing models which incorporate linear frameworks in their design. The presence of herding has been shown to be associated with nonlinearities inducing bubbles and crashes (Lux, 1995; Lux and Marchesi, 1999; Equíluz and Zimmermann, 2000; Wagner, 2002; Xie *et al.*, 2002), excess kurtosis (Cont and Bouchaud, 2000) and reduced cross-sectional return dispersion (Chang *et al.*, 2000; Caparelli *et al.*, 2004; Gleason *et al.*, 2004; Henker *et al.*, 2006; Caporale *et al.*, 2008).

However, an issue here arises as many of these studies have been undertaken in emerging capital markets, a typical feature of which is thin trading. As many studies have illustrated (Lo and MacKinley, 1990; Miller *et al.*, 1994; Antoniou *et al.*, 1997; Siriopoulos *et al.*, 2001; Solibakke, 2001; Solibakke, 2005; Saadi *et al.*, 2006) thin trading is particularly conducive to nonlinearities in asset dynamics due to the fact that it delays the incorporation of information into securities' prices. Therefore, prices tend to reflect information emanating from trades of previous sessions and end up changing at a lower frequency, which leads them to exhibit increased serial dependence. As Antoniou *et al.* (1997) and Siriopoulos *et al.* (2001) further demonstrated correcting for thin trading tends to reduce these phenomena, thus suggesting that thin trading introduces a bias in nonlinear empirical estimations. In view of the above though, the following question arises: is the herding estimated on the premises of nonlinear models robust to thin trading? If the aforementioned serial dependence of returns dissipates following the adjustment for thin trading, does the latter also occur to herding estimates in nonlinear frameworks? It would therefore be interesting to examine whether herd-related nonlinearities persist after thin trading has been accounted for in emerging markets.

Our study aims at covering this gap by examining the impact of thin trading over herding at the nonlinear dimension utilizing the empirical design proposed by Chang *et al.* (2000). More specifically, we perform our tests on the premises of the New Securities Stock Exchange (NEX) of Montenegro for the period between March 2003 and May 2008. We consider our study to be contributing to existing herding research in two distinctive ways:

    a) it assesses for the first time the impact that thin trading may bear in an illiquid market upon nonlinear herding estimations

    b) it measures herding in a market which has never been investigated before in Finance.

Capital markets in Montenegro

Capital markets were first introduced in Montenegro in the early 1990s with the foundation of the Montenegro Stock Exchange in 1993. However, it was not before 2000-1 that investors' interest began to pick up following the launch of the mass privatization programme. It was during that time that the Securities and Exchange Commission was set up as the key regulatory authority in the stock exchange. By the end of 2001, a second trading venue, the New Securities Stock Exchange (NEX) was established operating on the basis of electronic trading, which formally commenced on March 4th, 2002 (Popović, 2004). It

is interesting to note here that, although the country's population hovers around 650,000 inhabitants, 430,000 of them (Popović, 2004) hold a shareholding position; the number of actively trading investors has been estimated at 10 percent of the population and their investment behaviour has been noted to be mostly based on word-of-mouth, rather than fundamentals (Sofia Echo, July 9th, 2007). Despite the large number of listed companies in both the Montenegro Stock Exchange and the NEX (over 400), trading activity is mostly concentrated among very few (a dozen or so) stocks (Popović, 2004), thus raising the issue of thin trading there despite the gradual increase of investors' participation (Radanovic, 2006).

Data and methodology

Data

Our data includes the daily closing prices and daily trading volume of all historical constituents of the NEX20 which is the main index of the New Securities Stock Exchange accommodating the twenty largest listed stocks (Popović, 2004). The choice of the New Securities Stock Exchange instead of the Montenegro Stock Exchange was motivated here by the unavailability of data for the Montenegro Stock Exchange. The data covers the period beginning March 2003 when the NEX20 was launched and ending May 2008 and was obtained from the New Securities Stock Exchange. According to the historical constituent lists of the NEX20 obtained from the NEX, the total number of stocks that have been included at any point during that period in the composition of the index equals 50.

Methodology

The first attempt in Finance to trace herding through nonlinearities was undertaken by Chang *et al.* (2000) who aimed at detecting herding through the dispersion of returns using the cross-sectional absolute deviation (CSAD) of returns for that purpose:

$$CSAD_t = \frac{1}{N}\sum_{i=1}^{N}\left|\beta_i - \beta_p\right|\left|r_{i,t} - r_f\right| \tag{1}$$

where β_i represents the systematic risk of the individual security i, β_p reflects the systematic risk of the market portfolio, $r_{i,t}$ is the return of the individual security i at time t, r_f is the risk free rate, and N is the number of securities in the market portfolio.

As Henker *et al.* (2006) illustrated, equation (1) can equivalently be expressed as:

$$CSAD_t = \frac{1}{N}\sum_{i=1}^{N}\left|r_{i,t} - r_{p,t}\right| \tag{2}$$

where $r_{i,t}$ is the return of the individual security i at time t, $r_{p,t}$ is the return of the market portfolio at time t and N is the number of securities in the market portfolio. In the present framework, the market portfolio is formed by the 20 constituent stocks of the NEX20, whose composition varies over time; moreover, returns here are calculated as the first logarithmic difference of daily closing prices.

According to Chang *et al.* (2000), an increased clustering of returns around the market average is indicative of herding; therefore, a decreasing cross-sectional absolute dispersion

would suggest the presence of herding. However, herding here is not reflected in the cross-sectional absolute dispersion *per se*, but rather in the relationship between the cross-sectional absolute dispersion and the market return. Chang *et al.* (2000) argued that this relationship is of nonlinear nature, since herding can give rise to dynamics not predicted by rational pricing models; to formalize this nonlinear relationship in an empirical framework, Chang *et al.* (2000) proposed the following test:

$$CSAD_t^{UP} = \alpha + \gamma_1^{UP} \left| R_{m,t}^{UP} \right| + \gamma_2^{UP} \left(R_{m,t}^{UP} \right)^2 + \varepsilon_t \qquad (3)$$

$$CSAD_t^{DOWN} = \alpha + \gamma_1^{DOWN} \left| R_{m,t}^{DOWN} \right| + \gamma_2^{DOWN} \left(R_{m,t}^{DOWN} \right)^2 + \varepsilon_t \qquad (4)$$

where $R_{m,t}$ is the equal-weighted market portfolio (in our case, the NEX20-portfolio) return and the UP/DOWN superscripts denote up/down market days. Chang *et al.* (2000) employ the above two regressions in order to account for possible directional asymmetries in herd behaviour contingent upon market direction. In other words, the authors want to test whether herding exhibits any differences during periods of up- versus down-markets. As herding is assumed here to be related to market nonlinearities, we are particularly interested in the γ_2-coefficient. In view of what we mentioned above, a negative and statistically significant estimate for γ_2 would be suggestive of the presence of significant herding. To test for the robustness of our results, we also estimate equations (3) and (4) using the volume-weighted cross-sectional absolute dispersion in order to control for any impact of heavily traded stocks in our estimates.

However, despite the fact that the NEX20 index includes the largest stocks in the New Securities Stock Exchange, many of them realize a number of non-trading days (Popović, 2004), thus raising the issue of the thin trading bias here. In order to adjust for thin trading, Miller *et al.*, (1994) proposed correcting for it by using a methodology based on a moving average process reflective of the number of non-trading days. However, given the complexity of identifying non-trading days, Miller *et al.*, (1994) have demonstrated that the correction for thin trading can be accomplished using an AR (1) process, as follows:

$$R_t = a_1 + a_2 R_{t-1} + e_t \qquad (5)$$

where R_t is the individual stock return at time *t*; R_{t-1} is the individual stock return at time *t-1* and e_t is the error term.

Realized returns can then be adjusted as follows:

$$R_t^{adj} = \frac{e_t}{(1 - a_2)} \qquad (6)$$

where R_t^{adj} is the return at time *t* after thin trading has been taken into account.

Antoniou *et al.* (1997) pointed out that an assumption underlying the Miller *et al.* (1994) approach is that the adjustment for thin trading is taken to be constant throughout time. They argue that this assumption may be inappropriate when dealing with emerging markets as they may well accommodate substantial windows of trading inertia. As the latter constitutes a feature of the market under investigation here, equation (5) is estimated

recursively. Once individual returns are adjusted for thin trading, they are then used to re-calculate the cross-sectional absolute dispersions (equal- and volume-weighted ones) and re-estimate equations (3) and (4).

Table 1. Sample statistics for the NEX20-portfolio returns ($R_{m,t}$) and the cross-sectional absolute deviations (CSAD), using different versions of the NEX20-portfolio, i.e. equal-weighted, equal-weighted with returns corrected for thin trading, volume-weighted, volume-weighted with returns corrected for thin trading (* = indicates significance at the 1 percent level).

NEX20-portfolio designations	Variables	Number of observa-tions	Mean	Variance	Maximum	Minimum	Serial correlation at lag					DF test
							1	2	3	5	20	
Equal-weighted	$R_{m,t}$	1299	0.0013	0.000617	0.4662	-0.4566	-0.17	-0.02	0.03	-0.01	0.02	-42.92*
	CSAD	1299	0.0208	0.001645	0.8755	0.0000	0.41	0.09	0.07	0.07	0.05	-23.23*
Equal-weighted adjusted for thin trading	$R_{m,t}$	1296	-0.0214	2.7643	13.5678	-12.2209	0.23	0.05	0.05	-0.01	0.07	-30.13*
	CSAD	1296	1.9706	4.1835	24.3206	0.0304	0.24	0.24	0.21	0.24	0.14	-28.75*
Volume-weighted	$R_{m,t}$	1299	0.0083	0.0030	0.7729	-0.4167	0.02	-0.01	0.01	0.07	0.06	-35.23*
	CSAD	1299	0.0304	0.0032	0.8395	0.0000	0.15	0.02	0.01	0.04	0.01	-31.00*
Volume-weighted adjusted for thin trading	$R_{m,t}$	1296	0.2018	19.1461	70.3693	-51.3972	0.08	-0.01	0.00	0.02	0.05	-33.89*
	CSAD	1296	2.7300	15.4109	69.9199	0.0195	0.07	0.07	0.02	0.04	0.01	-14.48*

Descriptive statistics

Table 1 presents some statistics for the NEX20-portfolio returns ($R_{m,t}$) and their corresponding cross-sectional absolute dispersions (CSAD), both equal- and volume-weighted ones, before and after adjusting for thin trading. It is interesting to note here that the means and variances of both the NEX20-portfolio returns and their cross-sectional absolute dispersions exhibit a notable increase following the correction for thin trading. This is indicative of thin trading bearing a substantial presence in the NEX-market. The first order autocorrelations for the cross-sectional absolute dispersions' series appear quite high, and always assume higher values for each NEX20-portfolio designation (equal-/volume-weighted) prior to adjusting for thin trading. In view of this, all standard errors of the estimated coefficients here are adjusted for heteroscedasticity and autocorrelation, in line with Chang *et al*. (2000). Finally, the Dickey – Fuller statistic suggests that all cross-sectional absolute dispersions' series exhibit stationarity.

Results - Discussion

Table 2 presents the estimates obtained for equations (3) and (4) of the Chang *et al*. (2000) model on the premises of both the equal- as well as the volume-weighted NEX20-portfolios, before and after adjusting for thin trading. The α coefficient, reflective of the average value of the cross-sectional absolute dispersion of returns, is found to be positive and significant in all tests at the 1 percent level; interestingly enough, its value appears to rise dramatically following the adjustment for thin trading in all cases. This is something perhaps to be

expected as in the presence of thin trading, individual stocks' series would include a number of zero-observations, thus rendering the dispersion of stocks' returns around their mean tighter.

Regarding the γ_1 coefficient, it is also found to be significantly (1 percent level) positive for all tests, thus being suggestive of a positive linear relationship between the cross-sectional absolute dispersion and the $R_{m,t}$. This indicates that the cross-sectional absolute dispersion increases with the absolute value of the NEX20-portfolio returns and it is in line with the findings of Chang *et al.* (2000), Caparelli, *et al.* (2004), Gleason *et al.* (2004), Henker *et al.* (2006) and Caporale *et al.* (2008). An interesting feature of our results relates to the fact that volume-weighted tests furnish us with consistently lower γ_1 estimates compared to equal-weighted tests, both prior to and after correcting for thin trading. This indicates that the above documented positive linear relationship between the cross-sectional absolute dispersion and the $R_{m,t}$ becomes weaker (i.e. the dispersion increases at a decreasing rate) when taking the impact of trading volume into account. We also notice that there seems to be a general trend[1] for γ_1^{UP} to be greater than γ_1^{DOWN}. This means that dispersions increase at a lower rate during periods of market declines compared to periods of positive market returns; however, the F_1 test statistic in Table 2 used to test the null hypothesis $\gamma_1^{UP} = \gamma_1^{DOWN}$ shows that the null hypothesis is accepted in all cases, thus implying that γ_1^{UP} is not significantly different from γ_1^{DOWN}.

Table 2. Regression results for the Chang et al. (2000) model.

	Up-market model				Down-market model				Test statistics	
	α	γ_1^{UP}	γ_2^{UP}	Adjusted R^2	α	γ_1^{DOWN}	γ_2^{DOWN}	Adjusted R^2	F_1	F_2
Equal-weighted	0.0080 (14.52)*	1.1702 (31.34)*	1.4551 (13.84)*	0.883	0.0073 (11.11)*	1.3324 (30.3)*	1.2578 (11.08)*	0.930	0.0000000000000421908	0.0000000000000017753
Equal-weighted adjusted for thin trading	0.6905 (12.21)*	1.4593 (25.32)*	-0.0200 (-3.06)*	0.752	0.8328 (13.32)*	1.0204 (15.89)*	0.0395 (4.23)*	0.690	0.0000000000000032968	0.0000000000000048689
Volume-weighted	0.0074 (7.81)*	1.0208 (33.18792)*	-0.0437 (-0.88)	0.884	0.0127 (12.56)*	0.6028 (12.9)*	2.2043 (15.37)*	0.875	0.0000000000000241761	0.0000000000000002042
Volume-weighted adjusted for thin trading	1.1350 (15.9)*	0.8828 (35.16)*	0.0011 (2.62)*	0.929	1.0438 (16.24)*	0.8209 (26.29)*	0.0029 (3.53)*	0.789	0.0000000000001185930	0.0000000001631320000

This table reports the estimated coefficients of the following set of regressions (standard errors in brackets):

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

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[1] With the exception of the equal-weighted case prior to adjusting for thin trading.

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

*F_1 and F_2 statistics test respectively the following null hypotheses: $\gamma_1^{UP} = \gamma_1^{DOWN}$ and $\gamma_2^{UP} = \gamma_2^{DOWN}$; * = indicates significance at the 1 percent level.*

With regards to γ_2, it is found to be significant (1 percent level) for nearly all tests[2], thus being indicative of a significant nonlinear relationship between the cross-sectional absolute dispersion and the $R_{m,t}$; however, its sign is mostly positive[3], thus failing to generate much evidence in favour of herding here. It is further interesting to observe that correcting for thin trading leads to a substantial depression of the γ_2 coefficient; while γ_2 assumes values above unity in absolute terms before adjusting for thin trading, its values decline well below unity in absolute terms once thin trading has been corrected for, with the exception of the γ_2^{UP} coefficient in the volume-weighted tests. The decline of the γ_2 coefficient after thin trading has been adjusted for constitutes a very important finding here as it indicates a positive impact of thin trading over the nonlinear relationship between the cross-sectional absolute dispersion and the NEX20-portfolio returns. This finding is in line with evidence documented in the literature regarding the contribution of thin trading to nonlinearities. Antoniou *et al.* (1997) and Siriopoulos *et al.* (2001) showed that adjusting for thin trading in nonlinear market efficiency tests tended to reduce the magnitude of the nonlinear components in the Turkish and Greek stock exchanges respectively. Solibakke (2001; 2005) showed that thin trading accounted for the most part of the nonlinear dynamics observed in the structure of stock-returns in Norway; according to the evidence he presented, the most illiquid securities in the Oslo stock exchange were those typified by the most consistent and pronounced nonlinearities. Saadi *et al.* (2006) argued that, given transaction costs, noise investors have a tendency to delay their trades in order to observe informed investors' behaviour and that this delay in anticipation of new information gives rise to nonlinear trends in asset prices. Saadi *et al.* (2006) pointed out that nonlinearities due to market imperfections are even more likely in emerging markets, given their particular features such as thin trading, low liquidity and high presence of noise traders and argued that these features imply greater complexity of the nonlinear dynamics characterising asset prices. Although we notice that there exists a general tendency[4] for γ_2^{DOWN} to be higher than γ_2^{UP}, the hypothesis $\gamma_2^{UP} = \gamma_2^{DOWN}$ cannot be rejected here as the results from the F_2 test-statistics in Table 2 accommodate very small values, equal almost to zero.

Our results, thus furnish us with some interesting findings on the impact of thin trading over nonlinear herding estimations for the first time in the literature. First of all, the absence of herding in the New Securities Stock Exchange appears robust to correcting for thin trading on the premises of the Chang *et al.* (2000) nonlinear model framework; conditioning upon volume and market direction further confirms this finding. Although the relationship between the cross-sectional absolute dispersion of returns and the market returns in the

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[2] With the exception of the volume-weighted case prior to correcting for thin trading in up-markets.

[3] With the exceptions of the γ_2^{UP} in two cases: equal-weighted adjusted for thin trading; volume-weighted unadjusted for thin trading.

[4] With the exception of the equal-weighted case prior to adjusting for thin trading.

context of the NEX20 index is found to accommodate significant nonlinearities, the increasing nature of this relationship implies that herding is absent. Perhaps more interestingly, though, correcting for thin trading appears to confer a notable impact over these nonlinearities, since the latter endure a major decline following the adjustment for thin trading. Since the impact of thin trading over herding has been examined here for the first time in a nonlinear framework, we consider our findings to contribute substantially to the Finance literature.

Conclusion

A series of studies have attempted to detect herding through nonlinearities in return-dynamics in both developed and emerging capital markets. However, although the latter are normally expected to be characterized by thin trading, its impact over herding estimates has largely been overlooked despite the positive association between thin trading and nonlinearities widely documented in the literature. Our research aims at covering this gap by examining the impact of thin trading over herding in the New Securities Stock Exchange of Montenegro on the premises of the NEX20 index. Results seem to suggest that herding is non-existent, irrespective of whether one corrects for thin trading or not. However, our findings also illustrate that the Montenegrin market accommodates significant nonlinearities, which, despite being irrelevant to herding, undergo a substantial depression following the adjustment of returns for thin trading.

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