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Discretionary Trading and Asset Price Volatility

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Abstract

Against the backdrop of emerging stock markets, this paper examines an asset market where investors behave strategically based on their private information. It is shown that if the investor base expands in the form of more informed traders entering the market, in contrast to the commonly held view, price volatility actually increases. Moreover, if entry is endogenized using transaction costs (brokerage fees), it turns out that the level of participation is stochastic and the market displays "excess volatility" in price. Informed traders participate in trading only when they believe that the probability of making speculative profits is large and therefore informed trading is discretionary. An extension of the model opens up the possibility of the market displaying informational herding-like behavior despite traders having long trading horizons.

JEL Classification Numbers:
D82, G12

1/ Research on the paper was initiated when I was in the Policy Development and Review Department. I would like to thank Steven Dunaway and Robert Rennhack for their suggestions and comments. I remain responsible for all remaining errors. The views expressed in this paper do not necessarily represent those of the International Monetary Fund.

Contents

Summary

It is generally believed that as the number of participants in an asset market increases, the pooling of idiosyncratic differences among traders will deepen the market and reduce volatility in asset prices. This paper argues that the line of causality from market "thinness" to market "depth" depends critically on the assumption of a competitive market structure. In particular, if the market is rendered noncompetitive owing to asymmetric information, asset price volatility may increase.

This paper assumes that the asset market is rendered noncompetitive owing to the presence of agents with informational advantage (informed or insider traders). In such an environment, if the investor base increases because more informed traders enter the market, market makers and arbitrageurs react more aggressively to changes in the level of trading because they assume that these changes contain information about the true value of assets. Consequently, volatility in the price of assets increases despite the expanded investor base. It is shown that at the limit, the variance in the asset price can be as much as twice the volatility of the asset value. This result conforms to the observation that the competitive model cannot be recovered even if the number of informed traders decreases. The fact that the variance in the price of an asset is not always larger than the variance in the value of the asset is somewhat unsatisfactory since a large number of studies have confirmed the presence of "excess volatility" in stock markets.

In order to address this problem the entry of traders is made endogenous. Unlike previous studies, which use a one-time research cost as the only cost of participating in the market, here it is assumed that there is a transaction cost associated with trading (brokerage fees). With this transaction cost structure, it follows that the level of participation will be not only limited but also stochastic. In particular, participation will increase when private information suggests the future value of an asset will move further from its mean value, that is, when entry by informed traders is discretionary with informed traders participating only when they believe there is a high probability of making speculative gains. This added volatility in the participation level causes the market to display excess volatility. Moreover, with minor modifications it can be shown that the market can display features that resemble "informational herding" despite the fact that traders can keep their positions open for long periods.

I. Introduction

It is generally believed that if the number of participants in an asset market increases, then, due to a larger pooling of the idiosyncratic differences among traders, the market is deepened thereby reducing the volatility in the price of the asset (Grossman and Stiglitz 1980, Pagano 1989). It is argued in this paper that this line of causality from market "thickness" to market "depth" depends critically on the assumption of a competitive market structure. In particular, if the market is rendered noncompetitive due to, for example, asymmetric information then asset price volatility may not only fail to diminish but can even increase.

In recent years, aided by improvements in institutional arrangements and macroeconomic and structural reforms, there has been rapid growth in the stock markets of the newly industrialized and some developing economies collectively termed emerging stock/capital markets (ESMs). 1/ This growth occurred in stock prices, market capitalization and in the flow of foreign portfolio investment. Prima facie evidence from observed price behavior suggests that the volatility in these markets have not decreased significantly. Experiences of these stock markets are not uniform, reflecting the differences in the importance of the private sector in the domestic economy; the macroeconomic and industrial policies adopted by the respective governments; the extent of capital controls that impede market participation by foreign investors; and the regulatory framework that govern the markets including accounting standards, disclosure requirements, information dissemination mechanisms etc. Despite these differences, except for few countries, the experience has been that the volatility in the prices has not declined, at least by any significant margin, since the markets began to expand.

The experiences in the ESMs provide a useful backdrop for revisiting arguments about the impact of market opening on asset price volatility for two reasons. First, given that all these ESMs were closed to foreign investors for a fairly long period of time with a significant expansion in the investor base occurring after liberalization, one can compare the degree of price volatility before and after the expansion. Second, the increase in price volatility that followed in a large number of markets subsequent to the liberalization has been viewed with apprehension in some quarters, especially in policy debates, raising questions about the merits of further liberalization.

In this paper, it is assumed that the asset market is rendered noncompetitive, in the sense of Kyle (1985), due to the presence of agents with

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1/ These are a group of 38 countries in Africa, Asia, Europe, Latin America and the Middle East. However, not all of these countries have an actively traded stock market or significant market capitalization, e.g, the IFC includes only 25 of these countries as part of their Emerging Stock Market Data Base.

informational advantage (informed or insider traders). An expansion of the investor base leads to greater volatility (increased variance) in the price of the asset, and it is shown that in the limit (as the number of investors tends to infinity) the variance in the price of the asset is twice that of the asset return. This result reiterates the Gale and Hellwig (1988) observation that the competitive model cannot be recovered even when informed traders become small relative to the market. The fact that the variance in the price of the asset is not always larger than that of the fundamental shock is somewhat unsatisfactory since a large number of studies (Shiller 1981, Campbell and Shiller 1988, LeRoy and Parke 1992) have confirmed the presence of "excess volatility" in stock markets.

In order to address this problem the entry of traders is endogenized. Unlike previous studies (Pagano 1989), which use a one-time research cost as the only cost of participating in the market, here it is assumed that there is a transaction cost associated with trading (brokerage fees). This is based on the evidence provided in King and Leape (1984). With such a transaction cost structure, it follows that the level of participation will not only be limited but also stochastic. In particular, participation will increase when private news about the future value of the asset is further removed from its mean value, i.e., entry by informed traders is discretionary with such traders participating only when they believe there is a high probability of making speculative gains. This added volatility in the participation level allows the market to display "excess volatility." Moreover, with minor modification it is shown that the market can display features that observationally resemble "informational herding" despite the fact that traders can keep their positions open for long periods.

The paper is organized as follows. The stylized facts from ESMs are discussed in Section 1. Followed by a discussion of the competitive model. In Section 3 the noncompetitive model is set up and its equilibrium features under exogenous entry of investors are analyzed. The entry decision is then endogenized and its implications noted in Section 4. The next section investigates the possibility of informational herding. Section 6 concludes the paper.

II. Volatility in Stock Prices and Returns

The analysis in this section is restricted by the availability of systematic data on all the 38 emerging stock markets. The readily available source is the IFC Emerging Market Data Base which tracks the developments in the stock markets of 21 countries 1/ and for which time series data of

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1/ The data base includes two European markets, Greece and Portugal; two Middle Eastern countries, Jordan and Turkey; six Latin American countries, Argentina, Brazil, Chile, Colombia, Mexico, and Venezuela; nine Asian countries, China, India, Indonesia, Korea, Malaysia, Pakistan, Philippines, Taiwan, and Thailand; and Nigeria and Zimbabwe in Africa.

reasonable length is available. This data base is used as the primary source for this part of the analysis. Before presenting the evidence, two analytical questions need to be answered, namely what is a reasonable measure of volatility in price and returns and when can a stock market be said to be open to foreign investment. The answer to the first question has been long debated and depending on the purposes of the analyses the volatility measures differ in both content and technique (see Shiller, 1982 for a survey of these measures). In this paper the choice of the volatility measure is dictated by the need to provide easy comparability among various other studies and the complexity of computation. Most studies and market participants use the annualized standard deviation of the monthly price and the coefficient of variation to compare across different stock markets. The same measure is adopted for the reasons alluded to before. While it would seem appropriate to detrend the data before calculating the standard deviations this is not done for two reasons. First, the analysis would be extremely sensitive to the detrending procedure and there does not seem to be any consensus regarding which procedure to use. In addition, detrending implies that the factors that determine the normal development of a stock market are different from those generating the volatility, a point which cannot be easily defended as the subsequent discussion will demonstrate. The answer to the second question regarding the timing of the liberalization of the markets is more subjective. In Table 1, summarizes the official dates when markets were opened to foreign investors are summarized. Adopting these dates as the opening dates may not be reasonable since it would imply that these announcements were completely unanticipated by the investors, whereas the existence of these markets is almost entirely based on participants trying to anticipate future events. Moreover, there could be level adjustments as investors adjusted the perceived over or under valuation of the stocks. To avoid these problems, a period of four months, two months prior and two months after the official opening date is truncated from the data. Consequently, the period defined as before market opening ends two months prior to the official date of the opening, while the period after the opening starts two months after that date.

In Tables 2 and 3, standard deviations of both price indices and total return indices are shown. A feature that immediately emerges is that the experience after the opening of the stock markets to foreign investors has not been uniform. Different stock markets seem to have reacted differently to the liberalization process and there is no evidence to support a general inference that there has been an decrease in the market volatility. In fact for a large number of countries the market volatility has either increased or has remained largely unchanged.

Greece exemplifies the concern that there has been a marked increase in stock price volatility due to the entry of foreign investors in emerging markets. The annual standard deviation of stock price changes or capital gains (Table 2) in this market increases from 28.92 percent to 44.81 percent, while the volatility in annual total returns increases from 28.3 percent to 45.6 percent (Table 3). But this is only half the story. While, on the average, prices fell on the average by 3.83 percent before the opening

Table 1. The Liberalization of Emerging Markets

Country	Opening Date	Status
Argentina	October 1991	Fully opened.
Brazil	May 1991	100 percent of nonvoting preferred stock, 49 percent of voting common stock.
Chile	December 1988	25 percent of the listed companies' shares.
Colombia	February 1991	Fully opened.
Greece	December 1988	Fully opened.
India	November 1992	24 percent of the issued capital.
Indonesia	September 1989	49 percent of all companies' listed shares.
Jordan	December 1988	49 percent investible.
Korea	January 1992	10 percent of listed companies' capital.
Malaysia	December 1988	30 percent for banks and financial institutions, 100 percent for other stocks.
Mexico	May 1989	30 percent of banking, 100 percent of other stocks.
Nigeria	--	Closed.
Pakistan	February 1991	Fully opened.
Phillipines	October 1989	Investable upto 40 percent.
Portugal	December 1988	Fully opened.
Taiwan, China	January 1991	Investable upto 10 percent.
Thailand	December 1988	Investable upto 49 percent.
Turkey	August 1989	Fully opened.
Venezuela	January 1990	Except banks 100 percent investable.
Zimbabwe	--	Closed.

Source: IFC.

Table 2. Descriptive Statistics of Annualized Percent Changes in Price Indices

	Before Opening			After Opening			Cumulative		
Country	Mean	Std. Dev.	Sharpe Ratio	Mean	Std. Dev.	Sharpe Ratio	Mean	Std. Dev.	Sharpe Ratio
Composite				0.19	0.23	0.81	0.02	0.07	0.81
Europe									
Greece	-0.04	0.29	-0.13	0.23	0.45	0.51	0.02	0.35	0.06
Portugal	1.05	0.73	1.44	0.03	0.25	0.12	0.34	0.47	0.71
Turkey	0.46	0.79	0.58	0.40	0.71	0.57	0.39	0.73	0.53
Jordan	0.07	0.16	0.45	0.07	0.18	0.41	0.07	0.17	0.44
Latin America	0.25	0.43	0.59	0.34	0.26	1.29	0.29	0.36	0.80
Argentina	0.62	1.02	0.60	0.60	0.67	0.89	0.61	0.98	0.63
Brazil	0.06	0.56	0.10	0.70	0.60	1.18	0.17	0.57	0.29
Chile	0.27	0.42	0.66	0.36	0.26	1.40	0.30	0.38	0.80
Colombia	0.22	0.22	1.00	0.63	0.42	1.49	0.38	0.32	1.18
Mexico	0.18	0.47	0.38	0.43	0.27	1.58	0.24	0.43	0.57
Venezuela	0.04	0.41	0.10	0.51	0.49	1.03	0.28	0.46	0.61
Asia	0.21	0.27	0.77	0.17	0.21	0.78	0.19	0.25	0.76
China				-0.29	0.55	-0.52	-0.29	0.55	-0.52
India	0.16	0.26	0.62	0.21	0.34	0.60	0.16	0.26	0.61
Indonesia				0.07	0.32	0.23	0.07	0.32	0.23
Korea	0.16	0.30	0.53	0.08	0.28	0.29	0.15	0.30	0.50
Malaysia	0.10	0.32	0.32	0.23	0.24	0.95	0.17	0.27	0.62
Pakistan	0.05	0.10	0.51	0.43	0.36	1.20	0.19	0.24	0.81
Philippines	0.72	0.38	1.88	0.22	0.37	0.60	0.46	0.38	1.20
Taiwan, China	0.51	0.54	0.94	0.14	0.50	0.27	0.36	0.53	0.67
Thailand	0.13	0.54	0.54	0.26	0.32	0.82	0.17	0.26	0.64
Nigeria				0.06	0.52	0.12	0.06	0.52	0.12
Zimbabwe				0.04	0.34	0.13	0.04	0.34	0.13

For the Asia and Latin America indices the opening dates are taken to be January 1991 and January 1990, rspectively.

Sources: IFC Emerging Market Data Base, 1976.01 to 1994.02.

Table 3. Descriptive Statistics of Annualized Percent Changes in Total Return Indices

Country	Before Opening			After Opening			Cumulative		
	Mean	Std. Dev.	Sharpe Ratio	Mean	Std. Dev.	Sharpe Ratio	Mean	Std. Dev.	Sharpe Ratio
Composite				0.22	0.24	0.92	0.22	0.24	0.92
Europe									
Greece	0.02	0.28	0.06	0.29	0.46	0.64	0.08	0.35	0.24
Portugal	1.07	0.73	1.47	0.06	0.25	0.22	0.36	0.47	0.77
Turkey	0.52	0.79	0.66	0.48	0.72	0.66	0.46	0.74	0.62
Jordan	0.11	0.16	0.65	0.12	0.19	0.62	0.11	0.17	0.64
Latin America	0.31	0.44	0.71	0.37	0.26	1.41	0.34	0.37	0.92
Argentina	0.64	1.03	0.62	0.62	0.68	0.91	0.64	0.98	0.65
Brazil	0.14	0.56	0.25	0.75	0.60	1.26	0.24	0.58	0.42
Chile	0.34	0.42	0.80	0.42	0.26	1.64	0.36	0.38	0.95
Colombia	0.32	0.22	1.47	0.67	0.42	1.59	0.45	0.32	1.43
Mexico	0.24	0.47	0.51	0.45	0.27	1.66	0.29	0.43	0.69
Venezuela	0.06	0.41	0.16	0.53	0.49	1.07	0.30	0.46	0.65
Asia	0.23	0.27	0.85	0.18	0.21	0.84	0.21	0.25	0.84
China				-0.29	0.56	-0.52	-0.29	0.56	-0.52
India	0.19	0.26	0.74	0.22	0.35	0.63	0.19	0.27	0.73
Indonesia				0.08	0.32	0.27	0.08	0.32	0.27
Korea	0.21	0.31	0.68	0.09	0.28	0.31	0.19	0.30	0.63
Malaysia	0.12	0.32	0.38	0.25	0.24	1.05	0.19	0.27	0.70
Pakistan	0.12	0.11	1.18	0.46	0.36	1.29	0.25	0.24	1.05
Philippines	0.77	0.38	2.01	0.23	0.37	0.63	0.48	0.38	1.27
Taiwan, China	0.53	0.54	0.97	0.14	0.50	0.29	0.37	0.53	0.70
Thailand	0.21	0.24	0.86	0.29	0.32	0.92	0.23	0.26	0.88
Nigeria				0.14	0.52	0.28	0.14	0.52	0.28
Zimbabwe				0.13	0.34	0.39	0.13	0.34	0.39

For the Asia and Latin America indices the opening dates are taken to be January 1991 and January 1990, rspectively.

Sources: IFC Emerging Market Data Base, 1976.01 to 1994.02.

of the stock market to foreign investors, i.e., there were capital losses, after the opening, prices increased on the average by 29.41 percent annually. This implied a ten-fold increase in the Sharpe Ratio (SR) of total returns, which is the ratio of mean to standard deviation, from 0.061 to 0.645. The SR measures the attractiveness of an asset, since it is the risk discounted mean return on the asset. Moreover, the standard asset market theory predicts that when the investor base expands, the price of the asset on the average increases while its volatility goes down, i.e., the SR should go down.

An almost opposite situation arises for Portugal. While, before the opening, the Portuguese stock index registered an annual increase of 105.35 percent with a 73.03 percent volatility and the total return index displayed an annual 107.11 percent return with 72.83 percent volatility, after the opening, average capital gains fell to 2.87 percent annually with a corresponding decrease in price volatility to 24.93 percent. The total return index displayed similar trends. The SR for total returns consequently, fell by almost seven times to 0.224 from 1.471. In contrast, stock markets in Turkey and Jordan displayed little change after their openings.

In Latin America, the experience across the six stock markets also was extremely dispersed regarding the changes in volatility. In Argentina, Chile, and Mexico price volatility as well as return volatility dropped significantly after these markets were opened. Argentina registering the most significant reduction with volatility declining from 102.4 percent to 67.12 percent. In Venezuela and Colombia, the volatility increased, and in Brazil, the volatility increased by a relatively small margin from 55.96 to 59.54 percent. On the other hand, for all the countries there were dramatic increases in stock prices after the liberalization.

The opening of stock markets to foreign investors led to changes of much smaller magnitudes in the Asian ESMs. In India, the annualized percent changes in the price index increased from 15.93 percent to 20.62 percent, while volatility increased from 25.89 percent to 34.5 percent. In Korea, capital gains were halved from an annual rate of 16.02 percent after the market opening, with volatility registering a 2 percent decrease to 28.3 percent. Stock markets in both Philippines and Taiwan displayed substantial decreases in average capital gains with small reductions in volatility. In Malaysia, Pakistan, and Thailand, the mean price changes increased and the stock market in Pakistan registered a ten-fold increase from 4.96 percent. In terms of Sharpe ratios India, Korea, Philippines, and Taiwan all became less attractive investment opportunities after their openings!

The above discussion demonstrate the heterogeneity in the experiences of the emerging markets regarding price volatility in the aftermath of liberalizing foreign participation. While there have been cases where the volatility has increased substantially, by and large the increases have been less dramatic, and in quite a few cases, there has been greater stability in price movements. Overall, given the measures of volatility employed, it is not possible to provide support to a general conclusion of decreased price volatility after liberalization.

A question that arises is whether changes in prices and the associated volatility reflect in some ways, changes in the returns or dividends of these assets. Put differently, are these assets priced according to their expected future dividends. The question is important since asset pricing models , Capital Asset Pricing Models (Lucas, 1978) and Arbitrage Pricing Paradigms (Ross, 1970) both assert that, in equilibrium, the price of the asset is some function of the discounted sum of expected future flows of dividends. There is evidence, for instance (Mullin, 1993), to suggest that cross-country relationships between stock market returns and export growth and asset dividends are significant. However, these studies also suggest that the performance of these markets cannot be explained by the fundamentals and this may reflect the presence of "excess volatility." However, this should not be surprising since even in more developed markets, e.g., the U.S. stock market, there is strong evidence of excess volatility. In fact, this has been one of the most widely researched and debated areas in financial economics. 1/ Most explanations are based on informational inefficiency of stock prices despite the existence of extremely sophisticated trading instruments and information gathering agencies. Therefore, given the low level of information dissemination and other institutional impediments that allow for greater accumulation of private information and insider trading, if emerging markets did not display this excess volatility it would have been surprising. The existence of high auto-correlation in emerging market stock prices (Errunza and Losq, 1985; Kapur and Ravallion, 1988) suggest the same.

Feldman and Kumar (1994), have proposed that the dramatic rise of the stock prices is due to the presence of speculative bubbles, with the volatility in these flows, to a large extent, viewed as a consequence of some investors acting on economic non-fundamentals, reflecting "herd" instincts of the market. It is quite easy to see that prices, which depend on future expectations of themselves, are given to "self-fulfilling prophecies" (see Azariadis, 1980) and therefore are vulnerable to "fads" and other forms of herding (Bikchandani et al., 1992; Froot et al., 1992). However, it is quite difficult to construct bubbles that sustain over a considerable period of time (Tirole, 1982), primarily because they need a large degree of repeated irrational or non-optimal behavior on the part of the market

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1/ See Shiller (1984) for a survey of the issues involved in this area. Summers (1986) provides more recent evidence. DeLong et al. (1990) and Campbell and Kyle (1993) provide some newer explanations to this phenomena. However, despite the diversity of possible explanations it is still an open issue with some degree of consensus over the existence of "excess volatility."

participants. 1/ But, as discussed in the earlier paragraphs, the focus of the study is not on the dramatic increase in the stock prices but on the volatility of these prices. Thus, whether there has been an actual speculative build up or not is a matter left to future research. For our purposes, the above discussion establishes that one cannot attribute the volatility in prices to the volatility in dividends and any explanation of such volatility needs to be imbedded in the context of informationally inefficient markets.

While data has shown that there has been an upsurge, both in the amount of funds as well as in the number of investors in emerging markets, leading to an increase in the price and thereby the market capitalization of these stocks, the increase in the investor base has not in general led to a decrease in the market volatility as traditional theory suggests. The remainder of the paper addresses the issue of whether there is a priori reason to expect market volatility to increase with increases in the investor base.

III. Asset Market Equilibrium with Risk Averse Investors

Most of our understanding of financial markets is based on the premise that the asset market is populated by small, competitive, risk-averse traders. These traders form expectations about the future value (dividends and future price) of the asset based on the information available to them and determine their optimal demand based on this expectation, the volatility of the future value, current asset price and their aversion to risk. In general, the amount of funds to be allocated to a particular asset is positively related to the expected future value and negatively to its riskiness, variability of the price of the asset and the opportunity cost or liquidity need.

Assuming that the supply of stocks is fixed (or not very variable, which is a reasonable assumption to make in the short run), the price of the asset is determined by the aggregate demand for the stock. But the aggregate demand is essentially an aggregation of the information held by individual investors which enters individual demand through the process by which investors form expectations about the future price and dividends of the stock, individual risk aversion and opportunity costs or liquidity needs. Therefore, the price of an asset is simply some form of an aggregation of individual risk, information and liquidity needs of the participants (Hellwig, 1980, Verrechhia, 1982, Admati, 1988). Grossman (1978) has shown that at least for the U.S. stock market, heterogeneity in risk aversion is not important in determining the volatility of stock prices.

1/ Allen and Gorton, 1993, have shown how "churning bubbles" can persist with rational behavior. These bubbles occur when there are asymmetric information between investors and portfolio managers with the managers "churning" their client's portfolio to perform better than the market.

This leaves us with the heterogeneity in information and liquidity. It is easy to see that if investors in a stock market, all have the same information or liquidity needs then the demand and therefore the price of the asset would be extremely volatile. This would occur since all investors would take up the same position (buying or selling) at the same time, consequently, the price would have to vary a lot to clear the market.

The question raised in this paper is what happens if the investor base expands. Traditional theory suggests that this would lead to a decrease in the market volatility. An increase in the investor base would increase the degree of heterogeneity in information and liquidity needs implying that at the aggregate level these would cancel out each other leading to small changes in the aggregate net demand, and therefore to small adjustments in price to clear the market (Grossman and Stiglitz, 1980). But since the flow of funds to the market has also increased simultaneously, the price of the asset would tend to rise along a trend. Therefore, according to the competitive neo-classical paradigm, after the opening of the market stock prices would increase but with reduced volatility.

To pin down these notions, a highly simplified model of the standard neo-classical theory is presented below. The model assumes identical risk aversion among traders to reflect the fact that heterogeneity along this dimension has not been an important factor in explaining volatility in stock prices as refereed to earlier.

Following Grossman and Stiglitz (1980) and Pagano (1989), I assume that the asset market is populated by N investors denoted by i, whose preferences over terminal wealth w_i is given by the mean-variance representation of an exponential (constant absolute risk aversion) utility function

$$U(w) = E(w) - (\frac{\rho}{2})Var(w),$$

where ρ is the coefficient of risk aversion. The risky asset's date 1 value p_1 is a random process x, which follows a normal distribution, $N(0,\sigma_x)$ (the mean has been normalized to zero). Let p be the date 0 price (to be determined by market-clearing) of this asset, q_i the amount purchased, r the date 0 risk-free rate of interest and w_0 the initial wealth. Then the terminal wealth $w_i = x.q_i + r(w_0 - p.q_i)$. While there is a large body of evidence to suggest that information is a central determinant of the volatility of asset prices (Fama 1970, Merton 1987 etc.), some authors have stressed liquidity shocks as having some impact (DeLong et. al. 1989, Tauchen and Pitts 1983, Telser and Higgimbotham 1977 etc.). For expositional purposes, I assume that informational differences are the only ones differentiating investors. Let each investor receive a signal $\theta_i = x + \epsilon_i$.

Where ϵ_i is a normally distributed white noise that follows $N(0,\sigma_\epsilon)$. 1/ Notice that the shock to the signal received is idiosyncratic since ϵ_i is drawn from the same distribution.

Standard utility maximization yields

$$(1) \qquad x_i = \frac{E(x|\theta_i) - p\,r}{\rho\sigma_x^2(\theta_i)}.$$

$E(x|\theta_i)$ is the expected value of x conditional on the signal θ_i and $\sigma_x(\theta_i)$ its conditional standard deviation. Since ϵ_i is drawn from the same distribution, $\sigma_x(\theta_i)$ will be identical for all individuals. Let this be denoted by δ. Using the properties of multivariate normal distribution, $E(x|\theta_i) = \beta(x + \epsilon_i)$, where $\beta = cov(x,\theta_i)/var(\theta_i)$. Let X be the aggregate supply of the asset. Then market clearing requires $\sum_i q_i = X$. Using this condition and rearranging terms, in equilibrium,

$$(2) \qquad p = \frac{1}{r}[\beta\,(x + \sum \frac{\epsilon_i}{N}) - \rho\delta\frac{X}{N}].$$

The above is the familiar pricing rule for one-period assets. One can approximate the pricing rule associated with multi-period assets by letting x, the terminal value in this case, include expectations regarding the next period's price of the asset. Exploiting the linearity of the pricing rule the variance of the price is given by

$$Var(p) = (\frac{\beta}{r})^2(\sigma_x^2 + \frac{\sigma_\epsilon^2}{N} + \frac{\rho^2\delta^2 var(X)}{N^2}).$$

Assuming that the aggregate supply is fixed, i.e., var(X)=0,

$$(3) \qquad Var(p) = (\frac{\beta}{r})^2(\sigma_x^2 + \frac{\sigma_\epsilon^2}{N}).$$

1/ This is a convenient way to introduce differences among investors. Alternatively, one could, with little modification, introduce differentiation based on the liquidity needs of each investor. Qualitatively, the results in this section are invariant to the exact specification of the differences among investors as long as they affect investor trading in an idiosyncratic manner.

Therefore, if the investor base N expands, the volatility of price decreases. This is the standard result connecting the increase in the investor base ("thickness" of the market) with a consequent increase in market liquidity ("depth" of the market) and a reduction in the volatility of price. Going back to Table 2, only Chile displays these characteristics after the opening of the market and the consequent increase in the investor base. The average annual price change increased from 27.27 percent to 36.21 percent while the volatility dropped from 41.52 percent to 25.94 percent increasing the Sharpe ratio from 0.657 to 1.396. None of the other stock markets display this phenomenon.

The problem with the traditional theory is that it relies on the increasing liquidity or "depth" of the market to deliver lower volatility and assumes that an increase in the investor base is equivalent to an increase in the depth of the market, i.e., that a "thick" market is necessarily a "deep" market. Put differently, the argument assumes that the differences in information and liquidity among investors are largely orthogonal to one another or idiosyncratic, such that an increase in the number of traders imply, via some version of the law of large numbers, aggregate changes in liquidity and information that are of much smaller magnitude than changes in individual information or liquidity needs. But what happens if the new investors that enter the market are not from the same population that contained the incumbent investors? In this case, the liquidity needs and information of the new investors might be systematically different from that of the incumbent investors. When markets are opened to foreign investors, the sample of foreign investors that enter the market are drawn from a different population than that of the existing domestic investors. They have different liquidity needs and access to different forms of information and expert systems. Consequently, the addition of these investors instead of adding idiosyncratic or orthogonal differences to the pool of incumbent investors might be adding systematic differences. With the addition of systematic differences, the one-to-one correspondence between increasing investor base and increasing market liquidity or depth is rendered suspect.

IV. Stock Market Equilibrium with Private Information

The traditional approach is less tenable if one looks at the characteristics of the ESMs. Among other things, a feature of these capital markets is that they are characterized by the lack of credible public information regarding returns on assets and consequently information acquisition is costly and remains largely private. This implies that the market is covered by a small number of large investors who are informed alongside possibly large numbers of less informed investors. These large investors frequently take the form of mutual funds or open-ended funds.

Mutual funds, by aggregating the idiosyncracies among their participants have a lower aggregate risk aversion and can therefore take up more aggressive positions in the market than individual investors. In contrast, the standard analytical framework as discussed in the last paragraph assumes the market to be covered by small risk averse traders in which case the riskiness of the asset plays a dominant role in determining the demand for stocks. However, due to the risk neutrality, with the same level of asset riskiness, mutual funds take up larger positions in the stock market than the small risk averse traders. This fact alone would imply that emerging markets would be more volatile than developed asset markets since such markets have a larger proportion of risk averse small investors. The predominance of mutual funds in markets where information gathering is costly also implies that on the average, these funds will have access to private information regarding the return on the asset. The informational advantage follows from the fact that the average cost of acquiring information, i.e., per investor cost, in a mutual fund is considerably lower than that incurred by an investor acting on her own. In particular, the attractiveness of mutual funds is largely rationalized by their ability to produce a lower aggregate risk aversion and lower average information acquisition cost.

Once we allow the existence of mutual funds who have some market power in an environment where information acquisition is costly, the pricing rule needs to be altered to allow for the possibility of strategic manipulation by these large traders and the existence of pure economic rents, so that the informed traders can cover the cost of acquiring information. The following sections describe a market structure with risk-neutral, privately informed, strategic trading.

1. The market

I follow the trading structure used in Kyle (1985) and Kyle and Campbell (1989) as the point of reference in discussing such a pricing rule. Assume that the market is populated by N risk neutral privately informed investors who, by incurring some research cost, observe a signal θ_i about the future value of the asset. Apart from these informed investors the market also has those who are noise traders or liquidity traders. Their aggregate demand for the asset is given by z, which is normally distributed following $N(0,\sigma_z)$. 1/ Furthermore, there are speculators who arbitrage across different assets using the publicly available information. The publicly available information in this market is the volume of aggregate trading activity and the properties of the stochastic processes that underly

1/ The presence of the liquidity trades as in other models prevent the breakdown of the market. However, instead of assuming noise trading one could have introduced a nonmarketable asset among the traders endowments whose return is at least partially correlated with x (see Bhattacharya and Spiegel 1989, Pagano, 1986). In this model like in the original Kyle set up, the liquidity traders provide the profits to the informed traders. Without these traders, arbitrageurs would, in any rational expectations equilibrium, be able to deduce all the private information of the informed traders and thereby set the price correspondingly to eliminate all possible profits.

both x, θ_i and z. Arbitrageurs observe the aggregate order flows and extract information regarding the value of x so as to remove any arbitrage profits. 1/

2. The informed investor's problem

Following Kyle, I assume that the equilibrium price is linear in the aggregate order flow Q+z, where $Q=\sum_i q_i$, is the aggregate purchases of the informed traders and z the amount of liquidity trading. This implies that the equilibrium price is given by $p = \lambda(x + \epsilon_i)$. Given the risk neutrality of the informed trader, his expected profit is given by $E[(x - p).q_i|\Omega_i]$, where Ω_i is his conditioning information. The optimization problem of the trader therefore becomes,

$$(4) \qquad Max\ E[x + \lambda(\sum_{-i} q_j + z)q_i|\Omega_i = x + \epsilon_i].$$

As the price function is assumed to be linear, the optimal purchase orders of the informed trader will also be linear in the conditioning information. Let $q_i = \beta(x + \epsilon_i)$, be the functional form of the optimal orders. Using the first-order condition of the optimization problem, q_i is given by

$$(5) \qquad q_i = \frac{x+\epsilon_i}{2\lambda} + \frac{E[\sum_{-i} q_j|x + \epsilon_i]}{2}.$$

$E[\sum_{-i}q_j|x+\epsilon_i)$ is the ith trader's conjecture about the purchases of the other traders in the market. Rearranging (5) and using standard signal extraction techniques to solve for $E[\sum_{-i}q_j|x+\epsilon_i)$, one gets

$$(6) \qquad E[\sum_{-i} q_j|x + \epsilon_i] = (\frac{n-1}{n+1})\frac{1}{\lambda}(\frac{\sigma_x^2}{\sigma_x^2 + \sigma_\epsilon^2})(x + \epsilon_i)$$

1/ In the original Kyle (1985) model instead of the arbitrageurs there is a market-maker who observes the total order submitted and sets the price such that her expected profits, conditional on the observance of the aggregate orders, is zero. The equilibrium condition that determines the price of the asset is not altered whether a market-maker or arbitrageurs are assumed to eliminate any excess profits based on public information.

where n is the number of traders who participate in the market in equilibrium. For this section of the analysis, n will be taken to be exogenous. This assumption will however, be relaxed in a subsequent section. As assumed previously, the functional form the optimal purchase orders $q_j = \beta(x + \epsilon_i)$. This implies that

$$(7) \qquad E[\sum_{-i} q_j | x + \epsilon_i] = \beta(n - 1)\left(\frac{\sigma_x^2}{\sigma_x^2 + \sigma_\epsilon^2}\right)(x + \epsilon_i).$$

Comparing (6) and (7) one has

$$\beta = \frac{1}{\lambda(n + 1)}, \qquad q_i = \frac{1}{\lambda(n + 1)}(x + \epsilon_i)$$

3. The equilibrium

The only public information which is relevant in this environment is the aggregate demand since, this will contain more information about the terminal value of x than simply the knowledge of the distribution of x. Arbitrageurs therefore, treat the aggregate volume of trading as conveying information regarding the next period value of the asset. Denoting the publicly available information as Ω_p, the equilibrium price is set at the zero-profit condition, 1/ such that

$$(8) \qquad p = E[x|\Omega_p = \beta \sum_i (x + \epsilon_i) + z].$$

Exploiting the properties of multivariate normal distributions one gets,

$$(9a) \qquad \lambda = \frac{n}{1+n}\sqrt{\frac{\sigma_x^2 - \frac{\sigma_\epsilon^2}{n}}{\sigma_z^2}},$$

1/ This condition also ensures that given the structure of the market, the equilibrium price is efficient. For a more detailed analysis see Kyle (1985).

$$(9b) \qquad p = \frac{n}{1+n} x + \frac{\sum_i \epsilon_i}{1+n} + \frac{n}{1+n} \sqrt{\frac{\sigma_x^2 - \frac{\sigma_\epsilon^2}{n}}{\sigma_z^2}}\, z.$$

The argument made so far is based essentially on the recognition that prices convey information through the actions of the participants in the market. In fact, it is this single feature of a market that makes it a successful allocative mechanism. Information enters the price by way of "good" assets being demanded more than "bad" assets. However, this notion of information transfer to prices implicitly assumes that the information is public, symmetric and costless. What happens if the information regarding the actual riskiness of an asset is costly? Under such circumstances large traders will have access to superior information while smaller traders will not, a feature which the model tries to capture in its most stark form. Do prices still convey the privately held information? If indeed prices conveyed all of this information, then there would be no rents to be extracted by the informed traders to pay for the acquisition of this information, and consequently, they would not choose to be informed. In which case prices would be uninformative. This has been the argument put forward to suggest the impossibility of informationally efficient asset markets in the presence of costly information acquisition (Grossman and Stigltz, 1980).

But how do informed traders prevent their privately held information from leaking into the price? It is here that the "non-fundamentals" or "noise" driven trading comes into play. The volatility in capital flow resulting from the noise trading allow informed traders to disguise their trades and by implication their information. In other words, traders speculating on public information (the aggregate orders for an asset or the demand for the asset) or market-makers trying to price an asset based on the response received in "road-shows", are unable to discern whether the particular level of trade is a result of informed trading or simply trading driven by liquidity needs or noise. Consequently, the price does not reflect fully the private information acquired by the informed traders or "smart-money" and therefore these traders are able to make extra profit which is essential if they are to cover their information acquisition costs. If informed trading is discernible from noise trading, then the private information of "smart-money" will be incorporated in the price such that there are no excess profits or rents to be made.

To verify the necessity of noise trading, note that, if σ_z is zero, then λ tends to infinity. Which means, that even the smallest change in the actions of the informed traders is immediately captured in the price of the asset such that, the market essentially breaks down. Alternatively, as will be shown later, the expected profits to an informed trader goes to zero if $\sigma_z = 0$.

Once we accept the necessity of noise/liquidity trading, the next element is to recognize that informed traders, given their market power can through their trades, strategically manipulate the amount of information that gets transmitted through the price. In other words, given a new piece of information regarding the future value of the asset, how aggressively (the value of β) a trader will act upon it will depend on the extent to which the trade is reflected in the price (the conditioning information of the arbitrageurs contains β). If by acting too aggressively more information gets leaked into the price and thereby changing the price to reflect the value of the asset more fully (and reducing the profits of the trader), the informed trader will hold back on the purchase or sell orders for that asset. In other words, each informed trader will act strategically such that the aggregate purchases do not reflect their private information.

Two corollaries follow from this. First, the aggregate demand and therefore price will not reflect fully the information held by the larger market participants. To see this, note that in (9) even if $\sigma_i = 0$, the price of the asset only incompletely reflects private information, x. Second, the larger the level of liquidity trading the more aggressively the informed traders will act on their information. As σ_z increases, λ falls, implying that β, the measure of a traders sensitivity to his private information, increases. Hence, given the behavior of the large traders, the equilibrium price can only be a function of the publicly available information and the amount of noise trading. Consequently, volatility in the price of the asset will be determined by the volatility in the public information, which depends on the rate at which informed investors allow their private information to permeate into their purchase or sell orders. The next section deals with this in greater detail.

4. Market depth and volatility

As discussed in Kyle, λ measures the "depth" or the resilience of the market. The smaller λ is, the deeper the market in the sense that only large variations in the level of activity (due either to movements in the conditioning news θ_i or the level of noise trading) lead to major changes in the price of the asset. Traditional theory, based on competitive risk averse, symmetrically informed, traders, implies a direct link between the number of participants in the market, i.e., market "thinness" and the "depth". An increase in n, by pooling idiosyncratic noise ϵ_i reduces the average level of noise, $\sum_i \epsilon_i/n$, in the price of the asset and consequently, leads to a reduction in the volatility. However, as the next two propositions show this need not be the case.

Proposition 1. *The depth of the market $1/\lambda$ increases with the number of traders, n.*

Proof: Follows directly from differentiating (8).

In particular,

$$(10) \qquad Lim_{n\to 1}\ \lambda = \frac{1}{2}\sqrt{\frac{\sigma_x^2 - \sigma_\epsilon^2}{\sigma_z^2}}\ , \qquad Lim_{n\to\infty}\ \lambda = \sqrt{\frac{\sigma_x^2}{\sigma_z^2}}\ .$$

The reason why market depth decreases with more participation or market "thickness", is because with more informed traders in the market, when arbitrageurs observe a change in aggregate activity, they infer that it is more probable that the fundamentals underlying the asset (in this case x) have changed, rather than the level of liquidity or noise trading z. Consequently, arbitrageurs adjust their holdings of the asset more aggressively, leading to larger changes in the price of the asset.

Furthermore, with an increase in the number of participants, the effect of the noise component $\sum_i \epsilon_i/n$ in λ, moves toward a further reduction in the depth of the market. In particular, as n is increased, idiosyncratic noise is pooled and they cancel out each other. Therefore, arbitrageurs rationally conjecture that changes in the level of trading reflect changes in the fundamentals with a larger probability. The pooling effect has formed the crux of the conventional argument (see Pagano, 1989) which predicts a lower volatility through greater market depth following an increase in the level of participation. However, from (9) it would seem that as n increases, the volatility in the price of the asset would decrease through the term $\sum_i \epsilon_i/(1+n)$. The next proposition shows that this is not the case.

<u>Proposition 2</u>. *The volatility of price σ_p is independent of σ_ϵ and σ_z, for all values of n.*

Proof: Follows directly from computing σ_p using (9). It turns out that,

$$(11) \qquad \sigma_p^2 = 2\left(\frac{n}{1+n}\right)^2 \sigma_x^2.$$

That the level of noise, either in trading or in information received by the traders, has no effect on the volatility of price is an artifact of the informed trading assumed in the model. Informed traders adjust their trades q_i to the depth of the market λ, such that fluctuations in the price of the asset is completely filtered out. If the level of noise is high, arbitrageurs lower the depth of the market and reacting to the lowered depth, informed investors trade more aggressively on the average such that the two effects cancel out each other. From (11) one derives the following proposition.

Proposition 3. *The volatility of price σ_p increases with n.*

What is of interest is that σ_p is bounded by

$$\frac{1}{2}\sigma_x^2 \leq \sigma_p^2 \leq 2\sigma_x^2$$

Consequently, σ_p is only half as volatile as the underlying fundamental shock x when n = 1, and possess at most twice the volatility. While this particular result is due to the linear restriction on pricing rules, in general, in models with informed noncompetitive trading, less information is incorporated in the price since traders do not act as aggressively on their private information, fearing that their trades would reveal their informational advantage. When n is large, aggregate informed trading is more aggressive leading to a higher volatility in the price of the asset. This result is similar to that derived in Gale and Hellwig (1988), who show that if there are informed traders, then despite the fact that their trades might be small relative to that of the market, the market structure does not approximate the competitive system. In a similar vein, Milgrom and Stokey (1982) point out that traders with newer information are never small in a market.

V. Endogenous Entry, Limited Participation, and Excess Volatility

Excess volatility or volatility in asset price over and above that which is consistent with the underlying dividend process seems to be a regular feature of most stock markets. Despite criticism (Merton 1987, West 1988) levied against initial studies (LeRoy and Porter 1981, Shiller 1981) that provided evidence suggesting the presence of excess volatility, later works (Campbell and Shiller 1988, LeRoy and Parke 1992) have shown that the phenomenon still persists even after correcting for the earlier use of inappropriate econometric techniques. In this section, I use the model developed earlier to explain why stock prices might display excess volatility.

In general, financial market studies that have endogenized market participation, assume that entry takes place prior to the realization of the conditioning information. In other words, investors first decide to enter a market, pay an entry cost which enables them to observe some signal regarding the future value of the asset, and then based on this information, the traders take up the appropriate position in the market. Implicit in this assumption, is the idea that all the costs in transacting in the market are upfront costs (research costs for example). In this section, I assume that not only is there a research cost, but also a transaction cost (brokerage fees for example) that needs to be incurred every time a trader participates in the market. In particular, to keep matters simple I assume that the research cost is zero.

Entry costs will imply limited participation in the market, in terms of only a fraction of the investors trading at any point in time. This repeats the results of earlier analyses for example Brennan (1975), King and Leape (1984) etc. Mankiw and Zeldes (1991) show that in the U.S. stock market only a small fraction of households actually hold stocks. However, assuming that the there are transaction costs, not only reinforces the above results but, as will be seen shortly, allows for the possibility of stochastic participation. In other words, in the earlier studies, while participation would be limited, once determined it would also remain constant over the period of analysis as long as the underlying parameters of the environment remain unchanged. Here, the level of participation turns out to be stochastic depending, among other things, on the realization of the conditioning information. It is this randomness, in the level of participation, that will be exploited to generate the excess volatility in the asset price. Note that the variability in the price is limited between $\frac{1}{2}\sigma_x$ and $2\sigma_x$. Therefore, depending on the number of participants, σ_p could be larger than σ_x. However, if the level of participation is rendered random in the way set up in this section, then σ_p in fact is larger than σ_x. To set up the entry problem, assume that each informed investor costlessly observes θ_i, the informing signal. After observing it, he then decides whether to pay a brokerage fee (transaction cost) c(i), and trade in the market or not participate. I shall assume that the informed investors are arranged in such a way that $c(i) > c(i+1)$. In order to determine whether an investor will trade or not, one has to compute the expected net profits from the trade. The expected net profit is given by $E[(x - p)q_i|\Omega_i] - c(i)$. Using the optimal solution for q_i and p from (9) net profit is given by

$$(12) \qquad E[\pi|\Omega_i] = \frac{n - \delta(n - 1)}{\lambda\,(1 + n)^2}\,(p_1 + \epsilon_i)^2 - c(i) \qquad where,\ \delta = \frac{\sigma_\epsilon^2}{\sigma_1^2 + \sigma_\epsilon^2}.$$

However, since the noise in the information ϵ_i has no effect on the volatility of price σ_p (Proposition 2), I simplify the analysis by assuming, for the remainder of the paper, that $\sigma_\epsilon = 0$. Under this simplification net profit is given by

$$(12a) \qquad E[\pi|\Omega_i] = \frac{n}{\lambda\,(1 + n)^2}\,x^2 - c(i).$$

As can be seen from the above expression, expected profit increases with x^2, i.e., if x is either very large or very small, expected profits are higher. Note that the distribution of x was assumed to follow $N(0, \sigma_x)$. If instead the mean of x was non-zero, e.g., $x_0 > 0$, then the expected profit would be given by

$$(13) \qquad E[\pi|\Omega_i] = \frac{n}{\lambda\ (1 + n)^2}\ (x - x_0)^2 - c(i).$$

Therefore, if x is close to its mean x_0, then expected profit is low. Further away x is from x_0 the higher is profits. In other words, since x_0 is public knowledge, a realization of x close to x_0 does not give any significant informational advantage to the informed trader. It is only when the realization of x is far from x_0 ,is there a possibility of extracting excess profit from the informational advantage. Replacing λ with its optimal value $(n/1{+}n)(\sigma^2{}_1/\sigma^2{}_z)^{1/2}$, one derives the expression for expected profit to be 1/

$$(14) \qquad E[\pi|\Omega_i] = \frac{1}{1+n}\sqrt{\frac{\sigma_z^2}{\sigma_x^2}}\ (x - x_0)^2 - c(i).$$

The equilibrium number of investors can now be determined by the highest cost investor for whom net profit is non-negative. Therefore, if n is the equilibrium number of traders in the market then n must solve the marginal entry condition

$$(15) \qquad c(n) \leq \frac{1}{1+n}\sqrt{\frac{\sigma_z^2}{\sigma_x^2}}\ (x - x_0)^2 \leq c(n + 1).$$

Assuming that the discontinuities in c(i) are not binding, the entry condition for the marginal trader is given by

$$(16) \qquad \frac{1}{1 + n}\sqrt{\frac{\sigma_z^2}{\sigma_x^2}}\ (x - x_0)^2 = c(n).$$

Since the LHS of (16) is monotonically decreasing in n, while the RHS strictly increasing, the solution to (16) for any given x is unique. I shall now assume that conditions hold for the applicability of the implicit

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1/ Note that if there is no noise trading, i.e., $\sigma_z = 0$, then $E[\pi|\Omega_i] = 0$ and no informed trader participates. This is the reason why in section 2 it was argued that without noise trading the market would collapse.

function theorem such that, the equilibrium n is given by a continuously differentiable function $\mu(x)$ with the property that μ is strictly increasing in $(x - x_0)^2$.

For analytical ease I revert back to assuming that $x_0 = 0$. In the case where the entry decision is made prior to observing θ_i.e., all transactions cost is taken to be a lump sum entry cost, the equilibrium participation condition modifies to

$$\frac{1}{1+n}\sqrt{\sigma_x^2 \sigma_z^2} = c(n).$$

Therefore, the level of participation will be constant determined by the parameters of the model , σ_x and σ_z. In this situation the price of the asset is given by

$$p = \frac{1}{1+n}\left(x + \sqrt{\frac{\sigma_x^2}{\sigma_z^2}}\, z\right).$$

with n being a function of σ_x and σ_z and not x. For this market

$$Lim_{n\to\infty}\, \sigma_p^2 = Var\left(x + \sqrt{\frac{\sigma_x^2}{\sigma_z^2}}\, z\right)$$

which implies that $\sigma_p^2 \leq 2\sigma_x^2$. Therefore it follows, that if the level of liquidity trading σ_z increases, the depth of the market $1/\lambda$ also increases. But, attracted by the depth of the market more traders enter. This causes the price to fluctuate more, since positions taken by the informed traders as a whole, accentuate the volatility in the conditioning information. Therefore, unlike the single-investor model of Kyle (1985), here even if the decision to enter is taken prior to observing the news, greater liquidity trading does increase the volatility of price.

If as assumed in this section, the decision to enter is taken after the revelation of the conditioning information, then in the equilibrium pricing rule of (9b), n needs to be replaced by $\mu(x)$. This implies that

$$p = \omega(x)(x + \sqrt{\frac{\sigma_x^2}{\sigma_z^2}}\, z), \qquad where,\ \omega(x) = \frac{\mu(x)}{1 + \mu(x)}.$$

A logarithmic transformation of the above yields

$$\log(p) = \log \omega(x) + \log(x + \sqrt{\frac{\sigma_x^2}{\sigma_z^2}}\, z).$$

This implies that,

$$Var(\log p) = Var(\log\omega) + Var(\log(x+\sqrt{\frac{\sigma_x^2}{\sigma_z^2}}\, z)) + Cov(\log\omega,\ \log(x+\sqrt{\frac{\sigma_x^2}{\sigma_z^2}}z)).$$

Since $\omega(x)$ is monotonically increasing in x^2, i.e., whenever the x is larger than its mean value, negatively or positively, $\omega(x)$ is always large and positive, the covariance term is close to zero. Assuming that $cov(\log\omega(x), \log(x + (\sigma^2_x + \sigma^2_z)^{1/2})) \approx 0$, $var(\log p) \approx var(\log\omega(x)) + \log(x + (\sigma^2_x + \sigma^2_z)^{1/2}))$. It therefore follows that even for extremely large n, the variation in price will be larger than in this case than when investors enter the market prior to the realization of θ_i. This is summarized in the next proposition.

Proposition 4. *The volatility of price* $\sigma^2_{log\ p} > \sigma^2_{log\ x}$, *the volatility in the value of the asset.*

Therefore, given any level of the liquidity trade σ_z and fundamental variability σ_x, the price of the asset will be more volatile than that in x. Consequently, the model displays "excess volatility", despite the fact that with informed, strategic trading, each trader acts in such a way that less information is leaked into the price of the asset (Kyle, 1985). When x is large positively, not only does each trader demand more of the asset but also more traders enter the market to buy the asset. This acts to amplify the increase in the price. When x is large negatively, the opposite occurs and the price is pushed down even further. When the stochastic shock is close to its publicly known mean value, there are few market participants and as a result the price remains stable around the mean value of the asset. The crucial element in this argument, is that not only is there limited participation, but the level of participation is itself stochastic and the direction of its movement acts in a way that amplifies changes in the fundamental shock. In this sense, the paper contributes to our understanding of why asset prices display excess volatility (Shiller 1989, DeLong et. al. 1989 etc).

VI. Informational Herding

Recent studies, e.g., Froot et. al. (1992) and Paul (1993), have investigated the problem of information acquisition when there are multiple and disparate stochastic processes underlying the value of the asset. In these studies, due to the costly nature of information acquisition, investors can observe only a subset of the information that drives the value of the asset. It then follows that if the trading horizon is short, i.e., traders have to close their positions, then the different subsets of information act as strategic complements which leads to herding on a particular subset. On the other hand, if traders could keep their positions open, then the pieces of information act as strategic substitutes and all the relevant information is conditioned upon, though different investors condition on different pieces. In this section, it is shown that in a natural extension of the model, even if investors trading horizon was long, i.e., investors could keep their positions open till the terminal value of the asset was realized, the market equilibrium would have features that observationally resemble informational herding.

It is argued that newly entering investors because of their unfamiliarity with the nature of the particular market would usually have shorter trading horizons. Therefore, such markets despite their increased investor base would be susceptible to informational herding which in turn would increase market volatility. The argument continues, that over time, the entering investors would become more familiar with the market and therefore take up more longer positions which would tend to stabilize fluctuations. A corollary to the argument, stresses the usefulness of attracting institutional investors with longer trading horizons, in order to provide price stability in asset markets. As will be shown in this section, it is observationally difficult to distinguish between true informational herding and herding-like behavior. Therefore, at times asset markets might display the apparently paradoxical behavior of having investors with long trading horizons engaging in informational herding.

In this section, instead of single shock driving the terminal value of the asset it is assumed that there are two independent shocks, x and y, underlying it, i.e., $p_1 = x + y$. Like x, y too follows $N(0,\sigma_y)$. Furthermore, it is assumed that observing these shocks is costly such that an investor chooses to observe only one of the processes. It can be shown that all potential participants will choose either x or y and the proportion of investors choosing one over the other will depend on the parameters of the model. Since this decision making is a modification of the one discussed in Paul (1993) it is not rehearsed here. Instead, I shall assume that N and M potential investors have chosen to observe x and y, respectively. Note, that given the transaction cost c(i), not all the investors in either group may actually end up trading. The optimization problem faced by the ith investor who observes x is given by

$$Max\ E[\{x + y - \lambda((n - 1)q_x + mq_y + z)\}q_x^i|\Omega_i = x]$$

where n is the number of type-x and m is the number of type-y investors in the market and q_x and q_y are the purchase orders of the two types. A similar optimization problem is faced by the type-y traders. Solving for the optimal purchase orders and using the fact that in a symmetric equilibrium $q^i_x = q_x$ and $q^i_y = q_y$ one gets,

$$q_x = \frac{x}{\lambda(1 + n)} \quad and \quad q_y = \frac{x}{\lambda(1 + m)}.$$

The equilibrium price is therefore given by,

$$p = E[x + y|\frac{n}{\lambda(1+ n)} + \frac{m}{\lambda(1 + m)} +z].$$

Using the same procedures as in Section 2,

$$\lambda = \frac{1}{(1 + n)(1 + m)}\sqrt{\frac{n(1 + m)^2\sigma_x^2 + m(1 + n)^2\sigma_y^2}{\sigma_z^2}}.$$

Replacing the above expression for λ in the expected profit functions one gets

$$E[\pi_x] = \frac{(1 + m)}{(1 + n)}x^2\sqrt{\frac{\sigma_z^2}{n(1 + m)^2\sigma_x^2 + m(1 + n)^2\sigma_y^2}} - c(n),$$

$$E[\pi_y] = \frac{(1+n)}{(1+m)} y^2 \sqrt{\frac{\sigma_y^2}{n(1+m)^2\sigma_x^2 + m(1+n)^2\sigma_y^2}} - c(m).$$

The equilibrium levels of participation n(x,y) and m(x,y) are jointly determined by the solution to $E[\pi_x] = 0$ and $E[\pi_y] = 0$. The equilibrium levels of n and m display the same properties as $\mu(x)$ in Section 2. What is of interest is that, depending on the realizations of x and y, participation in the market might be limited to only one type of investor. Therefore, the market will not aggregate information in an efficient manner (for more discussion on aggregation of information see Grossman and Stiglitz 1980, Hellwig 1980 etc.). For example assume,

$$(17) \qquad \frac{x^2}{(1+n)} \sqrt{\frac{\sigma_z^2}{n\sigma_x^2}} > (1+n)c(1) \quad and \quad (1+n)y^2 \sqrt{\frac{\sigma_z^2}{n\sigma_x^2}} < c(1).$$

In this case in equilibrium, m = 0 and n > 0. In other words, for all values of (x,y) such that the above conditions are met, all investors participating in the market will condition on x. All type-y investors will be absent. An observer of the market could then conclude that all the participants in the market are herding on the news about the expected realization of x and ignoring y altogether. Such a situation occurs if realizations of x^2 are large while that of y^2 are low. Here, unlike in the situation described in Froot et. al. (1992), investors can keep their positions open until the terminal value of the asset is realized. However, since investors are allowed the option of not participating in the market after observing the realization of the signal of their choice, for certain realizations of the stochastic processes, only those who observe a particular piece of information trade in the market. Therefore, in this model, herding-like behavior occurs that is not driven by fads or fashions (Bikchandani et. al. 1989) or by rational traders betting against sentiments of noise traders (DeLong et. al. 1989).

If condition (17) is reversed then in equilibrium n = 0 and m > 0, making it appear as if the herding is now on y. Consequently, there would be stochastic shifts in the information on which herding occurs and as a result sentiments in the market would seem to sway from one extreme to another.

VII. Conclusion

As a reaction to the perceived increase in the volatility of foreign portfolio flows, some economies have taken up measures that are intended to keep small liquidity traders out of the market by increasing the transaction costs by requiring a minimum time period before capital inflows can be withdrawn. However, if mutual funds or large informed traders dominate stock markets then as discussed earlier a reduction in the volatility of noise trading can actually reduce the flow of funds from the larger traders. This occurs because such capital controls discourages the small liquidity traders from entering these markets. Consequently, the market becomes too transparent for the large traders to participate, since their trades in a thin market would be easily discernible in the public information. This would allow the price of the asset to reflect the private information and thereby reduce the capital gains of the large traders.

In other words, controls that discourage small traders and reduce the volatility in the price also reduce the trades of the large traders who supply most of the funds in the market. In some sense therefore, as long as there are large traders dominating the market there is a trade-off between reduced volatility and a large capital flows.

Unlike competitive models where entry of traders, due to the pooling of their idiosyncratic differences, reduces the volatility of the price of the asset, in the case of markets where investors behave strategically, expansion of the investor base amplifies the variability. Since informed traders strategically release their information in the market, and there are only random differences in the conditioning information of investors, the market is akin to one populated by investors with identical information. Therefore, when the number of investors increase, price has to change by larger margins to equilibrate the market. In terms of the structure of the model, an increase in the number of traders signals to the arbitrageurs that the probability of a change in aggregate activity reflects changes in the fundamentals is higher. In reaction, the arbitrageurs reduce the "depth" of the market which results in greater volatility.

Exploiting this correspondence between volatility and the size of the investor base, it was shown that with endogenized entry, the market does in fact display "excess volatility." While no attempt is made to quantify this, it adds to our understanding of why markets display excess volatility.

In a slightly modified environment, the market displays behavior which is indistinguishable from informational herding. This is in sharp contrast to previous studies where a key feature that allowed for the possibility of herding was the short trading horizon of traders. In this model, all the traders could keep open their positions until the terminal value of the asset is realized.

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