Do Stock Exchanges Corral Investors into Herding?

Aditya Kaul, Vikas Mehrotra, Carmen Stefanescu[1]

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[1] All authors are from the University of Alberta. Contact author:

Carmen Stefanescu

School of Business, University of Alberta

Edmonton, Canada T6G.2R6

780-430-0583 Ph

780-492-3325 Fax

Email: carmens@ualberta.ca

All three authors are from the School of Business, University of Alberta, Edmonton, Canada T6G 2R6. Aditya Kaul can be contacted at 780–492–5027 or at aditya.kaul@ualberta.ca; Vikas Mehrotra can be contacted at 780-492-2976 or at vmehrotr@bus.ualberta.ca; Carmen Stefanescu can be contacted at 780–430–0583 or at carmens@ualberta.ca.

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Abstract

We study whether stock exchanges induce herding by examining a sample of firms that switch from NASDAQ to the NYSE. We find that trades for the switching firms co-move more strongly with NYSE trades and less strongly with NASDAQ trades following the switch, indicating that investors on the two major U.S. stock exchanges display herding behavior. The results are not driven by changes in the comovement of cash flows or by firm characteristics. A similar pattern is found for stock returns. Our analysis suggests that these results are not fully explained by rational models of herding, instead lending support to a behavioral view of comovement proposed by Barberis, Shleifer and Wurgler (2005).

1 Introduction

Despite the central position of stock exchanges in capital raising and price discovery, their direct influence on trading behavior has not been fully explored. Models in information economics have focused on market clearing for individual securities within particular dealer structures, and have tended to ignore the influence of location-specific aggregate order flow on trading decisions and return properties. In this paper, we conduct a series of tests to study the extent to which a stock exchange induces herding behavior among its listed firms. Our secondary goals are to examine whether such herding affects returns, as well as to undertake a preliminary exploration of its sources. We address this question by examining changes in the comovement of trades for a sample of firms that switch from NASDAQ to the NYSE.

Herding behavior has been studied extensively in the areas of economics[1], physics[2], and sociology[3]. Despite a lack of consensus on the precise definition of herding, certain common themes emerge. First, herding is usually defined in terms of crowd behavior – that is, a group is defined as a herd if members of that group tend to move more strongly with each other than with the collective movement of other groups; stronger versions of herding, such as the information cascade models of Bikhchandani, Hirshleifer and Welch (1992), further assume a suppression of private information in favor of crowd imitation.

Second, herding can occur due to comovement with fundamentals or to correlated

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[1] See Hirshleifer and Teoh (2001) for an excellent synthesis of the literature on herding based on information economics. For a behavioral economics view, see Shiller (1989).

[2] See, among others, Sornette (2003a, 2003b), Sornette and Andersen (2002), and Lux and Sornette (2002), for models of herding based on what is sometimes referred to as econophysics. These models mimic the behavior of clustering in non-living objects.

[3] See Parker and Prechter (2001) for a socio-economic perspective on herding.

sentiment that is decoupled from fundamentals. In the former case, imperfectly rational agents deduce information from the behavior of other agents within the herd, perhaps because of the high cost of verifying private information. Positive feedback trading patterns, including those found in asset price bubbles, can arise from rational herding where uninformed investors find it advantageous to mimic (with a lag) the trades of informed investors, as in Bikhchandani et al (1992). Alternatively, herding can be based on sentiment or fads if a large number of agents behave irrationally and limits to arbitrage prevent prices from converging to fundamental values. Even informed agents may rationally decide to jettison private information and ride the fad when fundamental information and arbitrage are costly.

Our tests of herding are based on comovement in trades (order imbalances). An advantage of examining switches in exchange listings is that we can sidestep the question of the *level* of herding prior to or even following the switch to the new exchange, and focus instead on the *change* in herding induced by the switch. Thus, while it is difficult to conclude that the sample firms display rational or excessive herding with NASDAQ stocks before the switch to the NYSE, the change in comovement with NASDAQ and NYSE trades associated with the switch is informative about herding.

Over a period of thirteen years between 1988 and 2000, we study comovement in trades for 536 firms that switch from NASDAQ to the NYSE. In order to isolate the effects of the listing venue on comovement, we benchmark these results against those for a sample of similar firms that qualify to list on the NYSE but choose to remain on NASDAQ. We find that after firms move to the NYSE, their trades co-move more strongly with trades for other NYSE firms and less strongly with trades for the firms they leave behind on NASDAQ. This comovement is evident at every frequency we examine—intraday, daily and weekly. The changes in comovement are dramatic: for instance, at the daily level, the mean sensitivity of a switching firm's trades to aggregate NYSE trades increases from 0.27 to 0.84, and its sensitivity to NASDAQ trades drops from 0.64 to 0.18. A size, price and industry matched control sample of NASDAQ firms does not display significant changes in comovement with either NASDAQ or NYSE trades. The contrasting comovement patterns for the switching and control samples indicate that the results for the switching firms are unlikely to be driven by economy-wide trends or jumps in comovement coincident with the switch.

It is possible that the change in trading comovement, although statistically significant, is of little economic consequence. To look into this issue, we examine changes in return comovement for the switching firms, and find similar patterns. That is, after the switch, returns for the sample firms co-move more strongly with the returns for other NYSE firms, and less strongly with the returns for NASDAQ firms. Approximately half of the change in the mean slope coefficients in the return comovement regressions for the switching firms is accounted for by the change in trading comovement. The control sample firms show no changes in return comovement.

We examine several explanations for the changes in comovement. First, we compare cash flow comovement for the firms around the switch and find that it does not change. As a result, the change in the comovement of trades is not due to changing comovement of fundamentals accompanying the switch to the NYSE. Alternatively, herding could appear to occur if investors react more quickly to NYSE news after the firms switch to the NYSE (e.g. due to lower trading costs). To test this explanation, we examine the change in the sensitivity of trades to contemporaneous and lagged aggregate NYSE and NASDAQ trades after the switch. The coefficients on lagged NYSE trades are small before and after the switch while that on the contemporaneous trades is virtually unchanged. Thus, we find no evidence that herding for the switching firms results from greater synchronicity in trades.

Finally, we consider the possibility that herding is driven by investors segmented along the lines of asset characteristics such as size or book-to-market ratios, with the trading venue serving as a proxy for such characteristics. We estimate cross-sectional regressions to examine whether firm or trading characteristics can explain the changes in the comovement of trades associated with the switch. While we find that larger firms and firms in an inferior information environment experience a greater increase in comovement with NYSE trades, the herding in trades documented earlier persists after we control for these characteristics.

Overall, our results support the idea that stock exchanges provide a natural herding environment, and are best understood in the context of behavioral models of excess return comovement, such as that of Barberis, Shleifer and Wurgler (2005, hereafter BSW). In BSW, investors sort assets into categories and habitats, and allocate funds at the category and habitat level rather than directly at the individual security level, perhaps because of transaction costs, trading restrictions or lack of information. In such cases, correlated sentiment can give rise to herding behavior.

Additional related evidence in favor of herding is found in other studies.[4] For example, closed-end country fund returns co-move more strongly with the returns for their listing market cohort than the returns for their home country stocks. Trades and returns for stocks in the S&P 500 index co-move more with those for other index stocks than for stocks outside the index.

[4] A partial list of recent papers in this area includes Pindyck and Rotemberg (1993), Rashes (2001), Feng and Seasholes (2004), Barberis, Shleifer and Wurgler (2005), Kumar and Lee (2006), Greenwood (2006), Hameed (2003), Ivkovic and Weisbrenner (2005).

Unlike these studies, we examine switches between two highly integrated domestic markets, with no obvious clienteles; this makes our results especially striking. Moreover, while the literature on herding has tended to focus on prices, we directly examine herding in trades.

The rest of the paper is organized as follows. In Section 2, we describe the data and our sample. In Section 3, we examine changes in the comovement of trades following the switch to the NYSE. Section 4 documents the change in return comovement around the switch. Section 5 probes alternative explanations for the herding results documented in the study. Section 6 presents cross-sectional analysis, and Section 7 concludes.

2 Sample and data

The paper focuses on a sample of 536 common stocks that move from NASDAQ to the NYSE between January 1988 and December 2000. Using the Center of Research in Security Prices (CRSP) files, we select all firms that switch their listing venue from NASDAQ to the NYSE over this 13-year period. We examine ordinary common shares (share code 10 and share code 11) and exclude non–U.S. firms, real estate investment trusts, and closed-end funds. Firms are required to have CRSP price data and intraday trade and quote data for one year before and one year after the switching date, as well as book equity data from COMPUSTAT. Using daily return data, we also study a broader sample of 1,030 NASDAQ firms that switch to the NYSE between January 1973 and December 2004.

Our purpose is to isolate the change in comovement in trading and returns associated with the move to the NYSE. However, it is possible that investors are drawn to firms of a certain size or industry for reasons unrelated to the switch. For instance, it is possible for the trades (returns) of *all* NASDAQ stocks to display greater comovement with overall NYSE trades (returns) if the markets have become more integrated over time or the NYSE captures economic prospects more closely than does NASDAQ. To isolate the effect of the exchange switch on comovement, we form a size, price and industry matched control sample of firms that remain on NASDAQ. The matching procedure follows Huang and Stoll (1996). In addition to controlling for industry, share price and size, the matching by switching date also provides a natural control for trends in trading.

Summary statistics for the test and control samples are presented in **Table 1**. The financial variables are measured as of the fiscal year end prior to the move to the NYSE, while share turnover is measured over the twelve months ending two months before the move. Book assets and market equity are slightly higher for the test firms. However, the mean and median values of market-to-book are similar for the test and control firms—to the extent that this ratio is a proxy for investment policy, the switching and control firms do not appear to be significantly different. Turnover, a measure of trading activity, is likewise similar for the two samples. Overall, Table 1 shows that the test and control samples are similar along most dimensions.

3 Herding in trades

We start by examining changes in the comovement of trades for the switching firm with NASDAQ trades and NYSE trades. Suppose that a stock i, previously listed on NASDAQ, starts trading on the NYSE. If fundamentals have not changed, the comovement of the stock's trades with aggregate NYSE and NASDAQ trades should be unaltered by the switch. However, if exchanges induce local herding, the firm's trades will co-move more with NYSE trades and less with NASDAQ trades following the switch.

A widely-used measure of trading activity is order imbalance. This is calculated as the difference between buying and selling volume.[5] Trades are classified as buys and sells using the Lee-Ready (1991) algorithm. Before applying this algorithm, we first exclude trades with negative prices, trades reported out of sequence, trades with special settlement conditions, trades and quotes recorded before the open or after the close, and quotes that imply a negative spread. The Lee-Ready algorithm uses the first quote at least five seconds before each trade to classify the trade, with a transaction occurring above (below) the quote midpoint regarded as a purchase (sale). If a transaction occurs at the quote midpoint, it is signed using the last non-zero transaction price change, as a buy if this price change is positive and a sell if it is negative. By convention, a buy is assigned a positive sign and a sell a negative sign.

For each stock, we calculate order imbalance as the difference between the volume of all buys and the volume of all sells in 15-minute intervals throughout the day, i.e. 9:30-9:45 a.m., 9:45-10:00 a.m., ..3:45-4:00 p.m. Where relevant, we aggregate order imbalance to the daily or weekly level. We standardize order imbalance for each interval (15-minute, daily or weekly) by total volume over that interval to make it comparable across stocks and through time. Thus, we study the fractional order imbalance at the intraday, daily and weekly frequency. The aggregate NYSE or NASDAQ imbalance is computed as the simple (i.e. equally-weighted) average of the imbalances for all ordinary shares trading in each market. In compiling these averages, we

[5] Two other measures of order imbalance are based on the number of trades and the value of trades. We repeat our analysis using these measures and arrive at identical conclusions.

exclude the order imbalance both of the switching firm and of its industry.[6] This reduces the likelihood of our finding a mechanical association between order imbalance for the switching stock and NYSE and NASDAQ imbalances. For instance, if a switching firm's industry has greater representation on the NYSE, increased comovement with the NYSE imbalance could be entirely rational (driven by common news about industry cash flows or risks). Dropping the switching firm's industry from the order imbalance index eliminates this source of comovement.

We then estimate the following specification (1) for order imbalance (*OF*) for each switching stock as well as each control stock.

$$OF_{i,t} = \alpha_{0i} + \alpha_{i1} D + \beta_i^{NYSE} OF_t^{NYSE} + \beta_i^{NASDAQ} OF_t^{NASDAQ} + \\ \Delta\beta_i^{NYSE} OF_t^{NYSE} D + \Delta\beta_i^{NASDAQ} OF_t^{NASDAQ} D + \varepsilon_{i,t} \quad (1),$$

where $OF_{i,t}$ is the imbalance for stock *i* in period *t*, OF_t^{NYSE} and OF_t^{NASDAQ} are aggregate imbalances for the NYSE and NASDAQ and *D* is a dummy that is one after the switch date for stock *i* and zero otherwise. The model is estimated using order imbalance data from day -300 to day +300, measured relative to the date of the switch. We exclude days (-50, +50) around the event to remove any effects related to the actual switch. Thus, $D = 1$ for trading days (+51, 300), and $D = 0$ for day (–300, –51). In this specification, β_i^{NYSE} and β_i^{NASDAQ} measure the base, pre-switch levels of comovement with NYSE and NASDAQ imbalances. Similarly, $\Delta\beta_i^{NYSE}$ and $\Delta\beta_i^{NASDAQ}$, the coefficients on the interaction terms, measure the change in comovement with NYSE and NASDAQ imbalances following the switch.

To interpret these coefficients, consider the following structural model of order imbalance

[6] The industry adjustment is accomplished by defining two-digit industries for all stocks, following Lewellen (2002).

for stock *i*.

$$OF_{i,t} = \alpha_{0i} + \alpha_{i1} D + [\phi_i^{NYSE} + \theta_i^{NYSE} + \gamma_i^{NYSE} D] OF_t^{NYSE} + [\phi_i^{NASDAQ} + \theta_i^{NASDAQ} + \gamma_i^{NASDAQ}(1-D)] OF_t^{NASDAQ} + \varepsilon_{i,t} \quad (2).$$

The comovement coefficients have been grouped into three types. The first pair, φ_i^{NYSE} and φ_i^{NASDAQ}, represent the true comovement of stock *i* imbalances with NYSE and NASDAQ imbalances. This can be thought of as comovement in trading associated with fundamentals. The second set, θ_i^{NYSE} and θ_i^{NASDAQ}, reflects herding based on economy-wide sentiment. For instance, θ_i^{NASDAQ} reflects the sensitivity of firm trades to NASDAQ sentiment, irrespective of where the firm is listed. The last pair, γ_i^{NYSE} and γ_i^{NASDAQ}, captures exchange specific herding. These effects arise only for firms listed on a particular market. So, if a firm is listed on NASDAQ, its exchange specific herding is γ_i^{NASDAQ}. Once it shifts to the NYSE, it loses its NASDAQ-specific herding and instead herds with NYSE trades (reflected in γ_i^{NYSE}). If there is exchange-specific herding, γ_i^{NYSE} and γ_i^{NASDAQ} will be positive. If there is economy-wide herding, θ_i^{NYSE}, θ_i^{NASDAQ} will be positive; in the absence of herding, γ_i^{NYSE}, γ_i^{NASDAQ}, θ_i^{NYSE} and θ_i^{NASDAQ} will all be zero.[7]

Before the switch to the NYSE (where D = 0), comovement with NASDAQ trades is given by $\phi_i^{NASDAQ} + \theta_i^{NASDAQ} + \gamma_i^{NASDAQ}$ and comovement with NYSE trades is given by $\phi_i^{NYSE} + \theta_i^{NYSE}$. After the switch (where D = 1), comovement with NASDAQ and NYSE imbalances is given by $\phi_i^{NASDAQ} + \theta_i^{NASDAQ}$ and $\phi_i^{NYSE} + \theta_i^{NYSE} + \gamma_i^{NYSE}$. In other words, the change

[7] Other variables could be introduced (e.g. lagged returns) without changing the interpretation—we use this simple model to conform to our empirical specification.

in comovement after the switch is given by γ_i^{NYSE} and γ_i^{NASDAQ}, the amount of exchange induced herding.

Comparing (2) with (1), the difficulty in drawing inferences about the *level* of herding pre-switch becomes apparent. The coefficient on the pre-switch NYSE imbalance in (1), β_i^{NYSE}, provides an estimate of $\varphi_i^{NYSE} + \theta_i^{NYSE}$; likewise, $\beta_i^{NASDAQ} = \phi_i^{NASDAQ} + \theta_i^{NASDAQ}$. However, the change in comovement in trades, as measured by $\Delta\beta_i^{NYSE} = \gamma_i^{NYSE}$ and $\Delta\beta_i^{NASDAQ} = -\gamma_i^{NASDAQ}$, allows us to draw inferences about exchange-specific herding. In the absence of exchange specific herding, these coefficients will be zero; otherwise, $\Delta\beta_i^{NYSE}$ is expected to be positive and $\Delta\beta_i^{NASDAQ}$ negative.

Table 2 presents the results for order imbalance measured over intraday (15-minute), daily and weekly windows. Looking first at the level of comovement prior to the switch, we note that trades display stronger local influence at higher frequencies; e.g. the coefficient on the NASDAQ aggregate imbalance is 0.82 at the 15-minute frequency, 0.64 at the daily frequency, and 0.47 at the weekly frequency. Over this period, the influence of the NYSE aggregate order imbalance is weakest at the intraday frequency, and becomes somewhat more prominent at the weekly frequency. This increase in the sensitivity of trades to NYSE trades at lower frequencies is consistent with the fact that cross-exchange information about trades is not immediately observable.

Turning to the changes in comovement, we find that at each frequency, switching stocks experience a sharp increase in the comovement of their imbalances with the aggregate NYSE imbalance and a large reduction in the comovement with the aggregate NASDAQ imbalance.

Starting with the 15-minute imbalance, the mean slope on the NYSE imbalance increases from 0.10 to 0.53 after the switch, while the slope on the NASDAQ imbalance drops from 0.82 to 0.44. Looking at the daily imbalance, the mean NYSE slope increases from 0.27 to 0.84 while the mean NASDAQ slope declines from 0.64 to 0.18. The mean NYSE slope in the weekly imbalance regression rises from 0.40 to 0.80 and the NASDAQ slope drops from 0.47 to 0.14.[8] These results show that trades for stocks switching to the NYSE display a strong increase in herding with NYSE trades, and an equally strong decoupling with NASDAQ trades.

It is possible that the NYSE listing criteria separate the switching stocks from those they leave behind on NASDAQ. To address this issue, we generate a control sample of stocks that are similar in size and share price, and belong to the same industry; these stocks would likely qualify to list on the NYSE, but have chosen to stay on NASDAQ. We re-estimate (1) for this control sample. As seen in Table 2, the coefficients measuring the change in imbalance comovement with NYSE and NASDAQ imbalances are never significant at conventional levels, and are significantly smaller than the coefficients for the switching sample.[9] The magnitudes of the control sample means for the change in comovement in trades are usually no larger than one-tenth as large as those for the switching stocks. Note that the pre-switch slope coefficients on the NYSE and NASDAQ imbalances are similar for the two sets of stocks; confirming that the samples are well matched in terms of pre-switch comovement.

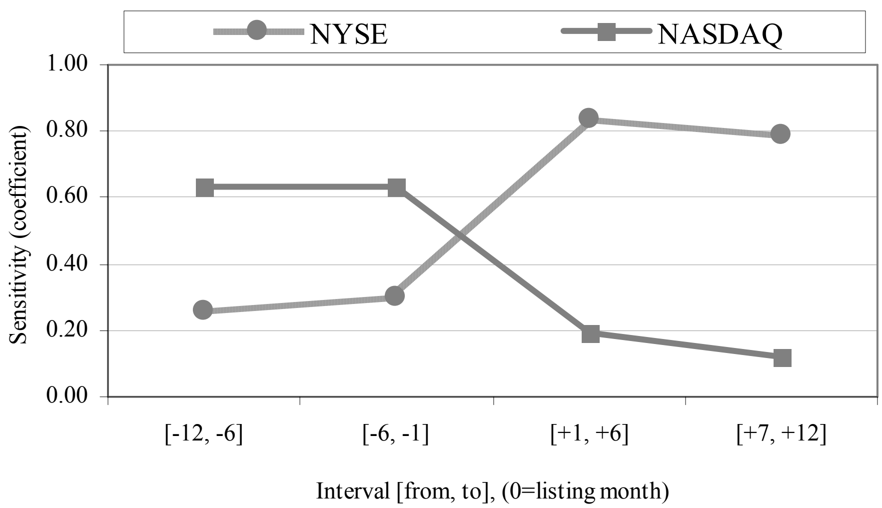
The proposition that exchanges influence trading would be more compelling if the change in comovement with NYSE trades occurred immediately after the switch. Since it is difficult to

[8] To check the robustness of our results, we also examine the medians instead of means in all our tests. This yields identical conclusions.

[9] The only exception is the change in the NASDAQ slope at the weekly horizon. Even here, however, the control stock mean is less than 50% as large as the switching stock mean.

precisely estimate the slope coefficients using short time-series, we estimate (1) for the switching stocks over non-overlapping six-month intervals, measured relative to the month of the move: [-12,-7], [-6,-1], [+1,+6], [+7,+12]. As above, a two-month window centered on the switching date is excluded from this analysis. We should see a sharp increase in the NYSE slope and a corresponding decline in the NASDAQ slope in the third window relative to the second window, and the slopes should be relatively stable between the third and fourth and between the first and second windows.

Fig. 1: Comovement of trades with NYSE and NASDAQ Aggregate Trades



This estimation (plotted above) reveals that the mean slope on the NYSE daily imbalance in the four windows is 0.26, 0.30, 0.84 and 0.79, while the mean NASDAQ slope is 0.63, 0.63, 0.19 and 0.12.[10] T-tests show that the mean NYSE and NASDAQ slopes over [+1,+6] are significantly different from the mean slopes over [-6,-1], as are the means over [+7,+12] relative to the means over [-12,-7]. However, the mean slopes over [+7,+12] are no different from those

[10] The patterns are identical for the intraday and weekly imbalance slopes.

over [+1,+6], nor are the slopes over [-6,-1] in relation to those over [-12,-7]. Thus, the change in the slopes appears to occur between windows immediately adjoining the date of the switch. This supports the conclusion that the changes in comovement documented in Table 2 are associated with the switch to the NYSE, rather than reflecting slow moving trends in comovement for these stocks.

One concern with these results is that the switch coincides with other events that induce comovement. It is particularly important to rule out index additions, given evidence in BSW and Harford and Kaul (2005) that stocks added to the S&P 500 see increased slopes on the S&P return and imbalance. We exclude the 13 stocks added to the S&P 500 index in the year after the switch and repeat the above analysis. We find that the mean NYSE and NASDAQ slope shifts for the remaining stocks are similar to those in the full sample, and continue to be highly significant. As a result, the change in comovement is not mechanically driven by the inclusion in the S&P 500 index of a few of the stocks in our test sample.

In summary, the results in table 2 show that exchanges induce comovement in trades. Before the switch, stock order imbalance co-moves strongly with the NASDAQ order imbalance and relatively weakly with that on the NYSE. After the switch, comovement with the NASDAQ imbalance shrinks appreciably while that with the NYSE imbalance increases dramatically. In the next section, we examine whether similar effects exist for returns, and measure the extent to which shifts in the comovement in imbalances induce shifts in return comovement.

4 Does herding in trades affect returns?

We have shown that a switch in exchange listing is associated with a dramatic change in the comovement of a firm's trades. In this section, we study the extent to which the change in comovement of trades induces changes in return comovement. To the extent that order imbalance affects prices (e.g. due to downward-sloping demand curves or information), we should see a similar pattern in return comovement. We examine return comovement via an analogous regression to (1):

$$R_{i,t} = \alpha_{0i} + \alpha_{i1} D + \beta_i^{NYSE} R_t^{NYSE} + \beta_i^{NASDAQ} R_t^{NASDAQ} + \Delta\beta_i^{NYSE} R_t^{NYSE} D + \Delta\beta_i^{NASDAQ} R_t^{NASDAQ} D + \varepsilon_{i,t} \quad (3),$$

where $R_{i,t}$ is the return in period t for stock i, R_t^{NYSE} and R_t^{NASDAQ} are the period t equally-weighted NYSE and NASDAQ returns, and D is, as before, a dummy variable that is one after the switch date for stock i and zero otherwise. As in (2), β_i^{NYSE} and β_i^{NASDAQ} measure the base, pre-switch level of return comovement with NYSE and NASDAQ returns, while $\Delta\beta_i^{NYSE}$ and $\Delta\beta_i^{NASDAQ}$ measure the change in comovement with NYSE and NASDAQ returns following the switch. If the switch in exchanges induces a change in return comovement, we expect to see $\Delta\beta_i^{NYSE} > 0$ and $\Delta\beta_i^{NASDAQ} < 0$.

We estimate (3) using return data from day -300 to day +300, measured relative to the date of the switch and, as in (1), exclude days (-50, +50). In order to assess the strength of herding at different frequencies, we examine intraday, daily and weekly return comovement. Since herding-induced pricing effects should be corrected over time, return comovement is expected to be stronger at higher frequencies. In the intraday analysis, we calculate 15-minute mid-quote returns (using ISSM and TAQ data) for the switching firms and all ordinary common shares on the NYSE and NASDAQ, and estimate (3) using the 15-minute returns. The NYSE and NASDAQ market returns in this regression are constructed as equally–weighted averages of the returns to all constituent stocks. As with order imbalance, we exclude the returns for the switching (or control) firm and all firms belonging to its industry from the aggregate NYSE and NASDAQ returns.

Table 3 presents the mean coefficient estimates from (3), and t-tests of the null hypothesis that the mean is significantly different from zero. Panel A contains the intraday (15-minute) betas. There is an average increase in the intraday NYSE beta ($\Delta\beta^{NYSE}$) of 0.19 (t-statistic of 8.6) and an average decline of -0.44 (t-statistic of 11.9) in the NASDAQ beta ($\Delta\beta^{NASDAQ}$) for the switching stocks. That is, a stock moving from NASDAQ to the NYSE sees its NYSE beta rise from 0.38 to 0.57 and its NASDAQ beta decline from 0.75 to 0.31. We also measure the corresponding change in betas for the sample of control stocks. The mean shift in the NYSE beta (0.02) and in the NASDAQ beta (-0.03) are insignificantly different from zero. The difference between the test and control sample means is always large in economic terms, and significant at better than the 5% level. The fact that comovement is unchanged for the matched sample of control firms suggests that firm characteristics and industry affiliation are unlikely to be driving the changes in comovement with NASDAQ and NYSE market returns.

Panel B shows that the mean change in the daily NYSE (NASDAQ) beta for the test sample is 0.15 (-0.20). Again, the changes in beta for the control sample, 0.03 and -0.08, are significantly different from those for the test sample. The result that the changes in the daily betas are less pronounced than the changes in the intraday betas is consistent with the view that high frequency prices are more susceptible to herding effects, perhaps because of the difficulty in observing cross-market developments in real time.

Panel C contains the results at the weekly frequency. The mean change in the weekly NYSE beta for the test sample is 0.21, slightly larger than the change in the intraday beta, while the mean change in the weekly NASDAQ beta is -0.23, half as large as the intraday beta shift and comparable to the change in the daily beta. While the beta shifts for the control sample are not statistically significant, the change in the NASDAQ beta of -0.11 is statistically indistinguishable from that for the test sample and about half as large.

The beta shifts become smaller (in absolute value) as the return measurement horizon changes from intraday to daily, but there are no further declines as we move from daily to weekly returns. Thus, our evidence suggests that herding-induced pricing effects take longer than one week to be corrected. Most important, there is a striking and statistically significant shift in return comovement at every frequency for firms that switch from NASDAQ to the NYSE, with returns becoming more sensitive to aggregate NYSE returns and less sensitive to aggregate NASDAQ returns.

Having identified strong shifts in return comovement, we now address the question of how much of these shifts can be explained by herding, i.e., by the change in the comovement in trades. We proceed in two steps. First, we compute the residual return for every switching stock via a regression of its return on its order imbalance. To minimize the effects of feedback from returns to trades, the regression is run and the residuals computed at the 15-minute horizon. We also do this for all the stocks in the NYSE and NASDAQ indexes, and thereby form an equally-weighted aggregate residual return for each market. In the second step, we regress the residual return for the switching stock on the aggregate residual NYSE and NASDAQ returns. As in the earlier tables, we estimate this model using 15-minute, daily and weekly residual returns. The daily and weekly residual returns are constructed by summing the 15-minute residual returns for each stock for the entire day or week.[11]

Table 4 contains the results. In almost each case, the shifts in the NYSE and NASDAQ slope coefficients in the residual return regressions are appreciably smaller than the shifts in the raw return regressions (Table 3). The mean change in the NASDAQ beta is -0.15 for intraday returns, -0.10 for daily returns and -0.05 for weekly returns. While the intraday and daily changes in the NASDAQ beta are still statistically significant, the weekly change is no longer significant at conventional levels; additionally, the difference between the change in the daily betas for the switching and control samples is only marginally significant (p-value=0.09). It is of interest to note that the magnitude of the slope shift is one-quarter to one-half as large as the corresponding slope shift using raw returns in Table 3. The slopes on the residual NYSE return are also much reduced, the only exception being the intraday beta shift of 0.20, which is similar to the value in Table 3. By contrast, the daily and weekly beta changes, 0.11 and 0.09, are 33% and 60% smaller than those computed using raw returns. The important message from this analysis is that, once comovement in trading is taken into account, the remaining comovement in returns is significantly weaker.

[11] To obtain the NYSE and NASDAQ residual return series, we estimate the regressions by stock and year. Note that, while the time-series average residual for each stock will be zero in each year, neither it nor the equally-weighted NYSE or NASDAQ residual return is constrained to be zero in any 15-minute interval.

5 Alternative explanations for herding

Thus far, we have documented the presence of exchange-specific herding in trades. Herding on stock exchanges can be wholly rational, e.g. due to a greater alignment of cash flows for firms that list on a common exchange, or to differences in the reaction of traders to common information originating from the two trading venues. However, if fundamentals-based explanations are not supported by the evidence, the implication is that this herding has behavioral or market friction roots. This section describes tests to assess these explanations.

5.1 Cash Flow Comovement

In our setting—where firms voluntarily shift exchanges—one reason that firms might switch to the NYSE is that they start to resemble other firms trading there. Perhaps these firms anticipate increased cash flow covariance with cash flows for other NYSE firms and decide to move. If investors respond to the change in covariance, this would lead to an increase in the comovement of trades (returns) with NYSE trades (returns) following the switch, with the opposite holding for comovement with NASDAQ. We have attempted to control for such effects by excluding the firm's industry from aggregate imbalances and returns, and by providing results for a control sample of firms matched on industry, price and size. In this section, we attempt to formally rule out changes in cash flow comovement as the source of our results.

For each switching (and control) firm, we calculate quarterly cash flow as EBIDT/Assets, and also compute a similarly defined equally-weighted cash flow index for the NYSE and NASDAQ. We do this for two years of data before and after the switch and then estimate a panel regression of firm cash flow on NYSE and NASDAQ cash flow:

$$CF_{i,t} = \alpha_{0i} + \alpha_i D + \beta_i^{NYSE} CF_t^{NYSE} + \beta_i^{NASDAQ} CF_t^{NASDAQ} + \Delta\beta_i^{NYSE} CF_t^{NYSE} D + \Delta\beta_i^{NASDAQ} CF_t^{NASDAQ} D + \varepsilon_{i,t} \qquad (4),$$

where $CF_{i,t}$ is the quarterly cash flow for stock *i*, CF_t^{NYSE} and CF_t^{NASDAQ} are the quarterly equally-weighted cash flow indices for the NYSE and NASDAQ (calculated excluding firm *i*), D is a dummy equal to 1 for quarters following the switching date and 0 beforehand. The specification is estimated with firm- and year-fixed effects and applies the Huber-White clustering correction to the standard errors.[12]

The results, presented in **Table 5**, show no material change in cash flow comovement. For the test sample, cash flow comovement with aggregate NYSE cash flow is insignificant both before and after the switch. Comovement with aggregate NASDAQ cash flow is positive before the switch and declines afterward, but neither effect is statistically significant. The lack of significance of the pre-switch NYSE coefficient is also of relevance since it casts doubt on the idea that firms move to the NYSE after seeing increased cash flow comovement with other NYSE firms. The patterns for the control sample are not statistically significant.

Overall, we do not find evidence of a change in cash flow comovement with the cash flows for stocks on either the old exchange or the new exchange. While the test admittedly has low power, the results are nevertheless at odds with a fundamentals-based explanation for the change in comovement around the switch.

5.2 Market Friction-based Explanations for Herding

Market frictions could lead to herding if some stocks incorporate information more quickly into their prices than others do. In particular, if investors trade more rapidly on local

[12] In this test, we use four years around the switch to get around the problem of having quarterly observations.

information than on cross-market information, there will be greater synchronicity in trades within a market.

Suppose that information about NYSE trades arrives at NASDAQ with a delay. Before the switch, the imbalance for the sample firms will react to the aggregate NYSE imbalance with a delay, giving rise to positive coefficients on lagged NYSE imbalances. After the switch to the NYSE, information on the aggregate NYSE imbalance is available sooner. Thus, the coefficients on lagged NYSE imbalances will decline, and the coefficient on the contemporaneous NYSE imbalance will increase.

To evaluate this explanation, we regress the imbalance for the switching and control stocks on the lagged and contemporaneous values of aggregate NYSE and NASDAQ imbalances both before and after the switch. We use five lags of NYSE and NASDAQ imbalances when examining intraday and daily imbalances and one lag when examining weekly imbalances, and interact these terms with the post-switch dummy.

Table 6 presents the mean coefficients from this regression using intraday imbalances. First, note that the coefficient on the contemporaneous NYSE imbalance changes by 0.41, nearly identical to the value in table 2 (0.43), indicating that the move to the NYSE does not strengthen the contemporaneous relation. This is inconsistent with the market friction explanation. Second, only two of the five coefficients on the lagged NYSE imbalances decline post-switch (those at lags 2 and 3), and these changes are small in magnitude, no larger than 0.02 in absolute value. Of the five NASDAQ interaction coefficients, only that at lag 4 has a significant mean and this is negative (-0.05). The change in the slope on the contemporaneous NASDAQ imbalance of -0.37 is similar to the value in Table 2 (-0.38). Thus, the incorporation of lags of aggregate NYSE and

NASDAQ imbalances does not change the conclusion that the sensitivity to the contemporaneous NYSE (NASDAQ) imbalance increases (declines) after a firm starts trading on the NYSE.

A similar pattern is revealed by the daily and weekly imbalances. The coefficient representing the change in the slope on the daily NYSE imbalance is 0.55 compared to 0.57 in Table 2. The change in the NASDAQ imbalance does decline in magnitude but, at -0.36, it is still large. When we incorporate aggregate imbalances from the previous week, the changes in the slopes on the contemporaneous weekly imbalances decline in magnitude. The change in the NYSE (NASDAQ) slope is 0.28 (-0.26), but both coefficients are still significantly different from zero and large in economic terms.

Overall, the results in this section do not support the market friction explanation for the increased post-switch herding with the NYSE. That is, there is no evidence of an improvement in the speed of adjustment to NYSE trades following the switch to the NYSE.

5.3 Is this a Closet Indexing Effect?

A third explanation is that some mutual funds track NASDAQ stocks and others track NYSE stocks. In response to investor flows, these funds buy and sell NASDAQ or NYSE stocks as a basket. If investor flows are correlated across funds, the resulting coordinated buying and selling by NYSE (NASDAQ) funds induces comovement in imbalances and in returns. When a firm switches exchanges, it attracts the NYSE index funds and loses the interest of the NASDAQ index funds.

We attempt to address this possibility by estimating (3) using daily returns for firms that switch to the NYSE over a longer period, 1973-1987, starting with the formation of NASDAQ.

We cannot examine imbalances for this test, since the period predates the availability of intraday data. Hence, we draw inferences about trading from the patterns in return comovement. Given our earlier evidence of a strong correspondence between the comovement in returns and in imbalances (Table 4), this seems reasonable. Over this period, the switching effects are similar to those observed in the 1988-2000 period. Switching stocks see their NYSE beta increase by 0.26, on average (t-statistic of 5.6), while the mean NASDAQ beta declines by 0.44 (t-statistic = -7.8). Thus, the patterns in return comovement observed in the shorter sample are also present in a substantially longer period, one that predates the rise of indexing. The results from this extended sample suggest that exchange-level indexing is unlikely to be driving our results.[13]

5.4 Behavioral explanations and information cascades

Barberis, Shleifer and Wurgler (2005) provide two behavioral explanations relevant to our herding results.[14] First, investors sort assets into broad categories, and allocate funds at the level of these categories. In our context, this means that investors invest at the levels of the NYSE and NASDAQ. Second, they place their trades in known habitats, perhaps because of transaction costs, trading restrictions or lack of information. It is possible that investors become aware of stocks after they move to the NYSE and buy or sell them in tandem with other NYSE stocks.

Information cascades models are essentially rational models where investors prefer to herd in the face of weak private information (see for e.g., Bikhchandani et al, 1992 and Welch,

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[13] Two additional pieces of evidence are inconsistent with this explanation. We find no increase in turnover at any point in the two years centered on the switch. This would be expected if shares are being exchanged between NASDAQ and NYSE indexers. Second, we compare the magnitudes of our coefficients with those in BSW's study of S&P index additions. Over the 1988-2000 period, our coefficients are very similar to theirs. Since the S&P 500 is the most popular benchmark (currently in the region of $1 trillion is indexed to the S&P 500), the size of NYSE and NASDAQ indexing implied by these coefficients would have to be enormous.

[14] They provide a third explanation that relates to the speed with which information is incorporated into prices. We have already examined a similar hypothesis when we address synchronicity in trades.

1992). Herding arises because investors choose to rely on external signals to compensate for their own low quality signals. An implication of these models is that herding is more likely to arise for stocks with low quality information environments. We attempt to address both explanations in the next section, where we examine cross-sectional variations in herding.

6 Herding: Cross-sectional analysis

We have shown that firms that move to the NYSE see their trades move more closely with aggregate NYSE trades and less so with aggregate NASDAQ trades, while a control sample of firms sees no changes in comovement. A concern with interpreting the results is that the test and control samples might differ along one or more important dimensions that we have not controlled for. Moreover, particular firm characteristics may appeal to investors segmented along stock market lines. That is, suppose that NYSE investors prefer to invest in larger or more liquid firms. Then, a switch to the NYSE will impact comovement for large or liquid firms to a greater extent. In this section, we estimate cross-sectional regressions both to ensure that the results for the test and control samples are robust to firm characteristics and to understand the determinants of exchange-induced herding.

We start with a set of variables that we conjecture are characteristics (a) desired by investors active on the two exchanges, or (b) crucial to comovement in general. These are described below.

Firm size. We use the book value of assets and the market value of the firm as alternative proxies for firm size. Both are measured at the end of the most recent fiscal year prior to the switching date.

Liquidity. We use mean turnover, defined as daily volume scaled by shares outstanding and the mean closing relative bid-ask spread as proxies for liquidity. These means are estimated over the year preceding the switching date, excluding the two months prior to the switch.

Institutional ownership. This is defined as the percentage of shares held by institutions one quarter prior to the quarter in which the firm moves to the NYSE. The ownership data are obtained from Spectrum/Thomson Financial.

Growth vs. value. We use the ratio of a firm's market value of equity to its book value as a proxy for growth options. Both are measured at the end of the most recent fiscal year prior to the switching date.

Information. We use the market model R-squared values for the stockss as an inverse proxy for the quality of firm-specific information available to investors (as in Morck, Yeung and Yu, 2000). The R-squared is estimated using daily data over the year prior to the switching date, excluding the two months before the switch.

Pre-switch comovement. The pre-switch comovement in imbalances with NYSE and NASDAQ imbalances is included as a control variable, since the change in comovement might be driven, in part, by the prior level of comovement. These coefficients are obtained from regression (1) above.

The dependent variables in the cross-sectional regressions are the change in comovement with respect to the NYSE imbalance ($\Delta\beta^{NYSE}$) and the change in comovement with respect to the NASDAQ imbalance ($\Delta\beta^{NASDAQ}$) for each firm, obtained from (1) above. The model is estimated using the SUR technique, which exploits the correlation between the dependent variables.

$$\Delta\beta_i^{NYSE} = b_0 + b_1 D + b_2 \beta_i^{NYSE} + b_3 TO_i + b_4 INST_t + b_5 MTB_i + b_6 SIZE_t + b_7 RSQ_i + e_i \quad (5a)$$

$$\Delta\beta_i^{NASDAQ} = c_0 + c_1 D + c_2 \beta_i^{NASDAQ} + c_3 TO_i + c_4 INST_t + c_5 MTB_i + c_6 SIZE_t + c_7 RSQ_i + u_i \quad (5b)$$

In (5a) and (5b), $\Delta\beta^{NYSE}$ and $\Delta\beta^{NASDAQ}$ are the changes in comovement with NYSE and NASDAQ imbalances (we report the results using the slopes from the intraday, daily and weekly imbalance regressions); *D* is a dummy that is 1 for the test sample and 0 for the control sample; β^{NYSE} and β^{NASDAQ} are the pre-switch betas; *TO* is share turnover; *INST*, *MTB*, and *SIZE* are the level of institutional ownership, the market to book ratio, and market value of equity, and *RSQ* is the market model R-squared for each firm.

The results are presented in **Table 7**. First we note that the test dummy coefficient is significant at better than the 1% level of significance in every specification. This indicates that the difference in herding for the test and control samples documented in table 2 is not driven by the firm-level characteristics that appear as control variables.

Turning to the coefficients on the other variables, we see some intriguing results. The negative coefficient on the pre-switch levels of comovement with NYSE and NASDAQ are intuitive, implying that firms that co-move strongly with NYSE trades before the switch see smaller increases in herding, while firms that co-move strongly with NASDAQ trades see greater decoupling after the switch.

Larger firms see a greater increase in herding with NYSE and a larger decoupling from

NASDAQ than do smaller firms. To the extent that investors have better quality information about larger firms, this is also inconsistent with the information cascades model of Bikhchandani et al (1992). Firms with higher market-model R-squared values display larger increases in herding with NYSE trades, and larger declines in comovement with NASDAQ trades. A plausible interpretation is that such firms trade in a relatively inferior information environment and therefore are more influenced by the locale they trade in. In other words, after the switch, investors in these firms place more emphasis on the information contained in NYSE trades and less emphasis on the information in NASDAQ trades. Consequently, herding with the NYSE is increasing, and herding with NASDAQ is decreasing, in R-squared values. This is consistent with the information cascade model.

The coefficients on the remaining variables are not consistently significant. Interestingly, stocks more heavily owned by institutions see increased comovement with NYSE trades. This suggests that pre-existing institutional ownership promotes herding, and is consistent with the results for the size variable presented earlier.

To sum up, we are able to explain some of the change in comovement associated with the switch to a new exchange on the basis of firm characteristics. The evidence regarding the sources of the change in comovement is mixed. We find some support for the conclusion that information cascades are responsible, in part, for the change in comovement. Most important, comovement for the sample of switching firms remains significant at all measurement intervals, after controlling for firm characteristics. This suggests that the change in the comovement in trades accompanying the switch to the NYSE is the result of exchange-specific herding, likely with behavioral origins.

7 Conclusion

This paper directly examines herding in trades. The primary contribution of our research is to document the prevalence of herding in a more general context than previously studied. Specifically, using a sample of 536 stocks that switch from NASDAQ to the NYSE over 1988-2000, we examine the extent to which exchanges induce herding in trades (defined as order imbalances). We find that once a stock switches exchanges, its trades start to move more with NYSE trades and less with NASDAQ trades. These changes in comovement are evident over several measurement windows, and are not visible in a matched sample of control firms. Moreover, the changes in the comovement in trades are accompanied by changes in return comovement and explain a large proportion of the changed return comovement.

We are able to exclude the possibility that the patterns in comovement are due to changes in the comovement of switching firm cash flows with NYSE and NASDAQ cash flows. Additionally, changes in the synchronicity of trades with aggregate NYSE or NASDAQ trades and in firm characteristics cannot explain the changes in comovement. Our evidence seems most consistent with behavioral models of herding.

References

Barberis, Nicholas, Andrei Shleifer and Jeffrey Wurgler (2005), Comovement, *Journal of Financial Economics,* vol. 75, 283-317.

Bikhchandani, Sushil; David Hirshleifer; Ivo Welch (1992), A Theory of Fads, Fashion, Custom, and Cultural Change as Informational Cascades, *The Journal of Political Economy*, 100 (5), 992-1026.

Bodurtha, J., Kim, D., Lee, C.M. (1995), Closed-end country funds and U.S. market sentiment, *Review of Financial Studies* 8, 879–918.

Chan, K., A. Hameed and S. T Lau (2003), What if Trading Location is Different from Business Location? Evidence from the Jardine Group?, *Journal of Finance* 58, 1221-1246.

Fama, E., French, K. (1995), Size and book-to-market factors in earnings and returns, *Journal of Finance* 50, 131–155.

Feng, Lei and Mark Seasholes (2004), Correlated trading and location, *Journal of Finance*, 59 (5), 2117-2144.

Froot, K., Dabora, E. (1999), How are stock prices affected by the location of trade? *Journal of Financial Economics* 53, 189–216.

Graham, John R. (1999), Herding among Investment Newsletters: Theory and Evidence, *Journal of Finance*, 54, 237-268.

Greenwood, R., Sosner, N. (2002), Trading patterns and excess comovement of stock returns, *Unpublished working paper*, Harvard University.

Greenwood, Robin (2006), Short- and long-term demand curves for stocks: theory and evidence on the dynamics of arbitrage, *Journal of Financial Economics,* Vol. 75, 607-649

Harris, L., Gurel, E. (1986), Price and volume effects associated with changes in the S&P 500: new evidence for the existence of price pressure, *Journal of Finance* 41, 851–860.

Hardouvelis, G., LaPorta, R., Wizman, T. (1994), What moves the discount on country equity funds? In: Frankel, J. (Ed.), The Internationalization of Equity Markets. The University of Chicago Press, Chicago.

Hirshleifer, David and Siew Hong Teoh (2003), Herding and Cascading in Capital Markets: A Review and Synthesis, *European Financial Management*, 9(1), 25-66.

Huang, Roger D., and Hans R Stoll (1996), Dealer versus auction markets: a paired comparison of execution costs on Nasdaq and NYSE, *Journal of Financial Economics*, 41, 313-357

Ivkovic, Zoran and Scott Weisbenner (2005), Local does as local is: information content of the geographyof individual investors common stock investments, *Journal of Finance*, 60, 267-306.

Kadlec, Gregory B. and John J. McConnell (1994), The effect of market segmentation and illiquidity on asset prices: evidence from exchange listings, *Journal of Finance*, XLIX (2).

Kalay, A., Portniaguina, E. (2001), Swimming against the tides: the case of Aeroflex move from NYSE to NASDAQ, *Journal of Financial Markets*, 4, 261-267

Kaul, A., Mehrotra, V., Morck, R. (2000), Demand curves for stocks do slope down: new evidence from an index weights adjustment, *Journal of Finance* 55, 893–912.

Kumar, Alok and Charles M. Lee (2006), Retail Sentiment and Return Comovements, *Journal of Finance*, 61(5), 2451-5486.

Lee, Charles, Mark Ready (1991), Inferring Trade Direction from Intraday Data, *Journal of Finance,* Vol. 46, No. 2, 733-746.

Lee, C., Shleifer, A., Thaler, R. (1991), Investor sentiment and the closed-end fund puzzle, *Journal of Finance* 46, 75–110.

Lewellen, Jonathan (2002), Momentum and Autocorrelation in Stock Returns, *Review of Financial Studies*, Vol. 15, 533-564.

Lux, T. and D. Sornette (2002), On Rational Bubbles and Fat Tails, *Journal of Money, Credit and Banking* part 1, vol. 34 (3), 589-610.

Lynch, Anthony and Richard Mendenhall (1997), New Evidence on Stock Price Effects Associated with Changes in the S & P 500 Index, *Journal of Business,* Vol. 70, 351-383.

Merton, R. (1987), A simple model of capital market equilibrium with incomplete information, *Journal of Finance* 42, 483-510

McConnell, J., Sanger, G. (1987), The puzzle in post-listing common stock returns, *Journal of Finance* 42, 119-140.

Morck, R., B. Yeung and W. Yu (2000) The Information Content of Stock Markets: Why Do Emerging Markets Have Synchronous Stock Price Movements? *Journal of Financial Economics*, 58, 215-260.

Prechter, Jr., Robert R. (2001). "Unconscious herding behavior as the psychological basis of financial market trends and patterns," *Journal of Psychology and Financial Markets [now Journal of Behavioral Finance]*, 2 (3), 120-125.

Pindyck, R., Rotemberg, J. (1993), Comovement of stock prices, *Quarterly Journal of Economics*, 108, 1073-1104.

Rashes, Michael S. (2001), Massively Confused Investors Making Conspicuously Ignorant Choices (MCI-MCIC), *Journal of Finance,* 56, 1911-1927.

Sornette, D. (2003a), Why Stock Markets Crash: Critical Events in Complex Financial Systems, Princeton University Press.

Sornette, D. (2003b), "Critical market crashes", *Physics Reports*, 378 (1), 1-98.

Sornette, D., and J.V. Andersen (2002), "A nonlinear super-exponential rational model of speculative financial bubbles", *International Journal of Modern Physics*, 13 (2), 171- 187.

Shiller, Robert J. (1989), Comovements in Stock Prices and Comovements in Dividends, *Journal of Finance*, 44 (3), Papers and Proceedings of the Forty-Eighth Annual Meeting of the American Finance Association, New York, New York, December 28-30, 1988, 719-729

Shleifer, Andrei (1986), Do Demand Curves for Stocks Slope Down?, *Journal of Finance,* 41, 579-590.

Welch Ivo (1992), Sequential Sales, Learning and Cascades, *Journal of Finance,* 47, 695-732.

Wurgler, J., Zhuravskaya, K. (2002), Does arbitrage flatten demand curves for stocks?, *Journal of Business* 75, 583–608.

Table 1: Descriptive statistics for firms that switch from NASDAQ to the NYSE

The table presents summary characteristics for the test sample and the control sample. The test sample includes stocks that switch listings from NASDAQ to NYSE during 1988–2000. The control firms are the non-event firms on NASDAQ matched by size and industry. The samples are restricted to stocks that have available price data for the estimation window of (-300, +300) trading days around the event. The matching procedure is as follows. We first find all firms with common stock as share code recorded in CRSP that remain traded on NASDAQ. We obtain fiscal year-end data on price and book equity for these firms from COMPUSTAT and their industry affiliation from CRSP. We delete firms with negative values of book equity or stock price, and calculate the market value of equity as our proxy for size. For each event firm that switches to the NYSE at date *t*, we retain as control firms that are in the same industry based on two-digit SIC. We eliminate potential pairs for which the price levels are too far apart. For each remaining available firm in the control sample, we calculate the Huang and Stoll (1998) size score, and select the control firm with the lowest score value. Assets, market to book ratio, market value of equity and stock price are measured at the end of the most recent fiscal year prior to the switching date. Turnover is measured as the mean over one year preceding the switching date and not including two months before the event date. Institutional ownership is measured as the percentage of shares held one quarter prior to the event quarter.

	Share Price, $		**Volume Turnover**		**Total Assets**		**Market to Book**		**Market Value of Equity**		**Institutional Investors Ownership**	
	Test	**Control**	**Test**	**Control**	**Test**	**Control**	**Test**	**Control**	**Test**	**Control**	**Test**	**Control**
Q1	16.25	11.88	1.30	0.90	155	88	1.65	1.59	181	129	29%	20%
Median	22.31	19.50	2.43	2.22	331	205	2.46	2.46	345	252	45%	37%
Mean	25.57	22.52	3.35	3.17	1783	1223	3.13	3.68	756	577	46%	38%
Q3	32.63	29.00	4.41	4.12	968	523	3.65	3.95	729	520	61%	55%

Table 2: Order flow comovement before and after firms switch from NASDAQ to the NYSE

The table presents estimates of the following model:

$$OF_{i,t} = \alpha_{0i} + \alpha_{i1}D + \beta_i^{NYSE} OF_t^{NYSE} + \beta_i^{NASDAQ} OF_t^{NASDAQ} + \Delta\beta_i^{NYSE} OF_t^{NYSE} D + \Delta\beta_i^{NASDAQ} OF_t^{NASDAQ} D + \varepsilon_{i,t}$$

$OF_{i,t}$ is the 15min/daily/weekly order imbalance for stock *i*; OF_t^{NYSE} and OF_t^{NASDAQ} are NYSE and NASDAQ 15min/daily/weekly aggregate imbalances computed as the simple (i.e. equally-weighted) average of the imbalances for all ordinary shares trading in each market. In compiling these averages, we exclude the order imbalance both of the switching (control) firm and of its industry. D is a variable equal to 1 for the trading days after the switching date and 0 before. All transactions are classified as buys and sells (using the Lee-Ready (1991) algorithm and order flow is calculated as (buy volume – sell volume) / (buy volume + sell volume). Panel A is based on 15-minute order flow, Panel B on daily order flow and Panel C on weekly order flow. For each stock *i* (test and control), the specification is estimated over (-300, +300) trading days around the event, and not including (-50, +50) around the listing date. The values reported are means along with their t-statistics. The p-values for a two-side test on the difference in means are provided. The test sample includes stocks that move from NASDAQ to NYSE between 1988 and 2000. The control firms are the non-event firms on NASDAQ matched on size and industry.

	Intercept	α_1	β^{NYSE}	β^{NASDAQ}	$\Delta\beta^{NYSE}$	$\Delta\beta^{NASDAQ}$
Panel A: Intraday OF						
Test sample	0.01	0.04	0.10	0.82	0.43	-0.38
	1.16	*6.75*	*8.12*	*41.69*	*25.38*	*-14.49*
Control sample	-0.02	-0.01	0.05	0.89	0.06	0.00
	-2.57	*-1.03*	*3.39*	*35.47*	*1.55*	*0.04*
Test of means (p-values)	0.01	0.00	0.01	0.04	0.00	0.00
Panel B: Daily OF						
Test sample	0.03	0.00	0.27	0.64	0.57	-0.46
	4.44	*0.52*	*9.47*	*15.54*	*12.52*	*-7.94*
Control sample	0.01	-0.02	0.23	0.73	-0.02	-0.10
	1.77	*-2.51*	*7.69*	*15.88*	*-0.43*	*-1.68*
Test of means (p-values)	0.68	0.01	0.20	0.06	0.00	0.01
Panel C: Weekly OF						
Test sample	0.01	0.02	0.40	0.47	0.40	-0.33
	0.74	*0.93*	*5.55*	*6.40*	*3.92*	*-3.09*
Control sample	0.02	-0.03	0.23	0.67	0.01	-0.15
	1.28	*-2.02*	*2.71*	*8.23*	*0.06*	*-1.52*
Test of means (p-values)	0.62	0.03	0.11	0.07	0.00	0.23

Table 3: Return comovement before and after firms switch from NASDAQ to the NYSE

The table presents estimates of the following model:

$$R_{i,t} = \alpha_{0i} + \alpha_{i1} D + \beta_i^{NYSE} R_t^{NYSE} + \beta_i^{NASDAQ} R_t^{NASDAQ} + \Delta\beta_i^{NYSE} R_t^{NYSE} D + \Delta\beta_i^{NASDAQ} R_t^{NASDAQ} D + \varepsilon_{i,t}$$

$R_{i,t}$ is the 15min/daily/weekly return for stock *i*; R_t^{NYSE} and R_t^{NASDAQ} are NYSE and NASDAQ 15min/daily/weekly market returns constructed as equally–weighted averages of the returns to all constituent stocks. In compiling these averages, we exclude the returns both of the switching (control) firm and of its industry. D is a dummy variable that is one after the switch date for stock *i* and zero otherwise. For each stock i, the specification is estimated over (-300, +300) trading days around the event, and not including (-50, +50) around the listing date, to avoid any return effect of the actual event. The values reported are means along with their t-statistics. The estimations are based on TAQ and ISSM midquotes. Panel A is based on 15-minute returns; Panel B is based on daily close-close returns; Panel C is based on close-close weekly returns. The table presents the estimates from the above specification for the test sample and the control sample and the p-values for a two-side test on the difference in means are provided. The test sample includes stocks that move from NASDAQ to NYSE between 1988 and 2000. The control firms are the non-event firms on NASDAQ matched on size and industry.

	Intercept	α_1	β^{NYSE}	β^{NASDAQ}	$\Delta\beta^{NYSE}$	$\Delta\beta^{NASDAQ}$
Panel A: Intraday returns						
Test sample	0.00	0.00	0.38	0.75	0.19	-0.44
	-2.45	*-5.81*	*18.93*	*19.00*	*8.56*	*-11.91*
Control sample	0.00	0.00	0.40	0.72	0.02	-0.03
	-6.83	*-0.11*	*17.54*	*19.94*	*0.75*	*-0.70*
Test of means (p-values)	0.00	0.14	0.49	0.63	0.00	0.00
Panel B: Daily returns						
Test sample	0.00	0.00	0.60	0.60	0.15	-0.20
	2.76	*-5.41*	*20.44*	*16.07*	*3.76*	*-4.53*
Control sample	0.00	0.00	0.54	0.68	0.03	-0.08
	-2.98	*-2.58*	*16.61*	*18.67*	*0.74*	*-1.85*
Test of means (p-values)	0.00	0.08	0.14	0.10	0.04	0.06
Panel C: Weekly returns						
Test sample	0.00	0.00	0.66	0.55	0.21	-0.23
	5.14	*-6.70*	*12.86*	*9.95*	*3.06*	*-3.37*
Control sample	0.00	0.00	0.53	0.66	0.02	-0.11
	-1.42	*-1.87*	*9.23*	*11.22*	*0.30*	*-1.44*
Test of means (p-values)	0.00	0.00	0.10	0.16	0.07	0.25

Table 4: Residual return comovement before and after firms switch from NASDAQ to the NYSE

The table presents estimates of the following model:

$$RES_{i,t} = \alpha_{0i} + \alpha_i D + \beta_i^{NYSE} RES_t^{NYSE} + \beta_i^{NASDAQ} RES_t^{NASDAQ} + \Delta\beta_i^{NYSE} RES_t^{NYSE} D + \Delta\beta_i^{NASDAQ} RES_t^{NASDAQ} D + \varepsilon_{i,t}$$

$RES_{i,t}$ is the 15min/daily/weekly residual on stock *i*; RES_t^{NYSE} and RES_t^{NASDAQ} are NYSE and NASDAQ 15min/daily/weekly equally-weighted aggregate residual return . *D* is an indicator variables equal to 1 for the trading days after the switching date and 0 before. We proceed in two steps. First, we compute the residual return for every switching stock via a regression of its return on its order imbalance. To minimize the effects of feedback from returns to trades, the regression is run and the residuals computed at the 15-minute horizon. We also do this for every ordinary common stock on the NYSE and NASDAQ, and thereby form an equally-weighted aggregate residual return for each market. In the second step, we regress the residual return for the switching stock on the aggregate residual NYSE and NASDAQ returns. As in the earlier tables, we estimate this model using 15-minute, daily and weekly residual returns. The daily and weekly residual returns are constructed by summing the 15-minute residual returns for each stock for the entire day or week. For each stock *i*, the above specification is estimated over (-300, +300) trading days around the event, not including (-50, +50) trading days around the listing date. The values reported are means along with their t-statistics. The p-values for a two-side test on the difference in means are provided. The test sample includes stocks that move from NASDAQ to NYSE between 1988 and 2000. The control firms are the non-event firms on NASDAQ matched on size and industry.

	Intercept	α_1	β^{NYSE}	β^{NASDAQ}	$\Delta\beta^{NYSE}$	$\Delta\beta^{NASDAQ}$
Panel A: Intraday						
Test sample	0.00	0.00	0.41	0.31	0.20	-0.15
	-0.20	*1.00*	*26.90*	*26.24*	*9.63*	*-10.20*
Control sample	0.00	0.00	0.43	0.36	0.02	-0.02
	-1.93	*0.28*	*26.33*	*28.10*	*1.04*	*-1.29*
Test of means (p-values)	0.18	0.65	0.32	0.01	0.00	0.00
Panel B: Daily						
Test sample	0.00	0.00	0.43	0.48	0.11	-0.10
	0.84	*1.05*	*18.44*	*22.07*	*3.68*	*-3.75*
Control sample	0.00	0.00	0.44	0.53	-0.01	-0.03
	0.12	*0.52*	*17.18*	*22.00*	*-0.33*	*-1.07*
Test of means (p-values)	0.64	0.79	0.80	0.14	0.01	0.09
Panel C: Weekly						
Test sample	0.00	0.00	0.37	0.55	0.09	-0.05
	0.06	*1.02*	*13.03*	*18.25*	*2.55*	*-1.34*
Control sample	0.00	0.00	0.39	0.58	-0.07	-0.01
	-0.29	*0.13*	*9.45*	*13.87*	*-1.21*	*-0.21*
Test of means (p-values)	0.78	0.71	0.65	0.60	0.02	0.57

Table 5: Cash flow comovement before and after firms switch from NASDAQ to the NYSE

The table presents estimates of the following model:

$$CF_{i,t} = \alpha_{0i} + \alpha_i D + \beta_i^{NYSE} CF_t^{NYSE} + \beta_i^{NASDAQ} CF_t^{NASDAQ} + \Delta\beta_i^{NYSE} CF_t^{NYSE} D + \Delta\beta_i^{NASDAQ} CF_t^{NASDAQ} D + \varepsilon_{i,t}$$

where $CF_{i,t}$ is the quarterly cash flow for stock *i*, $CF_{i,t}^{NYSE}$ and $CF_{i,t}^{NASDAQ}$ are the quarterly equally-weighted cash flow indices for the NYSE and NASDAQ (calculated excluding firm *i*), D is a dummy equal to 1 for quarters following the switching date and 0 beforehand. Cash flow is defined as EBIDT/Assets. The regression is based on data from year –2 to year +2 centered on the switching event. The specification is estimated with firm- and year-fixed effects and applies the Huber-White clustering correction to the standard errors (t-statistics are provided in italics). The test sample includes stocks that move from NASDAQ to NYSE between 1988 and 2000. The control firms are the non-event firms on NASDAQ matched by size and industry.

	Intercept	α_1	β^{NYSE}	β^{NASDAQ}	$\Delta\beta^{NYSE}$	$\Delta\beta^{NASDAQ}$
Test sample	0.05	-0.00	-0.45	0.61	0.17	-0.39
	2.47	*-0.08*	*-0.81*	*1.45*	*0.24*	*-0.88*
Control sample	-0.01	0.02	1.50	-0.08	-0.35	-0.38
	-0.34	*0.49*	*2.09*	*-0.17*	*-0.45*	*-0.69*

Table 6: Tests of the market frictions

Order imbalances for switching and control firms are regressed on lags (shown as *t-k*) of NYSE and NASDAQ equally-weighted industry-adjusted market order flow indexes. β^{NYSE} and β^{NASDAQ} are the pre-switch NYSE and NASDAQ coefficients, while $\Delta\beta^{NYSE}$ and $\Delta\beta^{NASDAQ}$ are the changes in the coefficients following the switch to the NYSE. Values that are significant at 5% level from t-statistics of the null hypothesis that the coefficients are zero are presented in bold font.

	β^{NYSE}	β^{NASDAQ}	$\Delta\beta^{NYSE}$	$\Delta\beta^{NASDAQ}$	β^{NYSE}	β^{NASDAQ}	$\Delta\beta^{NYSE}$	$\Delta\beta^{NASDAQ}$
	Switching Firms				**Control Firms**			
Panel A: Intra-day Order Imbalance								
t	**0.08**	**0.76**	**0.41**	**-0.37**	0.05	0.83	0.03	-0.03
t-1	**0.06**	-0.01	0.01	0.02	0.04	0.01	-0.01	-0.01
t-2	**0.02**	-0.02	**-0.02**	0.01	0.02	-0.03	-0.02	**0.06**
t-3	**0.03**	**-0.03**	**-0.02**	0.00	0.02	-0.03	-0.02	0.02
t-4	0.01	0.02	**0.02**	**-0.05**	0.01	0.01	-0.01	0.00
t-5	0.01	0.01	0.01	0.00	0.02	0.02	0.00	-0.02
Sum coefficients	0.21	0.74	0.40	-0.40	0.14	0.81	-0.03	0.02
From table 2	0.10	0.82	0.43	-0.38	0.05	0.89	0.06	0.00
Panel B: Daily Order Imbalance								
t	**0.27**	**0.58**	**0.55**	**-0.36**	**0.22**	**0.76**	-0.04	-0.10
t-1	**0.12**	0.02	-0.05	**-0.12**	**0.08**	-0.04	-0.02	0.00
t-2	-0.01	-0.02	-0.04	0.02	-0.01	-0.02	0.00	-0.04
t-3	**0.08**	**-0.14**	**-0.10**	**0.12**	-0.01	0.01	**0.12**	**-0.13**
t-4	0.00	0.05	0.02	-0.06	-0.01	-0.04	0.01	0.00
t-5	-0.02	0.00	0.04	-0.05	0.00	-0.05	-0.04	0.09
Sum coefficients	0.44	0.50	0.42	-0.45	0.28	0.63	0.03	-0.17
From table 2	0.27	0.64	0.57	-0.46	0.23	0.73	-0.02	-0.10
Panel C: Weekly Order Imbalance								
t	**0.37**	**0.46**	**0.28**	**-0.26**	**0.18**	0.86	0.07	-0.31
t-1	**0.12**	-0.10	-0.04	-0.10	0.05	-0.26	0.07	0.02
Sum coefficients	0.56	0.34	0.28	-0.28	0.20	0.66	0.15	-0.30
From table 2	0.40	0.47	0.40	-0.33	0.23	0.67	0.01	-0.15

Table 7: Cross-sectional determinants of herding

The table presents SUR estimates of the following system of equations:

$$\Delta\beta_i^{NYSE} = b_0 + b_1 D + b_2 \beta_i^{NYSE} + b_3 TO_i + b_4 INST_t + b_5 MTB_i + b_6 SIZE_t + b_7 RSQ_i + e_i \qquad \text{(i)}$$

$$\Delta\beta_i^{NASDAQ} = c_0 + c_1 D + c_2 \beta_i^{NASDAQ} + c_3 TO_i + c_4 INST_t + c_5 MTB_i + c_6 SIZE_t + c_7 RSQ_i + u_i \qquad \text{(ii)}$$

In the equations above, $\Delta\beta^{NYSE}$ and $\Delta\beta^{NASDAQ}$ represent the change in comovement with NYSE and NASDAQ, *D* is the event dummy representing the switch to the NYSE, β^{NYSE} and β^{NASDAQ} are the pre-switch betas, TO is the turnover of volume (scaled by number of shares outstanding), INST, MTB, and SIZE are the level of institutional ownership, the market to book ratio, and market value of equity prior to the switch, and RSQ is the market model R-square prior to the switch for each firm. T-statistics are provided in italics below the coefficient estimates. Bold entries represent significance at the 5% level.

	b_0	b_1	b_2	b_3	b_4	b_5	b_6	b_7	c_0	c_1	c_2	c_3	c_4	c_5	c_6	c_7
Intra-day	**-0.077**	**0.406**	**-0.773**	-0.001	**0.250**	0.00	**0.033**	**0.437**	**0.839**	**-0.387**	**-0.869**	0.002	**-0.189**	0.005	**-0.034**	**-0.531**
	-2.90	*19.63*	*-23.22*	*-0.35*	*5.32*	*0.41*	*5.68*	*2.82*	*18.26*	*-12.52*	*-32.43*	*0.45*	*-2.64*	*1.08*	*-4.03*	*-2.30*
Daily	**0.232**	**0.588**	**-0.99**	**-0.03**	0.209	-0.008	0.008	0.506	**0.862**	**-0.376**	**-0.939**	0.016	**-0.597**	0.000	-0.024	**-1.458**
	3.79	*12.44*	*-34.42*	*-4.00*	*1.80*	*-1.10*	*0.61*	*1.49*	*10.76*	*-6.36*	*-37.26*	*1.71*	*-4.11*	*-0.04*	*-1.5*	*-3.44*
Weekly	**0.473**	**0.46**	**-0.97**	-0.02	-0.155	-0.009	-0.004	0.266	**0.653**	**-0.275**	**-0.992**	0.019	-0.455	0.013	-0.032	**-1.566**
	3.55	*4.46*	*-39.27*	*-1.20*	*-0.61*	*-0.60*	*-0.12*	*0.36*	*4.58*	*-2.51*	*-39.52*	*1.08*	*-1.69*	*0.80*	*-1.07*	*-2.00*