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"Herding toward the market: Evidence from the stock market of Ukraine"

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Introduction

Modern asset pricing theory starts draw more attention to the ability of some concepts of psychology to explain behavior of stock market participants and their resulting effect on stock prices in order to present explanations for phenomenon existing in financial markets. Herd behavior in financial markets is the specific issue that starts to raise more interest of both practitioners and academic researchers. Such interest arises from the impact that herd behavior of stock market participants causes on financial markets' stability and efficiency. Investigation of the herding behavior became particularly relevant after the financial crises in 1990s. A number of studies focused on the extent of distortion impact caused by herd behavior in periods of financial crises (Eichengreen, Mody (1988); Folkerts-Landau, Garber (1999)). Herding in capital markets is in general described by propensity of an investor to mimic the actions of large group of investors, those he regards as better informed and at the same time neglecting his personal information and expectations.

According to Nofsinger and Sias (1999), herding can be observed when "a group of investors trading in the same direction over a period of time". At the same time, Banerjee (1992) suggests that herding exists when "everybody doing what everyone else is doing even when their private information suggests doing something else". The source of the herd behavior may be explained using two approaches. Devenow, Welch (1996) propose the irrational explanation of the existence of herding behavior, according which, an investor irrationally mimics the actions of the other investors due to desire of conformity, which arise because of people feel themselves more comfortable when copy the actions of others. On the other hand, rational view posits that herding may arise due to informational, reputation and compensational concerns (Banerjee (1992), Scharfstein, Stein (1990)). Usually investor tends to follow the herd since this behavior reduces the costs and the time of getting information from one hand, from another hand herd behavior is may be caused by the reputation concern. When less able investor mimics the actions of other investors in order to not reveal his abilities.

The distortion effects that arise due to propensity of the investors to follow the herd are widely discussed in the literature. Banerjee (1992) points that costly acquisition and asymmetry of information lead investors to neglect the fundamental value of the asset and follow the market which in turn lead the market to inefficiency. Kaminsky and Schmukler (1999) examine the origins of the Asian crisis and discuss the harmful effect of rumor, argue that the presence of herd behavior significantly deteriorate the economic conditions in period of market stress. Calvo and Mendoza (1996) discuss the effect of herd behavior on the volatility of capital market in the beginning of the Mexican crisis. Lu and Zhu (2006) consider the destabilizing effect caused by herd behavior of the fund investors on the stock market of Chine. Patterson and Sharma (2007) point that due to short-term pressure, caused by investors, that moves the market prices of the assets from their fundamental values may give the opportunities for the formation of bubbles and crashes. Kumar and Prasad (2002) ague that persistent herding in the sock markets may produce excessive inflows or outflows of capital without any accurate estimation of the credibility of coming news. Such behavior is entirely contagion. Huang and Salmon (2004) point the herding toward the market leads to misevaluation of systematic risk of the asset, produces biasness of beta estimates. Such bias in turn may cause the significant distortion in the investment decisions. It leads that project of the risky companies, whose betas are higher than the market beta (unit) would be adopted, as betas of these companies are underestimated; in turns considering the companies that are relatively less risky, comparing with the market, herding leads that profitable project would not be adopted as betas of these companies are overestimated. Also presence of herding toward the market induces investors to increase the number of shares in their portfolio in order to keep the same level of diversification as for market that does not suffer due to herd behavior. So considering the harmful impact of the herd behavior on the stock markets it is important to detect whether the herd behavior is persistent in the particular market as for inventors, as this gives them the possibility to adjust their estimates of risk, taking into account the bias caused by herding and so fund manager as persistent herding in the particular market decrease benefits from diversification. Policymakers might be interested in whether the herding presents in the stock market, as those aim among all is to eliminate existing inefficiencies in the economy.

The purpose of this paper is to investigate the presence of herding behavior and describe it's dynamics in the Ukrainian stock market. For the analysis I will adopt the definition of herding by Chang, Cheng and Khorana (2000) according to which herding is "the process through which participants of the market trade based on the collective actions of the market rather than their private expectations". That is herding toward the market consensus in which market participants follow the market return and buy or sell without deep assessment of assets characteristics. Herding toward the market consensus leads that returns on assets would be clustered around the market portfolio. Such behavior may arise due to fact that investors are sure that market portfolio captures all relevant information and do not spent resources in order to assess adequately the trends in market fundamentals. While this definition differs from that were proposed above (Nofsinger and Sias (1999), Banerjee (1992)), but this type of herding also lead to the biased assessment of individual securities due to the deviation of investors' beliefs from the equilibrium values which are predicted by asset pricing theories.

The studies that are aimed to detect the herding behavior in the developed markets provide the mixed evidence. Lakonishok, Shleifer and Vishny (1992) analyze the tendency of the pension funds managers toward the herding and results do not give any evidence of herding. Patterson, Sharma (2007) discuss the presence of herd behavior on the NYSE and find no market-wide herding. In contrast Huang, Salmon (2004) provide the supporting evidence of the presence of the herding behavior in the developed stock markets. Wermers (1999) analyzes the propensity of mutual funds mangers toward the herding in the USA stock market and provides the evidence that weakly support presence of herding behavior. From other hand, mostly all studies that are aimed to detect the presence of herding behavior in the developing stock markets support that herding is persistent in the emerging stock markets. Chang, Cheng, and Khorana (2000) document the presence of the herding behavior in the stock markets of South Korea and Taiwan. Huang and Salmon (2004) also provide the supporting evidence of the presence of the herding in the stock market of South Korea. Duasa and Kassim (2008) present the evidence of herding for capital market Malaysia. Chen, Rui and Xu (2003) document the existence of the herding for A- and B-share separately in the Chinese stock market. But the most of studies that are aimed to investigate the existence of the herding in developing markets are done for Asian countries. In contrast, considering Baek (2006) documents that there are different causes of investments for Asia and Latin America. Investments in Asia are highly depend on the tastes for risks of investors, the market mood, which produce significantly high volatility of Asian stock markets, from other hand portfolio investments in Latin America are very sensitive to the fundamental factors. So it is incorrect to make the conclusions about the presence of the herding behavior in the developing stock markets based on only evidence from Asian countries. Considering the Ukrainian stock markets, such factors as costly acquisition of information, low transparency, weak reporting requirements, informational uncertainty and low credibility to the public information push inventors to be engaged in the herd behavior. From other hand, the low level of liquidity of the stock market of Ukraine may cause the significant barrier for investors being engaged in herd behavior, as for example the investor that is interested in selling the particular asset may not found the buyer for that asset, which significantly reduces possibility for herding.

In order to detect whether the herding toward the market exist in the Ukrainian stock market approach proposed Hwang, Salmon (2004) would be used. The data for the analysis consists of the monthly return on PFTS index and monthly return on the stock that constitute the PFTS index_ covering the period from January 1, 1998 up to December 31, 2008. This paper is going to extend the approach proposed by Hwang, Salmon (2004). Hwang, Salmon (2004) assumed that asset betas are constant over time and the variation in beta with the time is observed due to herding. Such assumption is not appropriate for such developing economy as Ukraine. A vast amount of studies suggests that systematic risk of the stocks do really change through the time and this especially true for the emerging economies

The rest of the paper is designed in such way: in the next section there is overview of the empirical studies that concern the measurement of herding in the stock markets; in the third section, methodology for detection the presence of the herd behavior is discussed and then the discussion of the procedure that is used for calculation of time-varying betas is presented; in the fourth section the data that used for the analysis is presented and then the analysis of the results is documented.

Literature Review

There are a growing number of studies that devoted considerable effort for investigation of the issue of herding behavior in financial markets, its origins, impact on the stability of financial markets and measurement. Empirical and theoretical literature of analysis herding behavior in financial markets is evolved in different direction. The theoretical researches mostly concentrate their attention upon origins and causes of herding behavior among financial markets participants. Two concepts were developed to explain the origins of herding behavior: irrational (Devenow, Welch (1996)) and rational. The rational concept suggests that investors are engaged in herding behavior due to possessing informational payoff, compensation or reputation concerns (Banerjee (1992), Scharfstein, Stein (1990)).

The theoretical models of herding behavior have not been tested directly in the empirical literature, in contrast empirical researchers examine the presence of clustering of decisions in a particular market or among particular group of market participants in order to detect herding. In particular, Lakonishok, Shleifer, Vishny (1992) proposed a measure to detect whether herding took place among pension fund managers. The authors analyze the trading convergence between investors with respect to buying or selling particular asset at the same period of time. Basically, the correlation in trading pattern among group of investors was examined. As the result was found there is no trading convergence among pension fund managers. The measure proposed by Lakonishok, Shleifer, Vishny (1992) is widely used in other researches (Wermers (1999), Walter and Weber (2006)). Kim, Wei (2002) analyzed herding behavior among domestic and foreign investors in the Korean stock market using the measure proposed by Lakonishok, Shleifer, Vishny (1992). The results suggest that foreign investors tend to exhibit herding more comparing with domestic investors. These results stress that lack of information and opaque investment environment creates incentive of investors to be engaged in herding behavior in developing markets, which is also the case for stock market of Ukraine.

The above studies of herd behavior are focused mostly on the detection of herding among certain group of investors, in contrast this paper is aimed to detect whether the herd behavior is present in the Ukrainian stock market in the market-wide sense, that is the collective behavior of all investors with respect to market portfolio. Christie, Huang (1995) is the first study that proposed approach to detect whether the herd behavior is present in the market-wide sense. In order to examine whether the herd behavior is present in the particular market, authors used the cross-sectional standard deviation of individual security returns as the dependent variable and estimate the following model:

$$CSSD_t = a + b^L \cdot D_t^L + b^H \cdot D_t^H + e_t$$

where $CSSD_t$ is the cross-sectional standard deviation of returns; D_t^L and D_t^H represent dummies that take the value one when market return in the particular time lies in the extreme lower and upper tail of distribution correspondently. According to Christie, Huang (1995) study, in periods of extreme movements in the market, either significant increase or decrease of the market return (equally-weighted cross-sectional average of returns), market participants would tend exhibit herd behavior toward the market. As the result a return on the particular asset would cluster around the market return and cross-sectional standard deviation of returns would tend to decrease. So coefficients of D_t^L and D_t^H are expected to be significant and negative if herding toward the market presents in the particular market.

Chang, Cheng, Khorana (2000) extends approach proposed by Christie, Huang (1995) by using nonlinear specification of the relations between cross-sectional absolute deviation of returns and market return in the following way:

$$CSAD_t = a + b_1^U \cdot abs(R_{m,t}^U) + b_2^U \cdot (R_t^U)^2 + e_t$$
$$CSAD_t = a + b_1^D \cdot abs(R_{m,t}^D) + b_2^D \cdot (R_t^D)^2 + e_t$$

where $CSAD_t$ is cross-sectional absolute deviation of returns; $abs(R_{m,t}^U)$ and $abs(R_{m,t}^D)$ are the absolute values of the market return in the particular period t when market is up or down respectively. The following model allows for asymmetric impact of the herd behavior. The authors assume that in periods of market stress cross-sectional absolute deviation of returns would increase at decreasing rate so coefficients b_2^U and b_2^D are expected to be significant and negative if the herding forward the market is present in the particular market. The above model was applied to the stock markets of USA, Hong Kong, Japan, South Korea and Taiwan. The results support the presence of herding toward the market consensus in the stock markets of South Korea and Taiwan and provide evidence that rejects the presence of herding in the developed stock markets.

Henker, Henker, Mitsios (2005) used the approach proposed by Chang, Cheng, Khorana (2000) for the Australian stock market based the intraday data frequencies. The paper suggests that low frequencies in the data may miss intra-interval herding. The paper was aimed at detecting the herding behavior in the whole market and in industry sectors. Results based on the intraday and daily data provide no evidence of herding among agents in the Australian equity market and this evidence is supported by the capital asset pricing model. Here it must be pointed that the studies that tested the CAPM for the Australian equity market found that CAPM performs relatively well.

The studies that were aimed at detecting market-wide herding in developing stock market using the approach proposed by Chang, Cheng, Khorana (2000) documented supportive evidence of presence herding in these markets (Guglielmo, Fotini, Philippas (2008), Chiang, Mason, Nelling, Tan (2004)). Chen, Rui, Xu (2003) proposed more sophisticated approach for revealing herding behavior by accounting for the effect of momentum trading strategy and informational effect. The analysis was conducted for B-share and A-share markets in order to detect whether there is a difference in behavior of foreign and domestic investors. The results suggests that foreign investors are more likely be engaged in herding behavior which is explained by that fact that firm-specific information is less available for foreign investors. The results of Chen, Rui, Xu (2003) stress that low availability and accuracy of information is significant factor that drives the herding behavior in the developing stock markets.

Demirer, Gubo, Kutan (2007) examine the presence of herding in stock markets of Western Europe, the U.S.A, Asia, Central and Eastern Europe, Latin America, Middle East and Africa using approach proposed by Chang, Cheng, Khorana (2000). The authors investigate the presence of herding toward three anchors: S&P 500 index, MSCI world market index and oil prices instead of using only market return. The authors documented no evidence of herding in all regions, except Middle East and Asia. For Middle East and Asia results provide the supportive evidence of present herd behavior toward the MSCI index. So according to Demirer, Gubo, Kutan (2007) there is no evidence of presence herding toward S&P 500 index, MSCI world market index and oil prices in stock markets of Central and Eastern Europe, including Ukraine too. But approaches proposed by Christie, Huang (1995) and Chang, Cheng, Khorana (2000) have some drawbacks. Firstly, Hwang (2000) documents that there is a positive relationship between cross-sectional volatility of market return and time series volatility. So decrease in cross-sectional standard deviation of returns does not necessary imply presence of herding behavior but it may be explained by decrease in uncertainty of market return. From other hand, these approaches do not account for the effect of changes in fundamental variables, so do not distinguish spurious herding from intentional one (Bikchandani, Sharma (2001)). In addition, there is no strict guideline in which values of the market return must be considered as extreme. Also herding behavior is not necessary observable only in periods of market stress; it might be also recognizable in sufficiently quiet periods when herding drives reallocation of funds in the market toward particular industry, which does not reflect in significant change in market index. So identification herding only in periods of market stress leads us to miss some important part herding behavior. So results attained by Demirer, Gubo, Kutan (2007) for Ukraine might be doubtful.

Huang, Salmon (2004) propose a new approach for detection of market-wide herding, which overcomes drawbacks listed above. In order to detect herding toward the market the authors proposed to use cross-sectional dispersion of market betas of individual assets instead of cross-sectional volatility of market return. This approach takes into account the effect of correlation between cross-sectional volatility of market return and time series volatility; also it gives the possibility to detect intentional herding instead of spurious herding. Bikchandani, Sharma (2001) pointed that spurious herding may occur when all investors observe the same information and react in the same direction. Instead, intentional herding occurs when investor after observing the actions of other investors, changes his behavior and acts in the same way as others. Information that produces the spurious herding is might be public information, which is available for everyone. Huang, Salmon (2004) propose the approach which controls for the effects that might occur due to changes in fundamental variables. In more detail the model proposed by Huang, Salmon (2004) is discussed in the next section. Their model was applied to the analysis of the US, UK, and South Korean stock markets and was found statistically significant evidence about the existence of herding towards the market consensus. It must be stressed here, that Huang, Salmon (2004) documented the evidence that supports presence of herding behavior as for developing markets so for developed markets, which contradicts results attained by Christie, Huang (1995) and Chang, Cheng, Khorana (2000). In this paper, approach proposed by Huang, Salmon (2004) is used to detect the presence of the herding in the Ukrainian stock market.

Huang-Salmon approach was designed based on the assumption of constant equilibrium risk-return relationship. For analysis of herding behavior in Huang, Salmon (2004), betas were attained by running OLS regressions of daily excess individual return on daily excess return on market portfolio over monthly interval. In following way monthly betas were received. But in contrast a growing number of studies provide evidence that confirms time-varying nature of systematic risk (Black, Fraser, Power (1992); Wells (1994); Braun, Nelson, Sunier (1995)). So in order to examine the presence of herding behavior in stock market of Ukraine time-varying beta estimators are selected for the analysis. Canela, Wang (2006) investigated the presence of herding behavior in developed and developing economies using for analysis time-varying beta estimators. In their study, time-varying betas are attained based on rolling regression procedure. In contrast, Greonewold, Fraser (2000) pointed that time-varying coefficients, that are attained based on rolling regression procedure, suffer from high degree of autocorrelation that arises due to overlapping problem. Rolling regression procedure is designed in such way, that it is assumed that betas are fixed over five years. So each month individual excess return is regressed on excess return on market portfolio and only one new observation is added in 60 observations, which leads to overlapping of sub-periods. Marti (2005) used different techniques in order to attain time-varying betas, such as Kalman filter approach, several GARCH models, asymmetric beta model and rolling regression procedure and compared the accuracy of estimators. The results show that betas are attained based on Kalman filter approach dominates all other approaches in accuracy and betas based on rolling regression procedure are dominated by all other procedures. Here must be pointed that herding measure that is attained based on Huang-Salmon approach is very sensitive to the accuracy of beta estimation, as inaccurately calculated beta may produce spurious results concerning the presence of herding. So for analysis of herding behavior in the stock market of Ukraine, time-varying betas would be accomplished based on Kalman filter approach and GARCH models in order to attained robust results.

The analysis of herding behavior is different for emerging markets and development markets. The typical problem that arises in the analysis the emerging markets is the presence of thin trading that creates a bias of estimators. Several studies were conducted for different emerging markets with accounting for the bias that is generated in herding measure due to thin trading problem. Kallinterakis, Kratunova (2007) examine the herding behavior in Bulgaria stock market and provide the analysis of the impact of thin trading on the bias of herding measure. The results suggest that thin trading problem leads that actual level of herding is underestimated. Andronikidi, Kallinterakis (2008) examine the same issue for Israel stock market and results lead to the conclusion that thin trading problem produces bias in the estimation of herding measure. Kallinterakis, Kratunova (2007) and Andronikidi, Kallinterakis

(2008) use adjusted return of individual securities in order to account for thin trading. Adjusted return was found in following way:

$$r_t = a_0 + a_1 \cdot r_{t-1} + \varepsilon_t$$

$$r_t^{Adjust} = \frac{\varepsilon_t}{1 - a_1}$$

where r_t^{Adjust} is which was used for regression of excess return on excess return on market portfolio. Antoniou, Ergul, Holmes (1997) criticize the above technique of adjustment for thin trading, the authors ague that adjustment for thin trading must not be constant over time in the analysis of emerging markets. Brooks, Dark, Faf, Fry (2006) pointed that above technique makes some correction in beta estimation for thin trades but does not eliminate the problem entirely. Instead the authors proposed a proper approach to account for thin trading bias in beta estimation. A selectivity corrected beta estimator was proposed to correct for thin trading bias. On order to eliminate possible problems that may arise due to thin trading, the most liquid securities that do not suffer from thin trading were selected for the analysis of herding behavior in the stock market of Ukraine.

Methodology

The Sharpe (1964), Lintner (1965) asset pricing model suggests that there a positive relationship between expected return on asset and its riskiness. The main results of the Sharpe-Lintner study is that the risk of the asset is determined based on the beta and the main determinant of the beta is the covariance of expected return on market portfolio and the expected return on a particular asset. The second conclusion infers that there is a linear relationship between expected return on an asset and its beta. The static version of Sharpe-Lintner capital asset pricing model based on constant relationship between expected return of the asset and its beta was rejected by the subsequent studies of the asset pricing. The vast amount of the series of the studies indicate that the asset return and betas depend on the information that investors observe in every point of time, so the investors have time-variant expectation that differ cross time in accordance to observed information.

The asset pricing models describe the equilibrium relationship between the expected return on a asset and its fundamental risk. There is evidence that shows that expected return also reimbursed due to misevaluation of asset caused by such factors as faulty of investor and different social trend which may arise due to herding.

In this paper the Huang, Salmon (2004) measure of the herding behavior would be used in order to detect the presence of the herding in the Ukrainian stock market. Huang, Salmon (2004) determinant of the herding is detected based on the inspection of the deviation of the observed market betas of the assets from their long-run equilibrium level predicted by the CAPM, as this deviation arises from mistaken beliefs concerning the return on asset caused by herding.

The long-run equilibrium level of the expected return predicted by CAPM in the market where the agents form the rational expectations depicted in such way:

$$E_t(r_{i,t}) = \beta_{imt} E_t(r_{m,t})$$

where $r_{i,t}$ and $r_{m,t}$ represent the excess return on asset i and the excess return on the market portfolio at time t correspondingly, β_{imt} represents the risk measure that arise due to market risk

By going behind Huang, Salmon (2004) assumption concerning the behavior of the agents, here is assumed that the majority of the agents in the market form their belief concerning the expected return on asset based on the market-wide vision.

Misevaluation of the expected return based on the existence of the deviation the true market betas described by CAPM and the observed market betas. This mechanism can be depicted in such way:

$$\beta^b{}_{imt} = \frac{E_t^{\;b}(r_{i,t})}{E_t(r_{m,t})} = \beta_{\;imt} - h_{m,t}(\beta_{\;imt} - 1)$$

where $E_t^{\;b}(r_{i,t})$ represent the biased expected excess return on a asset, $E_t\ (r_{m,t})$ the expected excess return on the market portfolio, $\beta^b{}_{imt}$ represent the biased market return betas, $\beta_{\;imt}$ represent the true market betas of the asset i predicted by asset pricing model. $h_{m,t}$ depicts the latent variable that describe the herding. In the markets where the herd behavior is absent $h_{m,t}$=0 and $\beta^b{}_{imt} = \beta_{imt}$, which defines that there is no deviation from the long-run equilibrium level predicted by CAPM. If $h_{m,t}$=1 indicates that there is a pure herding toward the market. If $h_{m,t}$ not equal zero then the assets for which the true betas are higher than market betas, higher than 1, their return would be undervalued due to herding, the assets for which the true betas are less than market betas, less than 1, their return would be overvalued due to herding.

As the cross-sectional expected value of the betas is equal to 1, the cross-sectional variance of the betas can be shown in such way:

$$\operatorname{var}_c(\beta^b_{im,t}) = \operatorname{var}_c(\beta_{imt} - h_{m,t}(\beta_{imt} - 1)) = (1 - h_{m,t})^2 \operatorname{var}_c(\beta_{im,t})$$

Taking logarithm of the above equation we have:

$$\log(\operatorname{var}_c(\beta^b_{im,t})) = 2 \cdot \log(1 - h_{m,t}) + \log(\operatorname{var}_c(\beta_{im,t}))$$

Let $H_{mt} = \log(1 - h_{m,t})^2$ and $\mu_t = E(\log(\operatorname{var}_c(\beta_{imt}))$

Huang, Salmon (2004) study assumes that long-run equilibrium betas are constant, and if there is change in the betas through time then it is explained by changes in the herding behavior so μ_t is constant. For the emerging market it is inappropriate assumption, a vast amount of studies showed that risk exposure does really change through time as for emerging stock markets so for developed markets, so μ_t is also vary through time. It can be extracted from the multifactor asset pricing model for every period.

So we have:

$$\log(\operatorname{var}_c(\beta^b_{im,t})) = \mu_t + H_{mt} + v_t$$

By going behind Huang, Salmon (2004) $H_{m,t}$ is assumed to follow AR(1) process, so we have:

$$H_{m,t} = \phi \cdot H_{m,t-1} + \eta_t$$

To receive the robust estimate of the herding behavior, we need to be sure that the change in the $H_{m,t}$ represent the changes in the herding behavior and not depicts the effect of the other variables that influence on the $\operatorname{var}_c(\beta^b_{im,t})$. To extract the effect of the variables that depict the state of the market the following specification is presented:

$$\log(\operatorname{var}_c(\beta^b_{im,t})) = \mu_t + H_{m,t} + a_1 \cdot r_t + a_2 \cdot \sigma_t + v_{m,t}$$

$$H_{m,t} = \phi \cdot H_{m,t-1} + \eta_t$$

where r_t represents the market return and σ_t represent the volatility of market return. Taking into consideration the possible effect of the variables reflecting macroeconomic variables:

$$\log(\mathrm{var}_c(\beta^b_{im,t})) = \mu_t + H_{m,t} + a_1 \cdot r_t + a_2 \cdot \sigma_t + F'\alpha + v_{m,t}$$

where F' represent the vector of macroeconomic variables such as CPI, exchange rate, default spread, industry index. The insignificant variables $H_{m,t}$ indicates the changes in the $\log(\mathrm{var}_c(\beta^b_{im,t}))$ caused by changes in the included variables but not due to herding.

So the following state-space model is going to be estimated:

$$\log(\mathrm{var}_c(\beta^b_{im,t})) = \mu_t + H_{m,t} + a_1 \cdot r_t + a_2 \cdot \sigma_t + F'\alpha + v_{m,t}$$

$$H_{m,t} = \phi \cdot H_{m,t-1} + \eta_t$$

The significant value ϕ defines that the herding behavior exists in the economy. This model is standard state-space model and would be estimated using Kalman filter.

Time-varying betas.

GARCH conditional betas:

Despite that fact, that returns of the stocks assumed to be identically and independently distributed processes in finance theory this fact is not supported by evidence. It is well recognized that series of stocks returns demonstrate presence of autocorrelation and volatility clustering, which contradicts the theoretical assumptions. Instead, it is well documented that variance-covariance matrix of individual stocks and return on market portfolio is time-dependent. So time-varying betas can be represented in following way:

$$\beta_{i,t} = \frac{\operatorname{cov}_t(r_{i,t}, r_{m,t})}{\operatorname{var}_t(r_{m,t})}$$

Here the computations of time-varying betas are based on time-varying covariance between individual stock returns and return on market portfolio and time-varying variance of return of market portfolio.

Mergner, Bulla (2005) documented the accuracy of estimators of time-varying betas based on bivariate GARCH model proposed by Bollerslev (1990). Their approached would be used for computation of time-varying betas.

The estimated model is represented in the following way:

$$\begin{vmatrix} r_{i,t} \\ r_{m,t} \end{vmatrix} = \begin{vmatrix} \mu_i \\ \mu_m \end{vmatrix} + \begin{vmatrix} \varepsilon_{i,t} \\ \varepsilon_{m,t} \end{vmatrix}$$

$$\varepsilon_t = z_t \sqrt{H_t}$$

$$\varepsilon_t \sim N(0, H_t)$$

where r^c and r^m represent the series of returns of the individual stocks and market return; μ_i and μ_m are constants; ε_t represents the vector of residuals with zero conditional mean and variance H_t. Here H_t can be represented in following way:

$$H_t = \begin{vmatrix} \sigma_{11,t} & \sigma_{12,t} \\ \sigma_{21,t} & \sigma_{12,t} \end{vmatrix}$$

The variance equation can be specified in the following way:

$$vech(H_t) = C + \sum_{j=1}^{p} A_j vech(\varepsilon_{t-j})^2 + \sum_{j=1}^{q} B_j vech(H_{t-j})$$

where C is the vector of parameters; A and B are 3x3 parameter matrices of parameters. $vech(\cdot)$ represents the stacking operator, that transform nxn matrix in $\frac{\mathrm{n(n+1)}}{2}\mathrm{x\,1}$ vector (Hamilton (1994)).

The bivariate diagonal VEC (1,1) model, that is used for computation of time-varying betas in the following paper, has the following specification:

$$\sigma_{11,t} = C_1 + A_{11} \cdot \varepsilon^2{}_{1,,t-1} + B_{11}\sigma_{11,t-1}$$
$$\sigma_{12,t} = C_2 + A_{12} \cdot \varepsilon_{1,,t-1} \cdot \varepsilon_{2,,t-1} + B_{12}\sigma_{12,t-1}$$
$$\sigma_{22,t} = C_3 + A_{22} \cdot \varepsilon^2{}_{2,,t-1} + B_{22}\sigma_{22,t-1}$$

The time-varying beta of stock i can be calculated as the ratio between the conditional covariance of the return of individual stock i and return on market portfolio and conditional variance of return of market portfolio, expressed in the following way:

$$\beta_t = \frac{\sigma_{12,t}}{\sigma_{22,t}}$$

where $\sigma_{12,t}$ represents conditional covariance between individual stock return and the market return and $\sigma_{22,t}$ represents conditional variance of market return which are estimated based on the above model. As variance-covariance matrix is time-dependent, betas that are received are also time-dependent.

Kalman filter approach:

In previous section in order to attain the time-varying betas, the conditional variances must be firstly estimated; instead the Kalman filter approach gives the possibility to estimate time-varying betas directly. Kalman filter approach allows estimating time-varying beats numerically through the recursive algorithm. This framework is based on distinguishing the observable variables, in this case individual stock returns and market return, and unknown variables that is betas through observation and transition equations. The observation equation shows how observable variable is described by unobserved components. Marti (2005) proposed to estimate time-varying betas using the following observation equation:

$$r_{i,t} = a + \beta_{i,t} \cdot r_{m,t} + \varepsilon_t$$

Here $r_{i,t}$ and $r_{m,t}$ represent excess return on individual stocks and excess market return.

The time-varying betas are specified to be governed by following dynamics process:

$$\beta_{i,t} = c \cdot \beta_{i,t-1} + \eta_t$$

The above equation represents the transition equation of our state-space model. Here was assumed the time-varying betas follow AR(1) process. Other assumptions exist concerning the specification of process that governs betas series in dependence of assumption concerning the transition parameter *c* such as mean-reverting process or random walk, but above specification is the mostly widely used.

Data

In order to analyze the presence of herd behavior in the Ukrainian stock market as the proxy for market portfolio PFTS index is selected. The analysis would be made based on the data which consist of the monthly return on PFTS index and monthly return on of the stocks that constitute PFTS index that is 20 stocks (the descriptions of stocks included for the analysis is presented in the Appendix). The sample covers the period from January 1, 1998 up to December 31, 2008. The prices of the stocks and PFTS index are extracted from the last working day for every month of the sample period. In the analysis the quoted prices of the stocks are used. As the proxy for the risk-free rate the nominal money market rate was selected.

The return is calculated in such way:

$$r_t = (\ln(P_t) - \ln(P_{t-1}))$$

In order to attain the main dependent variable, which is the cross-sectional standard deviation of the market betas, the following formula is used:

$$E_c(\beta^b_{imt}) = \sum_{i=1}^{N} \beta^b_{imt}$$

$$\operatorname{var}_c(E_c(\beta^b_{imt})) = \frac{(\beta^b_{imt} - E_c(\beta^b_{imt}))^2}{N-1}$$

Here $E_c(.)$ is the cross-sectional expected value, $\operatorname{var}_c(E_c(\beta^b_{imt}))$ represents the cross-sectional standard deviation, β^b_{imt} represents the market beta of the stock i in period t. It must be pointed here that for estimation of time-varying betas the equally-weighted market portfolio is used.

Table1. presents the descriptive statistics of the cross-sectional standard deviation of betas attained based on GARCH model and Kalman filter approach.

Table 1. Descriptive statistics of cross-sectional standard deviation of market betas

Variable	Obs	Mean	Std. Dev.	Min	Max
SD^c, Kalman filter	132	0.5795433	0.635868	0.1421405	4.242194
$Ln(SD^c)$, Kalman filter	132	-0.160313	0.464151	-0.980038	0.734516
SD^c, GARCH	132	0.4182985	0.3443763	0.2502256	3.556462
$Ln(SD^c)$, GARCH	132	0.16417	0.440360	-0.902697	1.422311

The above table documents the descriptive statistics of cross-sectional standard deviation of betas and logarithmic values of cross-sectional standard deviation of betas. As we can see there is a significant difference in magnitudes and variations of cross-sectional standard deviation of betas found based on GARCH model and Kalman filter approach, which may generate the different results concerning the herding measure. Such difference may be explained by that fact that GARCH betas were computed indirectly, based on estimated conditional variances.

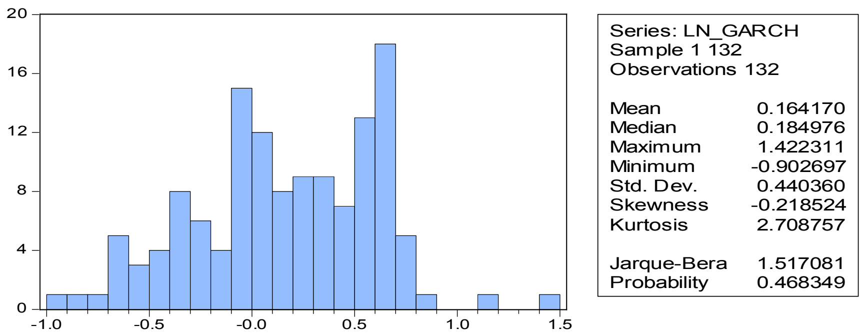

Figure 1. Distribution of cross-sectional standard deviation of betas found based on GARCH model

The above figure represents the distribution of logarithm of cross-sectional standard deviation of betas found based on GARCH model. As we see cross-sectional standard deviation of betas is leptokurtic, having significant negative skewness, kurtosis is less than three. But Jargue-Bera test supports the normality in cross-sectional standard deviation of betas series.

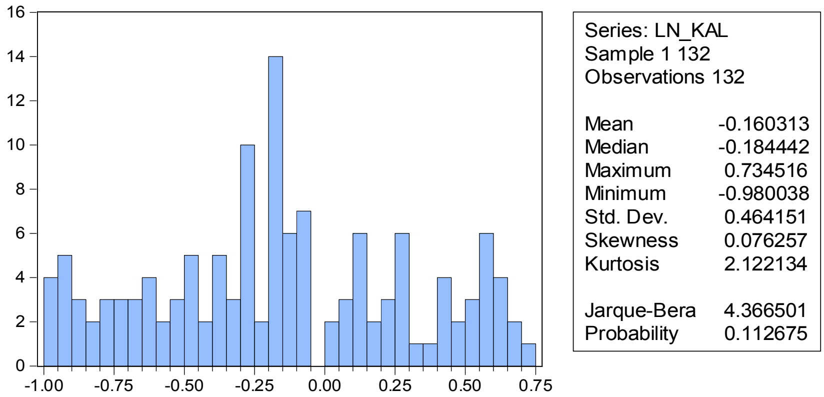

Figure 2. Distribution of cross-sectional standard deviation of betas found based on Kalman filter model

The above figure represents the distribution of logarithm of cross-sectional standard deviation of betas found based on Kalman filter model. We see that distribution of cross-sectional standard deviation of betas found based on Kalman filter model is different comparing with of cross-sectional standard deviation of betas found based on GARCH model. As we see cross-sectional standard deviation of betas based on Kalman filter model is the subject of right skewness, kurtosis is also less than three. But Jargue-Bera test also supports the normality of logarithm of cross-sectional standard deviation of betas series based on Kalman filter model.

As pointed above in order to distinguish the spurious herding from intentional, we need to account for the effect of fundamentals variables in order to attain the robust measure of herding. So in order to account for the possible effect of the economy performance on the dynamics of the cross-sectional standard deviation of the market betas the following factors were selected: the change in the monthly CPI, the change in the exchange rate, the growth of the industrial production and term structure.

Inflation presents the information concerning the real return of the securities; it increases the cost of equities. So inflation has considerable impact on the stork markets dynamics. The firms may differ in their sensitivity to the inflation changes, which must be reflected in the value of assets.

Exchange rate depicts the risk from the possibility that a firm's operations or value can be changed due to currency exchange rates changes, which also increases the cost of equities.

Production index is used to depict the cycle component of the real activity. It shows the monthly change in the production relatively to the corresponding month of the previous year. This is the single determinant of the real activity that has frequency higher than annual. It is well-known that the real sector has significant impact on the performance of the stock markets.

Table 4. presents some simple descriptive statistics of the factors.

Table 4. Descriptive statistic

Variable	Obs	Mean	Std. Dev.	Min	Max
Return of PFTS Index	132	0.0121433	0.1240126	-0.403304	0.3839589
Market volatility	132	0.0144742	0.0128198	0.0037664	0.0750541
Term structure	132	0.1659113	0.10576	0.0512	.446
Oil price	132	202.3273	135.5483	22.3098	638.5212
Inflation	131	0.0001222	0.0111893	-.0366441	0.0359282
Production index	132	107.3909	8.169702	71.4	122
Risk free rate	132	0.1489391	0.1778184	0.1274	0.8892
Exchange rate	132	4.917008	0.9076353	1.93	7.7

Market volatility was found as a square of market return based on the daily data over monthly window. We see that Ukrainian stock market is the subject of high volatility, which may arise due to presence of herding among the stock market participant.

Empirical results

The above table presents the results of estimated state space models using as dependent variables logarithm of cross-sectional standard deviation of betas based on Kalman filter and GARCH model.

Table 5. Estimates of state-space models

Dependent variable	Cross-sectional SD of GARCH betas			Cross-sectional SD of Kalman filter betas		
Coefficient:	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Herding measure	0.1647***	-0.5502***	-2.68**	-2.2548***	-2.255***	-2.36***
Market return		-1.640326*	0.2605*		-0.516750*	0.0036 *
Market volatility		-3.91308	-0.021*		-1.865130*	-0.0216 *
Oil price			-0.0041			-0.01512
Exchange rate			0.00183			0.033430
Production index			-0.0292			-0.0057
Inflation			-1.7925			-3.1374*
Term structure			0.13193			0.0059

As we can see the transition parameters in all models are significantly different from zero, which indicates that herding behavior is present in stock market of Ukraine leads. But important is that the signs of transition parameters are different. So more deeper analysis is needed.

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