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ABSTRACT

This paper summarizes our earlier research documenting the characteristic speculative dynamics of many asset markets and suggests a framework for understanding them. Our model incorporates "feedback traders," traders whose demand is based on the history of past returns rather than the expectation of future fundamentals. We use this framework to describe ways in which the characteristic return patterns might be generated, and also to address the long-standing question of whether profitable speculation stabilizes asset markets.

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The 1987 stock market crash demonstrated more convincingly than any econometric test ever could that not all movements in asset prices can be accounted for by news about fundamental values. The efficient markets hypothesis was probably the right place for serious research on asset valuation to begin, but it may be the wrong place for it to end. In this paper, we review some of our research directed at providing an alternative framework for thinking about fluctuations in speculative prices.

As proponents of the efficient markets hypothesis stress, repeated analysis of the single time series on U.S. stock returns is bound to turn up patterns sooner or later. Our research has therefore sought to determine whether there are regularities that appear not just in U.S. equity returns, but also in returns in other countries' stock markets, and in other assets. Given that risk factors are likely to operate differently in different markets, finding common patterns across markets suggests the need for consideration of the speculative process itself.

After summarizing our earlier research documenting the characteristic speculative dynamics of many asset markets, we go on to suggest a framework for understanding them. Our model incorporates "feedback traders," traders whose demand is based on the history of past returns rather than the expectation of future fundamentals. We use this framework to describe ways in which the characteristic return patterns might be generated, and also

to address the long-standing question of whether profitable speculation stabilizes asset markets.[1]

I. Characteristic Speculative Dynamics

Table 1, which is drawn from Cutler, Poterba and Summers (1990), where the results are described in much greater detail, provides summary evidence on three empirical regularities in the markets for stocks, bonds, foreign exchange, and various real assets. First, excess returns display positive autocorrelation at relatively short horizons. Both the one-month return autocorrelation (column 2) and the average of the first twelve monthly autocorrelations (column 3) are positive and statistically significant. The average one-month serial correlation coefficient for the thirteen equity markets we consider exceeds .10, and bond markets exhibit even greater autocorrelation.

Second, there is a weak tendency for returns to be negatively autocorrelated at durations of several years. The average autocorrelations at 13-24 months (column 4) are negative for stocks, bonds, and foreign exchange, although the latter finding is not statistically significant.

Many technical trading systems are designed to take advantage of exactly the sort of serial correlation patterns suggested here. It can be shown, for example, that procedures which involve using the crossing of two moving averages as a trading

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[1]Our discussion of destabilizing speculation is largely derivative of DeLong, Shleifer, Summers, and Waldmann (1990).

Table 1: Properties of Asset Excess Returns

Asset	Autocorrelation Horizon (Months) 1	1-12	13-24	Percent Reversion t Fundamental Within Four Years
Equities (1960-88, 13 markets)	.101 (.026)	.021 (.006)	-.026 (.008)	41.20 (27.48)
Bonds (1960-88, 13 markets)	.238 (.041)	.064 (.011)	-.013 (.005)	-10.21 (17.08)
Ex. Rates (1974-88, 10 markets)	.067 (.037)	.033 (.012)	-.010 (.012)	31.92 (18.43)
Gold (1974-88)	.020 (.075)	.051 (.022)	.017 (.023)	133.19 (20.98)
Houses (1970-86, 4 cities)	---	.206 (.032)	.083 (.033)	---
Collectibles (1968-88, 7 markets)	---	.365 (.160)	.011 (.153)	---

The excess returns on all assets are measured as nominal returns less the short term interest rate. These returns are monthly for all assets except houses (quarterly) and collectibles (annual). For all assets except gold, the standard errors in parentheses correspond to the standard error of the average autocorrelation across markets. The regression coefficient in the last column is the result of estimating an equation for 48-month returns using the logarithm of the ratio of fundamental value to the current asset price as the explanatory variable. The fundamentals are defined for each asset in the text. The values in brackets are the probability of observing regression coefficients at least as positive as the reported value. These p values are based on Monte Carlo simulations described in detail in Cutler, Poterba and Summers (1990).

signal are optimal if autocorrelations are at first positive and then negative.

Third, in most cases, returns over periods of several years can be predicted on the basis of crude proxies for the deviation of asset prices from fundamental value. For each market, we defined a proxy "fundamental value": a constant multiple of dividends in the case of stocks, the reciprocal of the short-term interest rate for bonds, and a constant real exchange rate and real gold price. The last column reports regression coefficients from equations relating subsequent forty-eight month excess returns to the logarithm of the current fundamental-price ratio. In the markets for equities and gold, and to a lesser extent foreign exchange, these measures have substantial forecast power for returns. The result for equities suggests that forty percent of the deviation between price and our fundamental value measure is eliminated within forty-eight months. Similar evidence for house prices is presented by Karl Case and Robert Shiller (1989), who show that the real cpaital gain on houses can be forecast using lagged values of the rental-to-price ratio. They also show that over horizons longer than those in Table 1, the real cpaital gains on houses exhibit negative serial correlation.

Changing risk factors have thus far been unable to explain these characteristic patterns of asset returns. For several reasons, we suspect that theories focusing on the dynamics of speculation will be more successful. First, the pattern of correlations is similar in markets where risk might be expected

to operate very differently, for example the bond and stock markets. Indeed, in the foreign exchange market, risk affects both currencies and thus has no predictable effect on exchange rate levels.

Second, qualitative discussions of major movements in speculative prices, for example Charles Kindleberger (1978) or Elliot Montrell and Wade Badger (1974), focus on the interaction between traders who extrapolate past price increases and traders whose expectations are formed on the basis of fundamentals. We suspect that such accounts may also explain more recent movements in asset prices. In the summer of 1987, for example, stock prices were near record highs relative to dividends or earnings. Although this could be attributed to investor perceptions that equities were safer than they had been in the past, a more plausible account is taht investor demand for equities was fueled by expected large capital gains from a continuing bull market.

Third, Poterba and Summers (1988) show that for specifications of the equity risk process which are consistent with empirical findings on volatility, increases in risk which raise future required returns should reduce current returns, thus leading to negative autocorrelation at high frequencies. John Campbell and Robert Shiller (1989) also show that there is little evidence that fluctuations in the price-dividend ratio forecast increases in real interest rates or other measurable aspects of risk.

II. Modelling Speculative Dynamics

This section develops a model of asset price dynamics when investors follow heterogeneous trading strategies. The importance of investor differences is clear from the substantial volume in modern securities markets, far more than would be expected if all investors held market portfolios and traded only to rebalance or finance consumption outlays. On the New York Stock Exchange, for example, almost 75 percent of the shares trade hands each year (New York Stock Exchange (1988)), and it is estimated that almost $400 billion of foreign currency is traded each day.

We consider a futures market, where there is a well-defined fundamental equal to the terminal value but where there are no dividend payments. We also assume that the asset is in zero net supply.

We postulate three types of traders. The first group invest on the basis of rational forecasts of future returns, holding a higher fraction of the speculative asset when expected returns are high:

$$(1) \qquad s_{1,t} = \gamma(E_t R_{t+1} - \rho); \qquad \gamma>0,$$

where R_t is the ex post return in period t, E_t is the expectation operator using information available as of time t, and ρ is the required return on the risky asset. For sufficiently large γ, this model reduces to the traditional constant required return model of asset pricing.

The second class of investors, fundamentals traders, base expected returns on prices relative to perceived fundamentals. When prices are high relative to perceived fundamentals, their demand is low. If the logarithm of the price and (true) fundamental value are respectively p_t and f_t, demand is:

$$s_{2,t} = \beta(p_t - \alpha(L)f_t); \qquad \beta<0; \quad \alpha(1)=1. \tag{2}$$

Such behavior is implied by investment strategies such as those based on "dividend discount models." We assume that the logarithm of the fundamental evolves as a random walk: $f_t = f_{t-1} + \epsilon_t$. We allow for the possibility that perceived fundamentals reflect true fundamentals with a lag, i.e., that $\alpha(L)$ does not equal unity. If some traders have quicker access to information than others, in any period only some of the traders will know the current state of fundamentals.

Finally, feedback traders base demand on past returns:

$$s_{3,t} = \delta(L)(R_t - \rho) \tag{3}$$

where $\delta(L)$ is an arbitrary lag polynomial. Positive feedback trading, buying after price increases, could result from the use of stop loss orders, from portfolio insurance, from a positive wealth elasticity of demand for risky assets, or from margin call-induced selling after periods of low returns. It could also result from technical analysis models designed to catch incipient trends. Negative feedback trading, buying after price declines, could result from "profit taking" as markets rise, or from

investment rules that target a constant share of wealth in different assets.

Asset market equilibrium requires:

$$(4) \qquad s_{1,t} + s_{2,t} + s_{3,t} = 0.$$

Assuming a constant required return (ρ) of zero, this yields a rational expectations difference equation for the asset price:

$$(5) \qquad E_t(p_{t+1} - p_t) = -\beta(p_t - \alpha(L)f_t)/\gamma - \delta(L)(p_t - p_{t-1})/\gamma.$$

Solving this equation gives the asset price as a function of past prices, expected future fundamentals, and past fundamentals. The pricing function also displays the property that fundamental innovations (ϵ_t) are ultimately fully reflected in prices.

III. Explaining the Stylized Facts

This model can generate positive serial correlation in returns in any of three ways. First, if fundamentals traders learn about true fundamentals with a lag ($\alpha(L)\neq 1$), then fundamentals perceived by these traders will differ from those perceived (correctly) by the rational traders. With no feedback traders ($\delta(L)=0$), this implies that following positive news, the rational traders will drive the price above perceived fundamentals of the fundamentals traders ($\alpha(L)f_t$) but below the true fundamental (f_t). The expected capital gain to the rational traders when news is ultimately incorporated in prices is just enough to induce them to hold a long position opposite the fundamentals

traders. As the information is incorporated, the fundamentals traders will purchase assets held by the rational traders. Returns will therefore be positively serially correlated for as many periods as it takes for the information to be incorporated in demand.

Negative feedback traders ($\delta(L)<0$) are a second potential source of positive autocorrelation. Consider the market without fundamentals traders ($\beta=0$) and with one period negative feedback traders ($\delta_1<0$). Positive returns associated with favorable shocks to fundamentals reduce asset demand from negative feedback investors. Rational investors must take offsetting long positions, so expected returns to these investors must rise. On average, subsequent returns will therefore be higher, and returns will be positively serially correlated. The higher returns will show up as capital gains on the asset so that, as with the earlier case, the initial price reaction to the news will be incomplete. Negative feedback trading by central banks "leaning into the wind" to delay the incorporation of news into exchange rates has been advanced as a possible explanation for positive autocorrelation in currency returns.

Finally, positive autocorrelation can result from the presence of feedback traders who respond to returns in several previous periods. If excess returns in one period affect feedback trader demand in many subsequent periods, feedback traders will persistently demand long or short positions. Required returns for rational investors will therefore be above or below

average for several periods, and this pattern will be reflected in positively correlated ex-post returns. The precise autocorrelation properties generated by this market depend both on the nature of the feedback demand and on the speed with which fundamentals traders incorporate news about fundamentals into demand. Even without fundamentals traders, however, slowly-adjusting positive feedback traders can induce positive autocorrelation of returns.

This third scenario, feedback traders with long memories, can generate negative autocorrelation at longer horizons as well as short run positive autocorrelation. With enough positive feedback demand, prices will over-react to fundamental news. In the long run, however, prices must change by only the amount of the fundamental shock. This implies that returns must be negatively serially correlated over some horizons.

IV. Can Profitable Speculation Lead to Instability?

Models with heterogeneous traders can be used to study a variety of issues concerning the performance of asset markets. We illustrate this by examining the effects of speculation on price stability. The traditional view, presented for example by Milton Friedman (1953), holds that profitable speculation -- buying when prices are low and selling when they are high -- will offset other market shocks and thereby stabilize prices. DeLong, Shleifer, Summers, and Waldmann (1990), however, show that this view may be incorrect when some market participants

engage in feedback trading. They present a stylized model in which profitable speculation can raise the variance of returns relative to the variance of shocks to fundamental values.

The framework developed above can be used to illustrate this point. Table 2 presents the results of numerical solutions of the autocorrelations, the variance of returns, and the variance of the fundamental-price deviation for the following special case of the model described above:

$$(6) \quad s_{1,t} = E_t p_{t+1} - p_t$$

$$(7) \quad s_{2,t} = -.25(p_t - .75f_t - .25f_{t-1})$$

$$(8) \quad s_{3,t} = .05(p_t - p_{t-1}) + .05(p_{t-1} - p_{t-2}) + .05(p_{t-2} - p_{t-3}).$$

As Table 2 shows, returns exhibit positive first-order autocorrelation, but are negatively serially correlated at two and three lags.

For this case, a speculator following a positive-feedback investment rule over short horizons would earn profits. Table 2 shows that while an increase in this type of speculation (an increase in δ_1) reduces the seriall correlation in returns, it raises their variability. In this example, prices initially undershoot changes in fundamentals. An increase in the importance of short horizon feedback trading brings prices closer to fundamentals, but also increases feedback demand in subsequent periods. This increases the variance of returns as well as the

Table 2: An Example of Destabilizing Speculation

Summary Statistic	Base Case	Properties After Increasing γ	δ_1	α
Autocorrelations				
Lag 1	.0220	.0196	.0137	.0200
Lag 2	-.0347	-.0324	-.0343	-.0346
Lag 3	-.0405	-.0374	-.0401	-.0405
Variance of Returns	1.106	1.100	1.124	1.110
Variance of Price Around Fundamental	.0092	.0081	.0100	.0094

The table shows numerical solutions of the three-equation model in (6)-(8). The last three columns increase the indicated parameters by .10 (for γ) and .01 (for δ_1 and α). The variance of returns and the variance of the deviation between price and fundamental value are scaled by the variance of fundamental innovations.

variance of prices around fundamentals. Profitable speculation is therefore destabilizing.

Table 2 also reports comparative static results for two other parameter changes. An increase in γ, which raises the responsiveness of rational traders to changes in expected returns, moves all autocorrelations toward zero and reduces the variance of returns and the variance of prices around fundamentals. Raising α_1, the speed with which fundamentals traders incorporate information into prices, also reduces the autocorrelations but destabilizes prices for reasons similar to those above.

V. Conclusion

Our analysis of how feedback traders affect asset returns assumes that investors do not learn from past experience. A more realistic model would allow trading rules to change in response to factors such as the recent success of different portfolio strategies or, as in Robert Barsky and DeLong (1989), new information about the stochastic process of dividends or prices. For example, if investors inferred from the pre-war experience that stock prices were negatively serially correlated at long horizons, and so rushed to purchase at troughs and to sell at peaks, they would reduce this serial correlation. Such adaptive trading rules would generate time-varying properties for asset returns and may provide a partial explanation for the finding, emphasized by Myung Kim, Charles Nelson, and Richard Startz (1989), that the

negative serial correlation in long-horizon U.S. stock returns is more pronounced prior to World War II than in the subsequent period.

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