

# Sentiment and Beta Herding in Financial Markets

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# Behavioural Finance

- Agent Based Models; Adaptive Markets Hypothesis (Lo) and Markets seen as Complex Evolving Systems.
- Refined notions of Efficiency; information sets include models and statistical methods used- allows some exploitable temporary excess return
- Limits to Arbitrage
- Loss Aversion
- Framing; Psychological and Social Factors

# Sentiment and Herding

- Sentiment and Beta Herding in Financial Markets;  
with Soosung Hwang
- Sentiment Waves and Asset Price Formation;  
with Nektaria Karakatsani

<http://www2.warwick.ac.uk/fac/soc/wbs/research/wfri>

# Beta Herding

- To measure herding we need to differentiate between a rational (efficient) reaction to changes in fundamentals and irrational (inefficient) herding behaviour. Both lead to common movements in asset prices at the same time.
- In order to do this we need to define herding in a new way.

## Definition

**Beta Herding:** arises when agents buy and sell assets in order to follow the market index or some other factor ignoring the underlying equilibrium risk return relationships (leading to biased betas).

# How do the betas become biased when herding occurs?

$$E_t(r_{it}) = \beta_{imt} E_t(r_{mt}),$$

- When investors' beliefs shift so as to follow the performance of the overall market more than they should in equilibrium, they disregard the equilibrium relationship ( $\beta_{imt}$ ) and will try to harmonise the return on individual assets with that of the market.
- For example, when the market increases, investors will often try to buy under-performing assets (relative to the market increase) and sell over-performing assets.
- Suppose the market index increases by 20%. Then we would expect a 10% increase for any asset with a beta of 0.5 and 30% increase for an asset with a beta of 1.5 in equilibrium.
- However, when there is *herding toward the market* portfolio, investors would buy the asset with a beta of 0.5 since it appears to be relatively cheap compared to the market and thus its price would increase. Investors would sell an asset with a beta of 1.5 since it appears relatively expensive compared to the market.

- So we define (beta) herding as the behavior of investors who simply follow the performance of specific factors such as the market portfolio itself or particular sectors, styles, - hence buy or sell individual assets at the same time disregarding the long-run risk-return relationship. *Herding within the Market and Herding towards the market.*
- Based on this definition, Hwang and Salmon Jnl.Emp.Finance(2004) ( HS) used a disequilibrium CAPM to measure herding based on the *cross-sectional* variance of the factor sensitivities of the individual assets in the market but taking expectations on the market as *given*.

- This paper extends HS in several ways.
  - First; we now investigate herding in the presence of market-wide sentiment. Sentiment is defined by the mean level of noise traders' subjective returns; relative optimism-pessimism.
    - Herding increases with market-wide sentiment and negative sentiment is found to reduce herding.
    - This supports empirical evidence in Brown and Cliff (2004) strong contemporaneous relationship between market returns and sentiment  $\Rightarrow$  herding activity increases in bull markets - decreases in bear markets.
    - Our measure of herding is now driven by two forces; one from cross-sectional convergence *within* the market towards the market portfolio, and the other from *market-wide* sentiment that evolves over time and drives the market as a whole.

- Second; we study the dynamics of herding over an extended time horizon.
  - Herding is not necessarily short run. The cycle of a bubble may not be completed within days, weeks or even months. - the Tulip Bubble in seventeenth-century Holland, the real estate bubble in the late 1980s Japan, and the recent dot-com bubble. It took years for these bubbles to develop and finally make their impact on the market.
  - Find evidence for slow moving herd behavior; we use monthly data rather than higher frequency data.



- Third; our measure of herding explains why and when CAPM fails ....when herding causes betas to deviate from the equilibrium betas.
  - There is clear difference before and after 1963; before 1963 CAPM works well – after 1963 it does not.
  - Many explanations have been proposed; time varying betas Jagannathan and Wang (1996), discount rate and cash flow betas by Campbell and Vuolteenaho (2004).
  - Most studies investigate the anomaly in a cross-sectional world. We measure herding (in the betas) through time indicating periodic failures of (equilibrium) CAPM.

- Finally –We propose a new *non-parametric* method to measure herding based on the cross-sectional variance of the betas
  - More flexible than the parametric model of HS as no particular parametric dynamic process for herding is assumed.
  - We derive a formal statistical framework within which the significance of the estimated herd measure can be calculated; is there any significant difference in the estimated levels of herd behavior between any two periods? or does the estimated level of herding change over time significantly ?

# Results

- US, UK, and South Korean stock markets
  - that “herding towards the market” does indeed move slowly, but is heavily affected by the advent of crises.
  - Contrary to the common belief that herding is only significant when the market is in stress, we find that herding can be much more apparent when market continues to rise slowly or when it becomes apparent that market is falling.
  - We also show that herding is not driven by macro business cycle factors nor by simple measures of the state of the stock market.
  - The results suggest that herding is persistent over time, like stock prices around the intrinsic values, as discussed in Shiller (1981, 2000, 2003), *but critically shows a different dynamic to stock prices.*

# Herding, Sentiment, and Betas

CAPM in equilibrium,

$$E_t(r_{it}) = \beta_{imt} E_t(r_{mt}),$$

- Herding towards the market;  $E_t(r_{it})$  is affected by the expected market movement  $E_t(r_{mt})$  more than CAPM suggests  $\Rightarrow \beta_{imt}$  biased towards 1 (ie. the market).
- *Conditional* on the expected market return HS model

$$\frac{E_t^b(r_{it})}{E_t(r_{mt})} = \beta_{imt}^b = \beta_{imt} - h_{mt}(\beta_{imt} - 1) \quad (1)$$

where  $E_t^b(r_{it})$  and  $\beta_{imt}^b$  are the market's biased conditional expectation of excess returns on asset  $i$  and its beta at time  $t$ , and  $h_{mt}$  is the herd parameter that changes over time,  $h_{mt} \leq 1$ .

- Encompasses equilibrium CAPM with  $h_{mt} = 0$ , but allows for temporary disequilibrium.

- Consider several cases in order to see how herding affects individual asset prices *given* the evolution of the market returns.
  - Perfect herding towards the market portfolio;  $h_{mt} = 1, \beta_{imt}^b = 1$  for all  $i$  and the expected excess returns on the individual assets will be the same as that on the market portfolio regardless of their systematic risks.
  - In general, when  $0 < h_{mt} < 1$ , herding exists in the market, and the degree of herding depends on the magnitude of  $h_{mt}$ .
    - when  $0 < h_{mt} < 1$ , we have  $\beta_{imt} > \beta_{imt}^b > 1$  for an equity with  $\beta_{imt} > 1$ , and  $\beta_{imt} < \beta_{imt}^b < 1$  for an equity with  $\beta_{imt} < 1$ .

Therefore when there is herding, the individual betas are biased towards 1.

- We need to allow a return towards equilibrium over time so that behaviour fluctuates around the equilibrium CAPM, we also explain ‘*adverse herding*’ when  $h_{mt} < 0$ .

It is critical to note that  $E_t(r_{mt})$  is treated as *given* in this framework and thus  $h_{mt}$  is conditional on the market. Therefore, the original HS herd measure is not directly affected by *market-wide mispricing* like bubbles, but is only designed to capture cross-sectional herd behavior *within* the market.

- Clearly however the two forces, cross-sectional and dynamic are intimately related.

## HS model with Sentiment

- We assume that sentiment on an individual asset ( relative to the expected market return) is decomposed into three components, market-wide (relative) sentiment, a herding effect and an idiosyncratic component  $\omega_{it}$ ;

$$s_{it} = s_{mt} - h_{mt}(\beta_{imt} - 1) + \omega_{it}, \quad (2)$$

- This is built up from the following ideas. Let  $\delta_{mt}$  and  $\delta_{it}$  represent sentiment on the market portfolio and asset  $i$  respectively. Then investors' biased expectations in the presence of sentiment is sum of a rational component and sentiment,

$$\begin{aligned} E_t^s(r_{it}) &= E_t(r_{it}) + \delta_{it} \\ E_t^s(r_{mt}) &= E_t(r_{mt}) + \delta_{mt} \end{aligned}$$

where for consistency  $\delta_{mt} = E_c(\delta_{it})$  and  $E_c(\cdot)$  represents the cross-sectional expectation, and the superscript  $s$  represents the bias due to the sentiment.

- Then we have

$$\begin{aligned}\beta_{imt}^s &= \frac{E_t^s(r_{it})}{E_t^s(r_{mt})} \\ &= \frac{E_t(r_{it}) + \delta_{it}}{E_t(r_{mt}) + \delta_{mt}} \\ &= \frac{\beta_{imt} + s_{it}}{1 + s_{mt}},\end{aligned}$$

where  $s_{mt} = \frac{\delta_{mt}}{E_t(r_{mt})}$  and  $s_{it} = \frac{\delta_{it}}{E_t(r_{mt})}$  represent sentiment in the market portfolio and asset  $i$  relative to the expected market return. i.e. the relative degree of optimism or pessimism.



- Can consider how beta is biased in the presence of sentiment in individual assets and/or market;

$$\beta_{imt}^s = \begin{cases} \beta_{imt} + s_{it} & \text{when } \delta_{it} \neq 0 \text{ and } \delta_{mt} = 0, \\ \frac{\beta_{imt}}{1+s_{mt}} & \text{when } \delta_{it} = 0 \text{ and } \delta_{mt} \neq 0, \\ \frac{\beta_{imt}+s_{it}}{1+s_{mt}} & \text{when } \delta_{it} \neq 0 \text{ and } \delta_{mt} \neq 0. \end{cases}$$

- Note that the model of sentiment satisfies the constraint that the cross-sectional expectation of the sentiment associated with individual assets is equal to market-wide sentiment;

$$\begin{aligned} E_C(s_{it}) &= E_C(s_{mt} - h_{mt}(\beta_{imt} - 1) + \omega_{it}) \\ &= s_{mt}, \end{aligned}$$

since  $E_C(\beta_{imt} - 1) = E_C(\omega_{it}) = 0$ . By substituting  $s_{it}$  into the expression for disequilibrium  $\beta_{imt}^s$ , we can derive the implied beta in the presence of both herding and sentiment;

$$\beta_{imt}^s = 1 + \frac{1}{1 + s_{mt}} [(1 - h_{mt})(\beta_{imt} - 1) + \omega_{it}]. \quad (3)$$

When there is neither herding nor market-wide sentiment, this implies the equilibrium beta,  $\beta_{imt}^s = \beta_{imt}$ .

- For given  $s_{mt}$  a positive  $h_{mt}$  (herding) makes  $\beta_{imt}^s$  move towards 1 while a negative  $h_{mt}$  (adverse herding) make  $\beta_{imt}^s$  move away from 1. On the other hand, when  $s_{mt}$  increases for given  $h_{mt}$ ,  $\beta_{imt}^s$  moves toward 1 and vice versa.
- When ( the equilibrium)  $\beta_{imt}$  is not related to  $\omega_{it}$ , we have

$$\begin{aligned} \text{Var}_c(\beta_{imt}^s) &= E_c \left[ \left( \frac{1}{1 + s_{mt}} [(1 - h_{mt})(\beta_{imt} - 1) + \omega_{it}] \right)^2 \right] \\ &= \frac{1}{(1 + s_{mt})^2} \left[ (1 - h_{mt})^2 \text{Var}_c(\beta_{imt}) + \text{Var}_c(\omega_{it}) \right]. \end{aligned}$$

- Consistent with equilibrium CAPM we assume that  $Var_c(\beta_{imt})$  is constant;
- Likewise the cross-sectional variance of the idiosyncratic sentiment  $\omega_{it}$  could be assumed to be constant.
- Therefore for given  $Var_c(\beta_{imt})$  and  $Var_c(\omega_{it})$  the left hand side decreases, *ceteris paribus*, when  $h_{mt}$  and  $s_{mt}$  increase. That is, we observe a reduction in  $Var_c(\beta_{imt}^S)$  when there is herding within the market and towards the market and positive market-wide sentiment.
- When there is no herding but market-wide sentiment exists, i.e.  $h_{mt} = 0$  and  $s_{mt} \neq 0$ , changes in  $Var_c(\beta_{imt}^S)$  are due to sentiment alone.

- So positive sentiment decreases  $Var_c(\beta_{imt}^s)$  suggesting that a bubble could reduce  $Var_c(\beta_{imt}^s)$ . This has similar effects to herding,  $h_{mt} > 0$ .
- However negative sentiment increases  $Var_c(\beta_{imt}^s)$  and thus during bear markets we should observe a larger  $Var_c(\beta_{imt}^s)$ , which could become even higher when there is adverse herding,  $h_{mt} < 0$ .
- It is fairly well documented that sentiment is positively contemporaneously correlated with market returns and lagged market returns. Thus a decrease in  $Var_c(\beta_{imt}^s)$  from an increase in  $s_{mt}$  is more likely during bull markets rather than bear markets. On the other hand, a decrease in  $Var_c(\beta_{imt}^s)$  from an increased  $h_{mt}$  is possible any time.

# Portfolios

- There are several benefits from using portfolios in the place of individual stocks.
  - First, for a well diversified portfolio the idiosyncratic sentiment of the portfolio  $s_{pt}$  is zero. i.e.,  $\omega_{pt} = 0$ . Then the impact of sentiment on the portfolio will be decomposed into just two components, market-wide sentiment and herding, so that;

$$s_{pt} = s_{mt} - h_{mt}(\beta_{pmt} - 1).$$

Then we have

$$\begin{aligned} \text{Var}_c(\beta_{pmt}^s) &= E_c \left[ \left( \frac{1}{1 + s_{mt}} [(1 - h_{mt})(\beta_{pmt} - 1)] \right)^2 \right] (4) \\ &= \frac{(1 - h_{mt})^2}{(1 + s_{mt})^2} \text{Var}_c(\beta_{pmt}). \end{aligned}$$

Therefore under the assumption that  $\text{Var}_c(\beta_{pmt})$  is invariant over time, we observe beta herding by measuring  $\text{Var}_c(\beta_{pmt}^s)$ .

- Second, using portfolio betas has another important empirical advantage that the estimation error will be reduced. That is as the number of equities in the portfolio increases we have  $p \lim \hat{\beta}_{pmt}^S = \beta_{pmt}^S$ .

# The Herd Measure and Non-parametric Tests

A natural measure of beta herding would then seem to be the sample estimate of  $Var_c(\beta_{imt}^S)$

## Definition (Beta Based)

The degree of beta herding towards the market portfolio is given by

$$H_{mt} = \frac{1}{N_t} \sum_{i=1}^{N_t} (\beta_{imt}^S - 1)^2, \quad (5)$$

where  $N_t$  is the number of stocks at time  $t$ . Herding towards the market portfolio therefore decreases with  $H_{mt}$ .

- One major obstacle in calculating the herd measure is that  $\beta_{imt}^S$  is unknown and needs to be estimated. We use a rolling window.

A simple market model is used as an example

Given  $\tau$  (window size) observations, the simple market model is represented as

$$r_{it} = \alpha_{it}^s + \beta_{imt}^s r_{mt} + \varepsilon_{it}, \quad t = 1, 2, \dots, T, \quad (6)$$

where  $\varepsilon_{it}$  is the idiosyncratic error which we assume

$\varepsilon_{it} \sim N(0, \sigma_{\varepsilon it}^2)$ . The OLS estimator of  $\beta_{imt}^s$  for asset  $i$  at time  $t$ ,  $b_{imt}^s$ , is then simply

$$b_{imt}^s = \hat{\sigma}_{imt}^2 / \hat{\sigma}_{mt}^2, \quad (7)$$

$$\text{Var}(b_{imt}^s) = \hat{\sigma}_{\varepsilon it}^2 / \hat{\sigma}_{mt}^2, \quad (8)$$

where  $\hat{\sigma}_{imt}^2$  is the sample covariance between  $r_{it}$  and  $r_{mt}$ ,  $\hat{\sigma}_{mt}^2$  is the sample variance of  $r_{mt}$ , and  $\hat{\sigma}_{\varepsilon it}^2$  is the sample variance of the OLS residuals. Using the OLS estimated betas, we could then estimate the measure of herding as

$$H_{mt}^O = \frac{1}{N_t} \sum_{i=1}^{N_t} (b_{imt}^s - 1)^2.$$



- However,  $H_{mt}^O$  will be affected by insignificant estimates of  $\beta_{imt}^S$ 's. The significance of the OLS estimates of the betas could change over time, affecting  $H_{mt}^O$  even if  $\beta_{imt}^S$  was constant. In addition, when  $r_{it}$ ,  $r_{mt}$ , and  $\varepsilon_{it}$  do not move at the same rate,  $Var(b_{imt}^S)$  is affected by heteroskedasticity in either  $\varepsilon_{it}$  or  $r_{mt}$ .
- To avoid these unpleasant properties of  $H_{mt}^O$ , we standardize  $b_{imt}^S$  using its standard deviation; in other words we used the related  $t$  statistic which will have a homoskedastic distribution and thus will not be affected by any heteroskedastic behaviour in  $\frac{1}{N_t} \sum_{i=1}^{N_t} \frac{\sigma_{\varepsilon_{it}}^2}{\sigma_{mt}^2}$ . (The CAEE)
- The  $t$  statistic in the measure of herding based on  $t$  statistics is;

$$\frac{b_{imt}^S - 1}{\hat{\sigma}_{\varepsilon_{it}} / \hat{\sigma}_{mt}} \sim t \left( DF; \frac{\beta_{imt}^S - 1}{\sigma_{\varepsilon_{it}} / \sigma_{mt}} \right)$$

where  $DF$  is the degrees of freedom and  $\frac{\beta_{imt}^S - 1}{\sigma_{\varepsilon_{it}} / \sigma_{mt}}$  is a non-centrality parameter.

## Definition (t statistic based)

Beta herding towards the market portfolio can now be measured using

$$H_{mt}^* = \frac{1}{N_t} \sum_{i=1}^{N_t} \left( \frac{b_{imt}^s - 1}{\hat{\sigma}_{\varepsilon it} / \hat{\sigma}_{mt}} \right)^2, \quad (10)$$

where  $b_{imt}^s$  are the observed estimates of betas for the market portfolio for stock  $i$  at time  $t$ , and  $\hat{\sigma}_{\varepsilon it}$  and  $\hat{\sigma}_{mt}$  are as defined above. Herding towards the market portfolio increases with decreasing  $H_{mt}^*$ .

We call the two herd measures defined above as the beta-based herd measure and the  $t$ -statistic-based herd measure. The following distributional result applies to  $H_{mt}^*$ .

## Theorem

Let  $\mathbf{B}_{mt}^* = ( B_{1mt}^* \quad B_{2mt}^* \quad \dots \quad B_{N_t mt}^* )'$ , where  $B_{imt}^* = \frac{b_{imt}^s - 1}{\widehat{\sigma}_{\varepsilon it} / \widehat{\sigma}_{mt}}$ .  
Then under the classical OLS assumptions,

$$\mathbf{B}_{mt}^* \underset{N_t \times N_t}{\sim} N \left( \underset{N_t \times 1}{\delta_{mt}^*}, \underset{N_t \times N_t}{\mathbf{V}_{mt}^*} \right),$$

where  $\delta_{mt}^* = ( \delta_{1mt}^* \quad \delta_{2mt}^* \quad \dots \quad \delta_{N_t mt}^* )'$ ,  $\delta_{imt}^* = \frac{\beta_{imt}^s - 1}{\sigma_{\varepsilon it} / \sigma_{mt}}$ , and  $\mathbf{V}_{mt}^*$  is covariance matrix of  $\mathbf{B}_{mt}^*$ . Then

$$\begin{aligned} H_{mt}^* &= \frac{1}{N_t} \mathbf{B}_{mt}^{*'} \mathbf{B}_{mt}^* \\ &\sim \frac{1}{N_t} \left[ \chi^2(R; \delta_k^{*R}) + \mathbf{c}^* \right], \end{aligned} \quad (11)$$

where  $R$  is the rank of  $\mathbf{V}_{mt}^*$ ,  $\delta_m^{*R} = \sum_{j=1}^R (\delta_j^{A*})^2 / \lambda_j^*$ , and  $c^* = \sum_{j=R+1}^N (\delta_j^{A*})^2$ , where  $\delta_j^{A*}$  is the  $j$ th element of the vector  $\mathbf{C}_{mt}^{*'} \mathbf{B}_{mt}^*$ , where  $\mathbf{C}_{mt}^*$  is the  $(N_t \times N_t)$  matrix of eigenvectors of  $\mathbf{V}_{mt}^*$ , i.e.,  $\mathbf{V}_{mt}^* = \mathbf{C}_{mt}^* \Lambda_{mt}^* \mathbf{C}_{mt}^{*'}$ , where  $\Lambda_{mt}^*$  is the  $(N_t \times N_t)$  diagonal matrix of eigenvalues. The eigenvalues are sorted in descending order.

- This measure can be calculated easily using any standard estimation program since it is based on the cross-sectional variance of the  $t$  statistics of the estimated regression coefficients on the market portfolio.
- Theorem 1 shows that this new measure of herding is distributed as  $1/N_t$  times the sum of non-central  $\chi^2$  distributions with degrees of freedom  $R$  and with non-centrality parameters  $\delta_m^{*R}$  and a constant.
- Therefore the variance of  $H_{mt}^*$  is given by;

$$\text{Var}[H_{mt}^*] = \frac{2}{N_t^2} \left[ R + 2\delta_m^{*R} \right].$$

# Empirical Results

- Using equation (11), we calculate the herd measure at time  $t$  given an appropriate window of data ( $\tau$ ), and obtain confidence intervals from equation (12).
- The same procedure is then repeated over time by rolling windows (advancing the start date by one period, i.e.,  $t$ ,  $t + 1$ , ...).
- The test statistics provide us with a sequence of hypothesis tests. That is, we can use the confidence level calculated at time  $t$  to test if the value of the test statistic at  $t + 1$  changes significantly.
- In this way we can determine if the level of herding is significantly different over time.

- We present results using individual stocks in the US, UK and South Korean markets, and then compare herd behaviour across these different markets.
- We also apply the method to the Fama-French 25 and 100 portfolios formed on size and book-to-market from January 1927 to December 2003.

# Herding in the US Market

- We use monthly data from the Center for Research in Security Prices (CRSP) to investigate herding in the US stock market. Ordinary common stocks listed on the New York Stock Exchange (NYSE), American Stock Exchange (AMEX) and NASDAQ markets are included.
- The sample period consists of 488 monthly observations from July 1963 to December 2003. For excess market returns we use the CRSP value weighted market portfolio returns and 1 month treasury bills.
- For the other factors we use Fama-French's (1993) size (Small minus Big, SMB) and book-to-market (High Minus Low, HML), and momentum from Kenneth French's data library in addition to the excess market returns.

- As explained above, a number of monthly observations,  $\tau$ , needs to be chosen to obtain the OLS estimate. We have chosen  $\tau=24$ , but we tried a range of values, i.e.,  $\tau=36$ , 48, and 60, and found that the results are effectively not different from one other.
- We use the first 24 observations up to June 1965 to obtain the OLS estimates of betas and their  $t$  statistics for each portfolio and then calculate  $H_{mt}^*$  and its test statistic for June 1965. We then add one observation at the end of the sample and drop the first and so use the next 24 observations up to July 1965 to calculate the herd measure and its statistic for July 1965, and so on.
- We filter out small illiquid stocks by controlling the following three liquidity proxies; volatility, size, and turnover rate which leaves the number of stocks ranging from 570 to 1185 for our sample period.



The Fama-French three factor model with momentum used to estimate the betas is

$$r_{it} = \alpha_j^S + \beta_{im}^S r_{mt} + \beta_{is}^S r_{smbt} + \beta_{ih}^S r_{hmlt} + \beta_{imm}^S r_{mmt} + \varepsilon_{it},$$

where  $r_{it}$  and  $r_{mt}$  are excess returns of asset  $i$  and the market portfolio, and  $r_{smbt}$ ,  $r_{hmlt}$ , and  $r_{mmt}$  are Fama-French's SMB, HML, and momentum factor returns. We also calculate the herd measures with the simple market model for comparison.

**Table 1 Properties of Beta Herd Measure in the US Market**

The Beta-based herd measure is calculated with the cross-sectional variance of OLS estimates of betas while the standardised herd measure is calculated with the cross sectional variance of t-statistics of OLS estimates of betas. We use 24 past monthly returns to estimate betas in the market model and in the Fama-French three factor model with momentum. Using 486 monthly observations from July 1963 to December 2003 and rolling windows of 24 months, we obtain 463 monthly herd measures from June 1965 to December 2003. In order to reduce possible bias from illiquid stocks we choose ordinary stocks whose market values are larger than 0.01% of the total market capitalisation, turnovers are larger than 6% a year, and volatilities are larger than half of the market portfolio's volatility. \*\* represents significance at the 1% level.

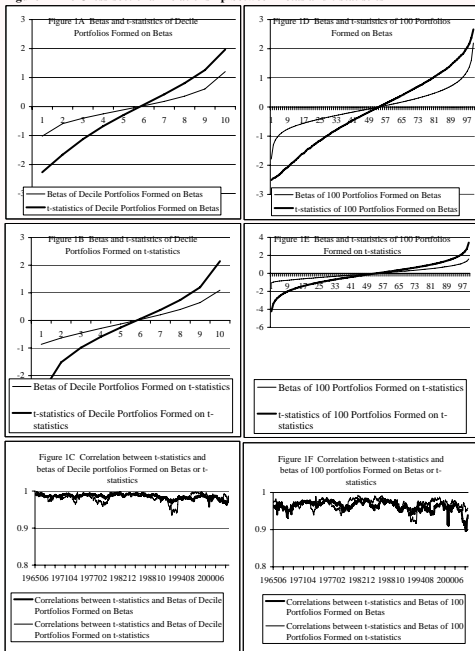
	Beta-Based Herd Measure		Standardised Herd Measure	
	Market Model (A)	Fama-French Three Factor with Momentum (B)	Market Model (C)	Fama-French Three Factor with Momentum (D)
Mean	0.322	0.416	3.518	1.896
Standard Deviation	0.216	0.188	1.171	0.530
Skewness	2.744	1.084	0.862	0.569
Excess Kurtosis	9.154	1.062	0.988	-0.470
Jarque-Beta Statistics	2197.756 **	112.484 **	76.153 **	29.280 **
Spearman Rank Correlations between A and B, and C and D		0.856 **		0.454 **
Spearman Rank Correlation between Cross-sectional Standard Deviations of Betas and t-Statistics	Between A and C	Between B and D		
	-0.200 **	-0.361 **		

**Table 2 Regression of Herd Measures on the Cross-sectional Average of the Variances of Estimation Errors of Betas**

The herd measures are regressed on the cross-sectional average of variances of the estimation errors of betas (CAEE). A total number of 463 monthly observations from June 1965 to December 2003 is used. The numbers in brackets are Newey and West (1987) heteroskedasticity consistent standard errors. \*\* represents significance at the 1% level.

		Constant	Average of the Variances of Estimation Errors of Betas	$R^2$
Beta-Based Herd Measure	Market Model	0.096** (0.025)	1.554** (0.228)	0.577
	Fama-French Three Factor with Momentum	0.105** (0.014)	0.973** (0.050)	0.836
Standardised Herd Measure	Market Model	-4.290** (0.189)	-5.313** (1.045)	0.230
	Fama-French Three Factor with Momentum	2.444** (0.079)	-1.717** (0.172)	0.329

**Figure 1 The Cross-sectional Relationship between Betas and t-statistics**



**Table 3 Regression of Beta Herding in Individual Stocks on Various Variables**

Herd measures calculated with Fama-French three factor model with momentum are regressed on various explanatory variables using 463 monthly observations from June 1965 to December 2003. Rm and Vm represent market return and volatility. DP and RTB represent the dividend price ratio and the relative treasury bill rate, while TS and CS show the term spread and the default spread. The numbers in the brackets are Newey-West heteroskedasticity robust standard errors. \*\* represents significance at the 1% level and \* represents significance at the 5% level.

**A. standardised herd Measure**

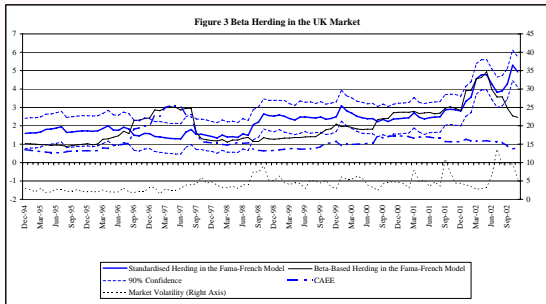
Constant	Rm	Vm	DP	RTB	TS	CS	CAEE	R <sup>2</sup>
1.596** (0.172)	-0.002 (0.006)	0.176* (0.075)	12.242** (4.439)	-0.010 (0.056)	0.112* (0.052)	-0.390** (0.142)		0.092
2.919** (0.176)	-0.001 (0.004)	0.090 (0.057)	-1.394 (3.907)	0.002 (0.038)	0.088* (0.039)	-0.474** (0.102)	-2.138** (0.198)	0.479

**B. Beta-Based Herd Measure**

Constant	Rm	Vm	DP	RTB	TS	CS	CAEE	R <sup>2</sup>
0.685** (0.069)	0.000 (0.002)	-0.015 (0.030)	-7.100** (1.844)	0.003 (0.018)	0.008 (0.016)	-0.033 (0.045)		0.250
0.095** (0.034)	-0.001 (0.001)	0.023 (0.018)	-1.011 (0.971)	-0.002 (0.008)	0.018 (0.007)	0.004 (0.024)	0.955** (0.048)	0.860

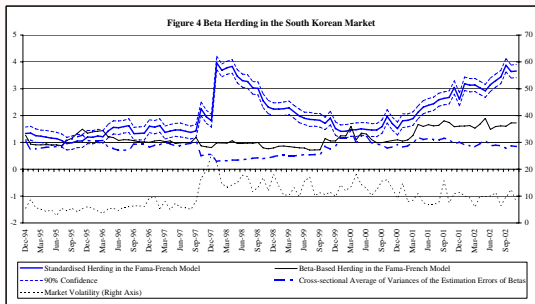


# Herding in the UK and Korean Markets

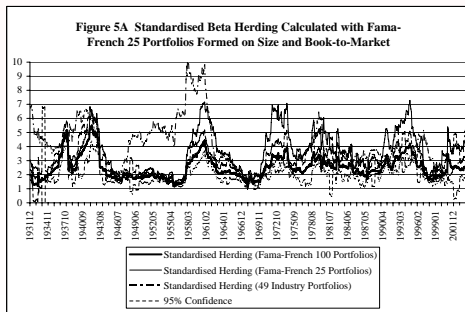


The herd measure is calculated using the constituents of the FTSE150 index (247 stocks), and FTSE150 index and 3 month treasury bills are used to calculate the excess returns. The standardised herd measure is calculated with the cross-sectional variance of  $t$ -statistics of OLS estimates of betas. The sample period is from January 1993 to November 2002, and 24 past monthly returns are used to estimate betas in the Fama-French three factor model. CAEE represents cross-sectional average of variances of the estimation errors of betas.





The herd measure is calculated using the constituents of the KOSPI index (454 ordinary stocks), and the KOSPI index and 1 year Korea Industrial Financial Debentures are used to calculate the excess returns. The standardised herd measure is calculated with the cross-sectional variance of t-statistics of OLS estimates of betas. The sample period is from January 1993 to November 2002, and 24 past monthly returns are used to estimate betas in the Fama-French three factor model. CAEE represents cross-sectional average of variances of the estimation errors of betas.



## Market Sentiment and Herding

- In the model we propose beta herding increases with sentiment *ceteris paribus*. The relationship is made clearer using portfolios and taking the log in the portfolio equation to give

$$\ln \text{Var}_c(\beta_{pmt}^s) = \ln \left[ (1 - h_{mt})^2 \text{Var}_c(\beta_{pmt}) \right] - 2 \ln(1 + s_{mt})$$

suggesting a negative relationship between  $\ln \text{Var}_c(\beta_{imt}^s)$  and  $\ln(1 + s_{mt})$ .

- Thus the first hypothesis to test is if market sentiment is negatively related to the cross-sectional variance of estimated betas. We run the following regression

$$\ln \text{Var}_c(\beta_{pmt}^s) = \alpha + \beta \ln S_{mt} + \eta_t \quad (13)$$

where  $\ln [(1 - h_{mt}) \text{Var}_c(\beta_{pmt})] = \alpha + \eta_t$  and  $\beta \ln S_{mt} = -2 \ln(1 + s_{mt})$  and  $S_{mt}$  is a sentiment index.

- The simple regression allows us to decompose  $\ln \text{Var}_c(\beta_{pmt}^s)$  into two components; herding and sentiment. This could provide further information on how cross-sectional herding evolves with sentiment.
- Brown and Cliff (2004) investigate various sentiment indices and conclude that direct sentiment measures (surveys) are related to indirect measures.

- We have taken a direct sentiment measure, i.e., market sentiment index constructed by Investors Intelligence for the period of December 1963 to December 2003. Each week weekly newsletter opinions on the future market movements are grouped as bullish, bearish, or neutral and we use the bull-bear ratio as a proxy of sentiment.
- The cross-sectional variance of betas in the left hand side of equation (17) is a moving average of the period of  $\tau$  (e.g., 24 or 60 months) because of the rolling windows we have adopted.
- In order to match the dependent and independent variables, we apply the same rolling windows method to the sentiment index to calculate a moving average sentiment index.
- We also report the herd measures calculated with the Fama-French 25 portfolios.

**Table 4 Regression of Beta Herding in Portfolios on Various Variables**

The herd measures calculated with the Fama-French three factor model with momentum are regressed on log sentiment index and other control variables. For the sentiment index we use bull-bear ratio of Investors Intelligence as in Brown and Cliff (2004), the 12 month expected business condition in the Michigan consumer confidence index, monthly sentiment index interpolated from Baker and Wurgler (2006), and finally 60 monthly average of the direct sentiment index. Rm and Vm represent market return and volatility. DP and RTB represent the dividend price ratio and the relative treasury bill rate, while TS and CS show the term spread and the default spread. The numbers in the brackets are Newey-West heteroskedasticity robust standard errors. The bold numbers represent significance at the 5% level.

A. Standardised Herd Measure		Calculated with Fama-French 100 Portfolios Based on Size and Book-to-Market								
	Constant	S <sub>it</sub>	Rm	Vm	DP	RTB	TS	CS	CAEE	R <sup>2</sup>
Direct Sentiment Index (November 1968 - December 2003)	<b>0.950</b>	<b>0.172</b>								0.026
	(0.032)	(0.106)								
	<b>1.123</b>	<b>0.178</b>	-0.002	-0.045	1.659	-0.009	0.035	-0.069	-22.688	0.175
	(0.140)	(0.108)	(0.002)	(0.043)	(2.728)	(0.024)	(0.023)	(0.064)	(11.693)	
	<b>1.316</b>	<b>-0.353</b>								0.256
	(0.062)	(0.061)								
Michigan Consumer Index (January 1978 - December 2003)	<b>1.410</b>	<b>-0.417</b>	-0.003	-0.068	3.056	-0.037	<b>0.850</b>	<b>-0.152</b>	2.954	0.454
	(0.119)	(0.058)	(0.002)	(0.030)	(1.940)	(0.023)	(0.019)	(0.056)	(6.942)	
	<b>0.959</b>	<b>-0.077</b>								0.073
	(0.026)	(0.034)								
Monthly Sentiment Index Interpolated from Baker and Wurgler (2006) (November 1968 - December 2003)	<b>0.884</b>	<b>-0.078</b>	-0.001	-0.033	<b>5.135</b>	-0.021	0.031	-0.051	-7.749	0.205
	(0.137)	(0.035)	(0.002)	(0.035)	(2.510)	(0.025)	(0.022)	(0.071)	(9.649)	
	<b>0.993</b>	<b>-0.644</b>								0.041
	(0.040)	(0.266)								
60 Monthly Average Direct Sentiment Index (November 1968 - December 2003)	<b>1.200</b>	<b>-0.852</b>	-0.001	0.007	<b>1.966</b>	-0.027	0.033	-0.093	<b>-27.703</b>	0.216
	(0.160)	(0.331)	(0.002)	(0.039)	(2.887)	(0.026)	(0.023)	(0.064)	(11.505)	

- Table 4 supports that the sentiment index is negatively related to the herd measures. All cases show significance at least at the 5 percent level even in the presence of the market and macroeconomic variables and the CAEE.
- The values of  $R^2$  however indicate that sentiment explains only from 2.6 to 25.6 percent of the dynamics of beta herd measure. Although our beta herd measure is explained by both within market herding and market wide sentiment, the main driving force behind beta herding appears to come from cross-sectional herding
- For herding measured using individual stocks we obtained similar results but the negative relationship is weaker than with portfolios due to the existence of idiosyncratic sentiment and estimation errors.

- Thus a decrease in  $Var_c(\beta_{pmt}^S)$  from an increase in sentiment is more likely during bull markets rather than bear markets because of the contemporaneous relationship between returns and sentiment.
- On the other hand, a decrease in  $Var_c(\beta_{pmt}^S)$  from an increased  $h_{mt}$  is possible any time.





- Figure 6. In most periods sentiment and  $Var_c(\beta_{pmt}^S)$  move in the opposite direction. However there are some periods that the two move in the same direction; from 1980 to 1982 and from 1998 to 2003.
- During 1980 to 1982 we expect an increase in  $Var_c(\beta_{pmt}^S)$  because of decreasing sentiment, but the result shows that both decrease. This suggests that during this period  $h_{mt}$  increases far more than sentiment decreases, and thus  $Var_c(\beta_{pmt}^S)$  decreases.
- We find the opposite during 1998 to 2003. Market sentiment increases, but herding ( $h_{mt}$ ) begins to decrease more than the increase of sentiment so that  $Var_c(\beta_{pmt}^S)$  increases.
- However although sentiment contributes to the dynamics of  $Var_c(\beta_{pmt}^S)$  the proportion of  $Var_c(\beta_{pmt}^S)$  that is explained by sentiment is far less than  $h_{mt}$ .

# Conclusions

- Herding is widely believed to be an important element of behavior in financial markets and particularly when the market is in stress, such as during the Asian and Russian Crises of 1997 and 1998.
- We have proposed an alternative method of measuring and testing for slow moving beta herding taking into account of movements in both market wide sentiment and within market cross sectional herding.
- We have applied our measure to the US, UK, and South Korean stock markets and found that herding toward the market portfolio disappeared during the Russian Crises in 1998 in the US and UK markets while the herding level in the South Korean market disappeared during the Asian crisis in 1997.
- We have shown that herding is more prevalent when the market is confident where it is going rather than in crises.
- Periods of Crisis are important in returning the market towards equilibrium as herding is removed.
- Herding was not found to be driven by either macro or market characteristics but had a dynamic of its own.
- Market wide Sentiment was not found to be a major determinant of beta herding and there appear to some degree to be separate forces at work.

- The herd measure calculated with Fama-French portfolios supports our main findings. However there were some time periods that the measure shows different explanation from the herd measure calculated with individual stocks. We show that the difference should be explained by changes in idiosyncratic sentiments of individual stocks. Methodologically it has been shown that  $t$ -statistic-based herd measure is more robust to the beta-based herd measure.
- This study has applied the new measure of herding to the market level. However, the measure can also be applied at a sector (industry) level and different herding behavior may well be found in different sectors such as IT and old economy stocks.