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From Efficient Markets Theory to Behavioral Finance

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Academic finance has evolved a long way from the days when the efficient markets theory was widely considered to be proved beyond doubt. Behavioral finance—that is, finance from a broader social science perspective including psychology and sociology—is now one of the most vital research programs, and it stands in sharp contradiction to much of efficient markets theory.

The efficient markets theory reached its height of dominance in academic circles around the 1970s. At that time, the rational expectations revolution in economic theory was in its first blush of enthusiasm, a fresh new idea that occupied the center of attention. The idea that speculative asset prices such as stock prices always incorporate the best information about fundamental values and that prices change only because of good, sensible information meshed very well with theoretical trends of the time. Prominent finance models of the 1970s related speculative asset prices to economic fundamentals, using rational expectations to tie together finance and the entire economy in one elegant theory. For example, Robert Merton published "An Intertemporal Capital Asset Pricing Model" in 1973, which showed how to generalize the capital asset pricing model to a comprehensive intertemporal general equilibrium model. Robert Lucas published "Asset Prices in an Exchange Economy" in 1978, which showed that in a rational expectations general equilibrium, rational asset prices may have a forecastable element that is related to the forecastability of consumption. Douglas Breeden published his theory of "consumption betas" in 1979, where a stock's beta (which measures the sensitivity of its return compared to some index) was determined by the correlation

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of the stock's return with per capita consumption. These were exciting theoretical advances at the time. In 1973, the first edition of Burton Malkiel's acclaimed book, *A Random Walk Down Wall Street,* appeared, which conveyed this excitement to a wider audience.

In the decade of the 1970s, I was a graduate student writing a Ph.D. dissertation on rational expectations models and an assistant and associate professor, and I was mostly caught up in the excitement of the time. One could easily wish that these models were true descriptions of the world around us, for it would then be a wonderful advance for our profession. We would have powerful tools to study and to quantify the financial world around us.

Wishful thinking can dominate much of the work of a profession for a decade, but not indefinitely. The 1970s already saw the beginnings of some disquiet over these models and a tendency to push them somewhat aside in favor of a more eclectic way of thinking about financial markets and the economy. Browsing today again through finance journals from the 1970s, one sees some beginnings of reports of anomalies that didn't seem likely to square with the efficient markets theory, even if they were not presented as significant evidence against the theory. For example, Eugene Fama's 1970 article, "Efficient Capital Markets: A Review of Empirical Work," while highly enthusiastic in its conclusions for market efficiency, did report some anomalies like slight serial dependencies in stock market returns, though with the tone of pointing out how small the anomalies were.

The 1980s and Excess Volatility

From my perspective, the 1980s were a time of important academic discussion of the consistency of the efficient markets model for the aggregate stock market with econometric evidence about the time series properties of prices, dividends and earnings. Of particular concern was whether these stocks show excess volatility relative to what would be predicted by the efficient markets model.

The anomalies that had been discovered might be considered at worst small departures from the fundamental truth of market efficiency, but if most of the volatility in the stock market was unexplained, it would call into question the basic underpinnings of the entire efficient markets theory. The anomaly represented by the notion of excess volatility seems to be much more troubling for efficiency markets theory than some other financial anomalies, such as the January effect or the day-of-the-week effect.[1] The volatility anomaly is much deeper than those represented by price stickiness or *tatonnement* or even by exchange-rate overshooting. The evidence regarding excess volatility seems, to some observers at least, to imply that changes in prices occur for no fundamental reason at all, that they occur because of such things as "sunspots" or "animal spirits" or just mass psychology.

The efficient markets model can be stated as asserting that the price P_t of a

[1] A good discussion of the major anomalies, and the evidence for them, is in Siegel (2002).

share (or of a portfolio of shares representing an index) equals the mathematical expectation, conditional on all information available at the time, of the present value P_t^* of actual subsequent dividends accruing to that share (or portfolio of shares). P_t^* is not known at time t and has to be forecasted. Efficient markets say that price equals the optimal forecast of it.

Different forms of the efficient markets model differ in the choice of the discount rate in the present value, but the general efficient markets model can be written just as $P_t = E_t P_t^*$, where E_t refers to mathematical expectation conditional on public information available at time t. This equation asserts that any surprising movements in the stock market must have at their origin some new information about the fundamental value P_t^*.

It follows from the efficient markets model that $P_t^* = P_t + U_t$, where U_t is a forecast error. The forecast error U_t must be uncorrelated with any information variable available at time t, otherwise the forecast would not be optimal; it would not be taking into account all information. Since the price P_t itself is information at time t, P_t and U_t must be uncorrelated with each other. Since the variance of the sum of two uncorrelated variables is the sum of their variances, it follows that the variance of P_t^* must equal the variance of P_t plus the variance of U_t, and hence, since the variance of U_t cannot be negative, that the variance of P_t^* must be greater than or equal to that of P_t.

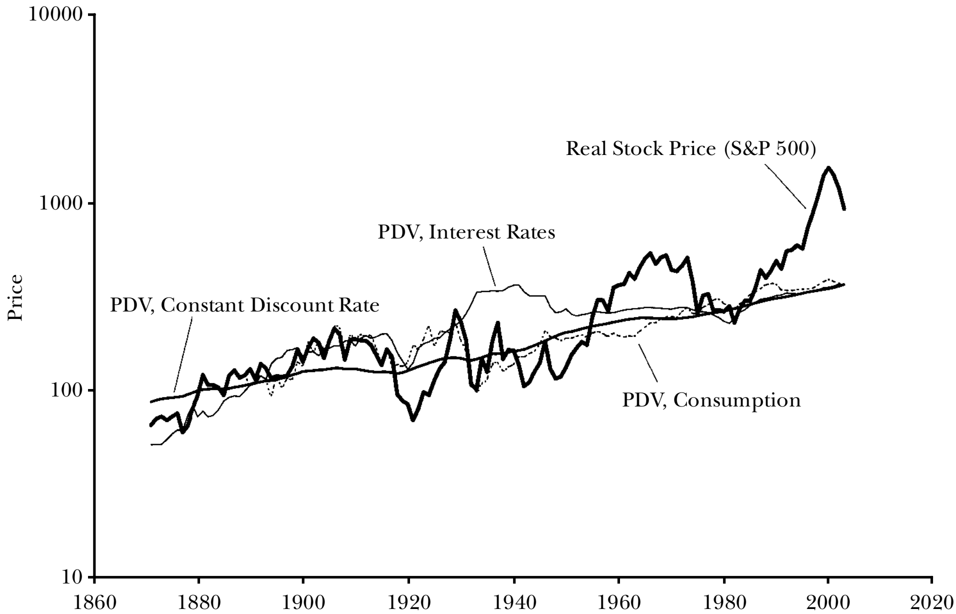
Thus, the fundamental principle of optimal forecasting is that the forecast must be less variable than the variable forecasted. Any forecaster whose forecast consistently varies through time more than the variable forecasted is making a serious error, because then high forecasts would themselves tend to indicate forecast positive errors, and low forecasts indicate negative errors. The maximum possible variance of the forecast is the variance of the variable forecasted, and this can occur only if the forecaster has perfect foresight and the forecasts correlate perfectly with the variable forecasted.

If one computes for each year since 1871 the present value subsequent to that year of the real dividends paid on the Standard & Poor's Composite Stock Price Index, discounted by a constant real discount rate equal to the geometric average real return 1871–2002 on the same Standard & Poor Index, one finds that the present value, if plotted through time, behaves remarkably like a stable trend.[2] In contrast, the Standard & Poor's Composite Stock Price Index gyrates wildly up and down around this trend. Figure 1 illustrates these patterns.

How, then, can we take it as received doctrine that, according to the simplest efficient markets theory, the stock price represents the optimal forecast of this present value, the price responding only to objective information about it? I argued in Shiller (1981), as did also Stephen LeRoy and Richard Porter (1981), that the stability of the present value through time suggests that there is excess volatility in

[2] The present value, constant discount rate, is computed for each year t as $p^*_{const,t} = \Sigma_{\tau=t+1}^{\infty} \rho^{(\tau-t)} D_\tau$, where ρ is a constant discount factor, and D_t is the real dividend at time t. An assumption was made about real dividends after 2002. See note to Figure 1.

Figure 1
Real Stock Prices and Present Values of Subsequent Real Dividends
(*annual data*)



Notes: The heaviest line is the Standard & Poor 500 Index for January of year shown. The less-heavy line is the present value for each year of subsequent real dividends accruing to the index discounted by the geometric-average real return for the entire sample, 6.61 percent. Dividends after 2002 were assumed equal to the 2002 dividend times 1.25 (to correct for recent lower dividend payout) and growing at the geometric-average historical growth rate for dividends, 1.11 percent. The thin line is the present value for each year of subsequent real dividends discounted by one-year interest rates plus a risk premium equal to the geometric average real return on the market minus the geometric average real one-year interest rate. The dashed line is the present value for each year of subsequent real dividends discounted by marginal rates of substitution in consumption for a representative individual with a coefficient of relative risk aversion of 3 who consumes the real *per capita* nondurable and service consumption from the U. S. National Income and Product Accounts. Real values were computed from nominal values by dividing by the consumer price index (CPI-U since 1913, linked to the Warren and Pearson producer price index before 1913) and rescaling to January 2003 = 100. Some of the very latest observations of underlying series were estimated based on data available as of this writing; for example, the consumer price index for January 2003 was estimated based on data from previous months. Source data are available on ⟨http://www.econ.yale.edu/~shiller⟩, and the further descriptions of some of the data are in Shiller (1989). See also footnotes 1, 5 and 6.

the aggregate stock market, relative to the present value implied by the efficient markets model. Our work launched a remarkable amount of controversy, from which I will recall here just a few highlights.

The principal issue regarding our original work on excess volatility was in regard to thinking about the stationarity of dividends and stock prices. My own work in the early 1980s had followed a tradition in the finance literature of assuming that dividends fluctuated around a known trend.[3] However, one might also argue, as do Marsh and Merton (1986), that dividends need not stay close to a trend and that even if earnings followed a trend, share issuance or repurchase could make dividends depart from a trend indefinitely. In addition, if business managers use dividends to provide a smoothed flow of payouts from their businesses, then the stock prices might be expected to shift more rapidly than dividends. Marsh and Merton argued that such dividend smoothing could make stock prices unstationary in such a way that in finite samples prices appear more volatile than the present values.

Thus, the challenge became how to construct a test for expected volatility that modeled dividends and stock prices in a more general way. As such tests were developed, they tended to confirm the overall hypothesis that stock prices had more volatility than an efficient markets hypothesis could explain. For example, West (1988) derived an inequality that the variance of *innovations* (that is, surprises) in stock prices must be less than or equal to the variance of the *innovations* in the forecasted present value of dividends based on a subset of information available to the market. This inequality is quite general: it holds even when dividends and stock prices have infinite variances so long as the variance of the innovation (the unexpected change) in these is finite. Using long-term annual data on stock prices, West found that the variance of innovations in stock prices was four to 20 times its theoretical upper bound.[4] John Campbell and I (1988) recast the time series model in terms of a cointegrated model of real prices and real dividends, while also relaxing other assumptions about the time series, and again found evidence of excess volatility.[5] Campbell (1991) provided a variance decomposition for stock returns that indicated that most of the variability of the aggregate stock market conveyed information about future returns, rather than about future dividends.

Another contested issue regarding the early work on excess volatility questioned the assumption of the early work that the efficient markets model was best conveyed through an expected present value model in which the real discount rate is constant through time. The assumption of a constant discount rate over time can only be considered a first step, for the theory suggests more complex relationships.

[3] It should be pointed out that dividend payouts as a fraction of earnings have shown a gradual downtrend over the period since 1871 and that dividend payouts have increasingly been substituted by share repurchases. Net share repurchases reached approximately 1 percent of shares outstanding by the late 1990s. However, share repurchases do not invalidate the theoretical model that stock prices should equal the present value of dividends. See Cole, Helwege and Laster (1996).

[4] In more technical terms, this argument is over whether dividends could be viewed as a stationary series. The discussion was often phrased in terms of the "unit root" property of the time series, where a unit root refers to notion that when a variable is regressed on its own lags, the characteristic equation of the difference equation has a root on the unit circle. West (1988) can be viewed as a way of addressing the unit root issue. In our 1988 paper, Campbell and I handled nonstationarity by using a vector autoregressive model including the log dividend-price ratio and the change in log dividends as elements.

[5] Barsky and De Long (1993), however, later showed that if one assumes that real dividends must be *twice* differenced to induce stationarity (so that dividends are even more unstationary in the sense that dividend *growth rates*, not just levels, are unstationary), then the efficient markets model looks rather more consistent with the data.

One such efficient markets model makes the discount rate correspond to interest rates. The line in Figure 1 labeled "PDV, Interest Rates" illustrates this concept.[6] However, allowing time-varying interest rates in the present value formula does little to support the efficient markets model. The actual price is still more volatile than the present value, especially for the latest half century. Moreover, what changes through time there are in the present value bear little resemblance to the changes through time in the stock prices. Note for example that the present value is extremely high throughout the depression years of the 1930s, not low as was the actual stock market. The present value is high then because real interest rates were at extreme lows after 1933, into the early 1950s, and since real dividends really did not fall much after 1929. After 1929, real Standard & Poor's dividends fell to around 1925 levels for just a few years, 1933–1935 and 1938, but, contrary to popular impressions, were generally higher in the 1930s than they were in the 1920s.[7]

An alternative approach to the possibility of varying real discount rates looks at the intertemporal marginal rate of substitution for consumption, which is shown in Figure 1 with the line labeled "PDV, Consumption."[8] The models of efficient financial markets from the 1970s like Merton (1973), Lucas (1978) and Breeden (1979) concluded that stock prices are the expected present value of future dividends discounted using marginal rates of substitution of consumption, and in these models the equations for stock returns were derived in the context of a model maximizing the utility of consumption. Grossman and Shiller (1981) produced a plot of that present value since 1881, using Standard & Poor dividend data and using aggregate consumption data to compute the marginal rates of substitution as discount factors, and this plot is updated here, and this is what is shown in Figure 1. We

[6] The present value, discounted by interest rates, is a plot for each year t of

$$P^*_{r,t} = \sum_{\tau=t}^{2002} \prod_{j=0}^{\tau} 1/(1 + r_{t+j} + \phi) D_\tau + \prod_{j=t}^{2002} 1/(1 + r_{t+j} + \phi) P^*_{const,2003}.$$

See note to Figure 1.

[7] Campbell and I (1989) recast the argument in terms of a vector autoregressive model of real stock prices, real interest rates and real dividends, in which each of these variables was regressed on lags of itself and lags of the other variables. We found that the dividend-price ratio not only shows excess volatility, but shows very little correlation with the dividend divided by the forecast of the present value of future dividends.

[8] The present value, consumption discounted, is a plot for each year t of

$$P^*_{c,t} = \sum_{\tau=t+1}^{2002} (C_t/C_\tau)^3 D_\tau + (C_t/C_{2003})^3 P^*_{const,2003},$$

where C_t is real *per capita* real consumption at time t. This expression is inspired by Lucas (1978) and derived in Grossman and Shiller (1981) assuming a coefficient of relative risk aversion of 3. See note to Figure 1.

found, as can also be seen here in Figure 1, that the present value of dividends as discounted in this model had only a tenuous relation to actual stock prices, and did not appear volatile enough to justify the price movements unless we pushed the coefficient of relative risk aversion to ridiculously high levels, higher than the value of three that was used for the plot.

Grossman and Shiller (1981) stressed that there were some similarities between the present value and the actual real price, notably the present value peaks in 1929 and bottoms out in 1933, close to the actual peak and trough of the market. But the present value does this because consumption peaked in 1929 and then dropped very sharply, bottoming out in 1933, and the present value takes account of this, as if people had perfect foresight of the coming depression. But in fact it appears very unlikely that people saw this outcome in 1929, and if they did not, then the efficient model does not predict that the actual real price should have tracked the present value over this period.

Actually, the consumption discount model, while it may show some comovements at times with actual stock prices, does not work well because it does not justify the volatility of stock prices. I showed (1982) that the theoretical model implies a lower bound on the volatility of the marginal rate of substitution, a bound which is with the U.S. data much higher than could be observed unless risk aversion were implausibly high. Hansen and Jagannathan later generalized this lower bound and elaborated on its implications, and today the apparent violation of this "Hansen-Jagannathan lower bound" is regarded as an important anomaly in finance.[9]

Some very recent research has emphasized that, even though the aggregate stock market appears to be wildly inefficient, individual stock prices do show some correspondence to efficient markets theory. That is, while the present value model for the aggregate stock market seems unsupported by the data, there is some evidence that *cross-sectional* variations in stock prices relative to accounting measures show some relation to the present value model. Paul Samuelson some years ago posited that the stock market is "micro efficient but macro inefficient," since there is considerable predictable variation across firms in their predictable future paths of dividends but little predictable variation in aggregate dividends. Hence, Samuelson asserted, movements among individual stocks make more sense than do movements in the market as a whole. There is now evidence to back up this assertion.

Vuolteenaho (2002) showed, using vector-autoregressive methods, that the ratio of book-to-market-value of U.S. firms explains a substantial fraction of changes in future firms' earnings. Cohen, Polk and Vuolteenaho (2002) concluded that 75 to 80 percent of the variation across firms in their book-to-market ratios can be explained in terms of future variation in profits. Jung and Shiller (2002) show that, cross-sectionally, for U.S. stocks that have been continually traded since 1926, the price-dividend ratio is a strong forecaster of the present value of future dividend

[9] See, for example, John Cochrane's (2001) book *Asset Pricing*, which surveys this literature. Much of the older literature is summarized in my 1989 book *Market Volatility*.

changes. So, dividend-price ratios on individual stocks do serve as forecasts of long-term future changes in their future dividends, as efficient markets assert.

This does not mean that there are not substantial bubbles in individual stock prices, but that the predictable variation across firms in dividends has often been so large as to largely swamp out the effect of the bubbles. A lot of this predictable variation across firms takes the form of firms' paying zero dividends for many years and investors correctly perceiving that eventually dividends will be coming, and of firms in very bad shape with investors correctly perceiving they will not be paying substantial dividends much longer. When it comes to individual stocks, such predictable variations, and their effects on price, are often far larger than the bubble component of stock prices.

There is a clear sense that the level of volatility of the overall stock market cannot be well explained with any variant of the efficient markets model in which stock prices are formed by looking at the present discounted value of future returns. There are many ways to tinker with the discount rates in the present value formulas, and someday someone may find some definition of discount rates that produces a present value series that "fits" the actual price better than any of the series shown in Figure 1.[10] But it is unlikely that they will do so convincingly, given the failure of our efforts to date to capture the volatility of stock prices. To justify the volatility in terms of such changes in the discount rates, one will have to argue that investors also had a great deal of information about changes in the factors influencing these future discount rates.

After all the efforts to defend the efficient markets theory, there is still every reason to think that, while markets are not totally crazy, they contain quite substantial noise, so substantial that it dominates the movements in the aggregate market. The efficient markets model, for the aggregate stock market, has still never been supported by any study effectively linking stock market fluctuations with subsequent fundamentals. By the end of the 1980s, the restless minds of many academic researchers had turned to other theories.

The Blossoming of Behavioral Finance

In the 1990s, a lot of the focus of academic discussion shifted away from these econometric analyses of time series on prices, dividends and earnings toward developing models of human psychology as it relates to financial markets. The field of behavioral finance developed. Researchers had seen too many anomalies, too

[10] Other factors are considered by McGrattan and Prescott (2001), who emphasize tax rate changes, and Siegel (2002), who considers not only tax rate changes but also changes in the volatility of the economy, changes in the inflation rate, and changes in transactions costs. Neither of these studies shows a "fit" between present value and prices over the long sample, however. Notably, the factors they use do not go through sudden changes at the time of the stock market booms and crashes surrounding 1929 and 2000.

little inspiration that our theoretical models captured important fluctuations. An extensive body of empirical work, summarized in Campbell, Lo and MacKinlay's 1996 book *The Econometrics of Financial Markets*, laid the foundation for a revolution in finance.

Richard Thaler and I started our National Bureau of Economic Research conference series on behavioral finance in 1991, extending workshops that Thaler had organized at the Russell Sage Foundation a few years earlier.[11] Many other workshops and seminars on behavioral finance followed. There is so much going on in the field that it is impossible to summarize in a short space. Here, I will illustrate the progress of behavioral finance with two salient examples from recent research: feedback models and obstacles to smart money. For overall surveys of the field of behavioral finance, the interested reader might begin with Hersh Shefrin's *Beyond Greed and Fear: Understanding Behavioral Finance and the Psychology of Investing* (2000) or Andrei Shleifer's *Inefficient Markets* (2000). There are also some new books of collected papers in behavioral finance, including a three-volume set, *Behavioral Finance*, edited by Hersh Shefrin (2001), and *Advances in Behavioral Finance II*, edited by Richard H. Thaler (2003).

Feedback Models

One of the oldest theories about financial markets, expressed long ago in newspapers and magazines rather than scholarly journals, is, if translated into academic words, a price-to-price feedback theory. When speculative prices go up, creating successes for some investors, this may attract public attention, promote word-of-mouth enthusiasm, and heighten expectations for further price increases. The talk attracts attention to "new era" theories and "popular models" that justify the price increases.[12] This process in turn increases investor demand and thus generates another round of price increases. If the feedback is not interrupted, it may produce after many rounds a speculative "bubble," in which high expectations for further price increases support very high current prices. The high prices are ultimately not sustainable, since they are high only because of expectations of further price increases, and so the bubble eventually bursts, and prices come falling down. The feedback that propelled the bubble carries the seeds of its own destruction, and so the end of the bubble may be unrelated to news stories about fundamentals. The same feedback may also produce a negative bubble, downward price movements propelling further downward price movements, promoting word-of-mouth pessimism, until the market reaches an unsustainably low level.

Such a feedback theory is very old. As long ago as 1841, Charles MacKay in his

[11] For a list of our programs since 1991, with links to authors' websites, see ⟨http://cowles.econ.yale.edu/behfin⟩.

[12] Descriptions of new era theories attending various speculative bubbles are described in my book (2000). Popular models that accompanied the stock market crash of 1987, the real estate bubbles peaking around 1990 and various initial public offering booms are discussed in my paper in this journal (1990).

influential book *Memoirs of Extraordinary Popular Delusions* described the famous tulipmania in Holland in the 1630s, a speculative bubble in tulip flower bulbs, with words that suggest feedback and the ultimate results of the feedback (pp. 118–119):

> Many individuals grew suddenly rich. A golden bait hung temptingly out before the people, and one after another, they rushed to the tulip marts, like flies around a honey-pot . . . . At last, however, the more prudent began to see that this folly could not last forever. Rich people no longer bought the flowers to keep them in their gardens, but to sell them again at cent per cent profit. It was seen that somebody must lose fearfully in the end. As this conviction spread, prices fell, and never rose again.[13]

The feedback theory seems to be even much older than this. Note of such feedback, and the role of word-of-mouth communications in promoting it, was in fact made at the time of the tulipmania itself. One anonymous observer publishing in 1637 (the year of the peak of the tulipmania) gives a fictional account of a conversation between two people, Gaergoedt and Waermondt, that illustrates this author's impression of the word-of-mouth communications of that time:

> Gaergoedt: "You can hardly make a return of 10% with the money that you invest in your occupation [as a weaver], but with the tulip trade, you can make returns of 10%, 100%, yes, even 1000%.
> Waermondt: " . . . . But tell me, should I believe you?"
> Gaergoedt: "I will tell you again, what I just said."
> Waermondt: "But I fear that, since I would only start now, it's too late, because now the tulips are very expensive, and I fear that I'll be hit with the spit rod, before tasting the roast."
> Gaergoedt: "It's never too late to make a profit, you make money while sleeping. I've been away from home for four or five days, and I came home just last night, but now I know that the tulips I have have increased in value by three or four thousand guilder; where do you have profits like that from other goods?"
> Waermondt: "I am perplexed when I hear you talking like that, I don't know what to do; has anybody become rich with this trade?"
> Gaergoedt: "What kind of question is this? Look at all the gardeners that used to wear white-gray outfits, and now they're wearing new clothes. Many weavers, that used to wear patched up clothes, that they had a hard time putting

[13] Garber questions MacKay's facts about the tulipmania in his 1990 article in this journal and in his book *Famous First Bubbles.* For example, the crash was not absolutely final; Garber documents very high tulip prices in 1643. The actual course of the bubble is ambiguous, as all contracts were suspended by the states of Holland in 1637 just after the peak, and no price data are available from that date.

> on, now wear the glitteriest clothes. Yes, many who trade in tulips are riding a horse, have a carriage or a wagon, and during winter, an ice carriage, ..."[14]

Casual observations over the years since then are plentiful evidence that such talk, provoking a sense of relative futility of one's day-to-day work and envy of the financial successes of others, and including some vacuous answer to doubts that the price rise may be over, is effective in overcoming rational doubts among some substantial number of people and tends to bring successive rounds of them into the market.

In my book *Irrational Exuberance*, published (with some luck) at the very peak of the stock market bubble in March 2000, I argued that very much the same feedback, transmitted by word-of-mouth as well as the media, was at work in producing the bubble we were seeing then. I further argued that the natural self-limiting behavior of bubbles, and the possibility of downward feedback after the bubble was over, suggested a dangerous outlook for stocks in the future.

One might well also presume that such simple feedback, if it operates so dramatically in events like the tulip bubble or the stock market boom until 2000, ought often to recur at a smaller scale and to play an important if lesser role in more normal day-to-day movements in speculative prices. Feedback models, in the form of difference equations, can of course produce complicated dynamics. The feedback may be an essential source of much of the apparently inexplicable "randomness" that we see in financial market prices.

But the feedback theory is very hard to find expressed in finance or economics textbooks, even today. Since the theory has appeared mostly in popular discourse, and not in the textbooks, one might well infer that it has long been discredited by solid academic research. In fact, academic research has until recently hardly addressed the feedback model.

The presence of such feedback is supported by some experimental evidence. Psychologists Andreassen and Kraus (1988) found that when people are shown real historical stock prices in sequence (and which they knew were real stock prices) and invited to trade in a simulated market that displays these prices, they tended to behave as if they extrapolate past price changes when the prices appear to exhibit a trend relative to period-to-period variability. Smith, Suchanek and Williams (1988) were able to create experimental markets that generated bubbles that are consistent with feedback trading. Marimon, Spear and Sunder (1993) showed experiments in which repeating bubbles were generated if subjects were preconditioned by past experience to form expectations of bubbles.

The presence of such feedback is also supported by research in cognitive psychology, which shows that human judgments of the probability of future events show systematic biases. For example, psychologists Tversky and Kahneman have shown that judgments tend to be made using a representativeness heuristic,

[14] Anonymous (1637). Bjorn Tuypens translated this passage.

whereby people try to predict by seeking the closest match to past patterns, without attention to the observed probability of matching the pattern. For example, when asked to guess the occupations of people whose personality and interests are described to them, subjects tended to guess the occupation that seemed to match the description as closely as possible, without regard to the rarity of the occupation. Rational subjects would have chosen humdrum and unexceptional occupations more because more people are in these occupations. (Kahneman and Tversky, 1974). By the same principle, people may tend to match stock price patterns into salient categories such as dramatic and persistent price trends, thus leading to feedback dynamics, even if these categories may be rarely seen in fundamental underlying factors.

Daniel, Hirschleifer and Subramanyam (1999) have shown that the psychological principle of "biased self-attribution" can also promote feedback. Biased self-attribution, identified by psychologist Daryl Bem (1965), is a pattern of human behavior whereby individuals attribute events that confirm the validity of their actions to their own high ability and attribute events that disconfirm their actions to bad luck or sabotage. Upon reading the above passage from the time of the tulipmania, one easily imagines that Gaergoedt is basking in self-esteem and relishing the telling of the story. Many readers today can probably easily recall similar conversations, and similar ego-involvement by the spreaders of the word, in the 1990s. Such human interactions, the essential cause of speculative bubbles, appear to recur across centuries and across countries: they reflect fundamental parameters of human behavior.

There is also evidence supportive of feedback from natural experiments, which may be more convincing than the lab experiments when they occur in real time, with real money, with real social networks and associated interpersonal support and emotions, with real and visceral envy of friends' investment successes, and with communications-media presence. Ponzi schemes may be thought of as representing such natural experiments. A Ponzi scheme (or pyramid scheme or money circulation scheme) involves a superficially plausible but unverifiable story about how money is made for investors and the fraudulent creation of high returns for initial investors by giving them the money invested by subsequent investors. Initial investor response to the scheme tends to be weak, but as the rounds of high returns generates excitement, the story becomes increasingly believable and enticing to investors. These schemes are often very successful in generating extraordinary enthusiasms among some investors. We have seen some spectacular Ponzi schemes recently in countries that do not have effective regulation and surveillance to prevent them. A number of Ponzi schemes in Albania 1996–1997 were so large that total liabilities reached half a year's GDP; their collapse brought on a period of anarchy and civil war in which 2000 people were killed (Jarvis, 1999). Real world stock-market speculative bubbles, I argued in my 2000 book *Irrational Exuberance*, resemble Ponzi schemes in the sense that some "new era" story becomes attached to the bubble and acquires increasing plausibility and investor enthusiasm as the market continues to achieve high returns. Given the obvious success of Ponzi schemes when they are not stopped by the law, we would need a good reason to think that analogous phenomena of speculative bubbles are not also likely.

The stock market boom that ended in early 2000 is another relevant episode. According to my survey data, now expressed in the form of stock market confidence indexes produced by the Yale School of Management and available at ⟨http://icf.som.yale.edu/confidence.index⟩, the confidence of individual investors that the stock market will go up in the next year, and will rebound from any drop, rose dramatically 1989–2000. As in the tulipmania centuries before, there was a focusing of public attention and talk on the speculative market and a proliferation of wishful-thinking theories about a "new era" that would propel the stock market on a course that, while uneven, is relentlessly upward, theories that were spread by word of mouth as well as the media.

It is widely thought that there is a problem with the feedback theories: the theories would seem to imply that speculative price changes are strongly serially correlated through time, that prices show strong momentum, continuing uniformly in one direction day after day. This seems inconsistent with the evidence that stock prices are approximately a random walk.

But simple feedback models do not imply strong serial correlation, as I stressed in Shiller (1990). There, I presented a model of the demand for a speculative asset as equaling a *distributed lag* with exponentially declining weights on past price changes through time (the distributed lag representing feedback distributed over time), plus other factors that affect demand. The model asserts that people react gradually to price changes over months or years, not just to yesterday's price change. A history of price increases over the last year may encourage buying today even if yesterday's price change was down. Also, the model recognizes that there are other shocks, besides feedback, influencing price.

In such a model, a disturbance in some demand factor other than feedback can in certain cases be amplified, at least for a time, because it changes the price and thus affects future prices through the distributed lag.[15] However, unless we know something about the other factors that drive demand, such a distributed lag model does not imply anything at all about the serial correlation properties of speculative price changes. The feedback model does not imply that there is much serial correlation in day-to-day stock price changes, since the noise in the other factors feeds directly into short-run changes, and the effect on today's price of lagged other factors operates at a low frequency that is essentially unrelated to day-to-day changes and has effects that can be observed only from its cumulative effect after a long period of time.

Thus, the approximate random walk character of stock prices is not evidence

[15] The feedback model is $p_t = c\int_{-\infty}^{t} e^{-\gamma(t-\tau)}\, dp_\tau + \pi_t$, $0 < c < 1$, $0 < \gamma$. Here, p_t is price at time t, and π_t is the combined effect of other factors on demand. It follows that $p_t = \pi_t + (c/(1-c))(\pi_t - \overline{\pi}_t)$, where $\overline{\pi}_t = (\gamma/(1-c))\int_{-\infty}^{t} e^{-(\gamma/(1-c))(t-\tau)}\pi_\tau d\tau$ is a weighted average of lagged π. See Shiller (1990, p. 60). Such a model does not imply that price behaves smoothly through time: price can look much like a random walk if, for example, π_t is a random walk.

against feedback. Moreover, even if feedback did imply some momentum, we can also note that the random walk character of stock prices is really not fully supported by the evidence anyway, and that in fact there has been more than a little momentum to stock prices. Jegadeesh and Titman (1993) found that winning stocks, stocks that showed exceptionally high six-month returns, beat losing stocks, stocks that showed exceptionally low six-month returns, by 12 percent over the following year. In contrast, over longer periods of time this momentum seems to reverse itself. De Bondt and Thaler (1985) find that over the period 1926 to 1982, stocks represented on the Center for Research in Security Prices data set of the University of Chicago whose returns had been in the top decile across firms over three years (thus, "winner" stocks) tended to show negative cumulative returns in the succeeding three years. They also found that "loser" stocks whose returns had been in the bottom decile over the prior three years tended to show positive returns over the succeeding three years. Thus, there is a tendency for stock prices to continue in the same direction over intervals of six months to a year, but to reverse themselves over longer intervals. Campbell, Lo and Mackinlay (1996) document this fact carefully.[16] A pattern like this is certainly consistent with some combination of feedback effects and other demand factors driving the stock market largely independently of fundamentals.

Smart Money vs. Ordinary Investors

Theoretical models of efficient financial markets that represent everyone as rational optimizers can be no more than metaphors for the world around us. Nothing could be more absurd than to claim that *everyone* knows how to solve complex stochastic optimization models. For these theoretical models to have any relevance to the stock market, it must somehow be the case that a smaller element of "smart money" or the "marginal trader" can offset the foolishness of many investors and make the markets efficient.

The efficient markets theory, as it is commonly expressed, asserts that when irrational optimists buy a stock, smart money sells, and when irrational pessimists sell a stock, smart money buys, thereby eliminating the effect of the irrational traders on market price. But finance theory does not necessarily imply that smart money succeeds in fully offsetting the impact of ordinary investors. In recent years, research in behavioral finance has shed some important light on the implications of the presence of these two classes of investors for theory and also on some characteristics of the people in the two classes.

From a theoretical point of view, it is far from clear that smart money has the power to drive market prices to fundamental values. For example, in one model with both feedback traders and smart money, the smart money tended to *amplify*, rather than diminish, the effect of feedback traders, by buying in ahead of the

[16] Grinblatt and Han (2001) have argued that this tendency of stock prices to show momentum for a while and then reverse themselves might be related to the phenomenon that investors tend to hold on to losers and sell winners (Statman and Shefrin, 1985; Odean, 1998).

feedback traders in anticipation of the price increases they will cause (De Long, Shleifer, Summers and Waldman, 1990b). In a related model, rational, expected-utility-maximizing smart money never chooses to offset all of the effects of irrational investors because they are rationally concerned about the risk generated by the irrational investors and do not want to assume the risk that their completely offsetting these other investors would entail (De Long, Shleifer, Summers and Waldman, 1990b).[17]

Often, speculative bubbles appear to be common to investments of a certain "style," and the bubbles may not include many other investments. For example, the stock market bubble that peaked in the year 2000 was strongest in tech stocks or Nasdaq stocks. Barberis and Shleifer (2002) present a model in which feedback traders' demand for investments within a particular style is related to a distributed lag on past returns of that style class. By their budget constraint, when feedback traders are enticed by one style, they must move out of competing styles. The smart money are rational utility maximizers. Barberis and Shleifer present a numerical implementation of their model and find that smart money did not fully offset the effects of the feedback traders. Style classes go through periods of boom and bust amplified by the feedback.

Goetzmann and Massa (1999) provided some direct evidence that it is reasonable to suppose that there are two distinct classes of investors: feedback traders who follow trends and the smart money who move the other way. Fidelity Investments provided them with two years of daily account information for 91,000 investors in a Standard and Poor's 500 index fund. Goetzmann and Massa were able to sort these investors into two groups based on how they react to daily price changes. There were both momentum investors, who habitually bought more after prices were rising, and contrarian investors, or smart money, who habitually sold after prices were rising. Individual investors tended to stay as one or the other, rarely shifted between the two categories.

Recent research has focused on an important obstacle to smart money's offsetting the effects of irrational investors. The smart money can always buy the stock, but if the smart money no longer owns the stock and finds it difficult to short the stock, then the smart money may be unable to sell the stock. Some stocks could be in a situation where zealots have bought into a stock so much that only zealots own shares, and trade is only among zealots, and so the zealots alone determine the price of the stock. The smart money who know that the stock is priced ridiculously high may well use up all the easily available shortable shares and then will be standing on the sidelines, unable to short more shares and profit from their knowledge. Miller (1977) pointed out this flaw in the argument for market efficiency, and his paper has been discussed ever since.

It seems incontrovertible that in some cases stocks have been held primarily by zealots and that short sellers have found it very difficult to short. One example is the

[17] Shleifer and Summers (1990) present a nice summary of these themes in this journal.

3Com sale of Palm near the peak of the stock market bubble (Lamont and Thaler, 2001). In March 2000, 3Com, a profitable provider of network systems and services, sold to the general public via an initial public offering 5 percent of its subsidiary Palm, a maker of handheld computers. 3Com announced at the same time that the rest of Palm would follow later. The price that these first Palm shares obtained in the market was so high, when compared with the price of the 3Com shares, that if one subtracts the implied value of the remaining 95 percent of Palm from the 3Com market value, one finds that the non-Palm part of 3Com had a *negative* value. Since the worst possible price for 3Com after the Palm sale was completed would be zero, there was thus a strong incentive for investors to short Palm and buy 3Com. But, the interest cost of borrowing Palm shares reached 35 percent by July 2000, putting a damper on the advantage to exploiting the mispricing.[18] Even an investor who knew for certain that the Palm shares would fall substantially may have been unable to make a profit from this knowledge. The zealots had won with Palm and had control over its price, for the time being.

The Palm example is an unusual anomaly. Shorting stocks only rarely becomes so costly. But the example proves the principle. The question is: How important are obstacles to smart money's selling in causing stocks to deviate from fundamental value?

Of course, in reality, the distinction between zealots and smart money is not always sharp. Instead, there are sometimes all gradations in between, especially since the objective evidence about the fundamental value of individual stocks is always somewhat ambiguous. If selling short is difficult, a number of individual stocks could become overpriced. It would also appear possible that major segments of the stock market, say the Nasdaq in 1999, or even the entire stock market, could wind up owned by, if not zealots, at least relatively optimistic people. Short-sale constraints could be a fatal flaw in the basic efficient markets theory.

The problem with evaluating Miller's (1977) theory that a lack of short selling can cause financial anomalies like overpricing and bubbles is that there has been little or no data on which stocks are difficult to short. There are long time series data series on "short interest," which is the total number of shares that are shorted. Figlewski (1981) found that high levels of short interest for individual stocks predicts low subsequent returns for them, a direction that would be predicted by Miller's theory. But the predictability was weak. On the other hand, differences in short interest across stocks do not have an unambiguous connection with difficulty of shorting. Stocks differ from each other in terms of the fraction of shares that are in accounts that are shortable. Differences across stocks in short interest can also reflect different demand for shorting for hedging needs. Thus, there is a significant

[18] Put option prices on Palm also began to reflect the negative opinions and became so expensive that the usual relation between options prices and stock price, the so-called "put-call parity," failed to hold. One must remember that options markets are derivative markets that clear separately from stock markets, and overpriced puts have no direct impact on the supply and demand for stock unless arbitrageurs can exploit the overpricing by shorting the stock.

errors-in-variables problem when using short interest as an indicator of the cost of shorting.

Some recent papers have sought to detect the presence of barriers that might limit short sales indirectly by observing the differences of opinion that can have an impact on price if there is a difficulty shorting stocks. Without observing barriers to shorting stocks directly, we can still infer that when differences of opinion are high about a stock, it is more likely that short-sale restrictions will be binding for that stock, and thus that the more pessimistic investors will not prevent the stock from becoming overpriced and hence subject to lower subsequent returns.

Scherbina (2000) measured differences of opinion by calculating the dispersion of analysts' earnings forecasts. She found that stocks with a high dispersion of analysts' forecasts had lower subsequent returns, and she linked the low returns to the resolution of the uncertainty. Chen, Hong and Stein (2000) measured difference of opinion by a breadth of ownership measure derived from a database on mutual fund portfolios. The breadth variable for each quarter is the ratio of the number of mutual funds that hold a long position in the stock to the total number of mutual funds for that quarter. They find that firms in the top decile by breadth of ownership outperformed those in the bottom decile by 4.95 percent per annum after adjusting for various other factors.

What we would really like to have to test the importance of short sales restrictions on stock pricing is some evidence on the cost of shorting. If those stocks that have become very costly to short tend to have poor subsequent returns, then we will have more direct confirmation of Miller's (1977) theory. There is surprisingly little available information about the cost of shorting individual stocks. Such data have not been available for economic research until recently. A number of recent unpublished papers have assembled data on the cost of shorting individual stocks, but these papers have assembled data for no more than a year around 2000.

Recently, Jones and Lamont (2001) discovered an old source of data on the cost of shorting stocks. In the 1920s and 1930s in the United States, there used to be a "loan crowd" on the floor of the New York Stock Exchange, where one could lend or borrow shares, and the interest rates at which shares were loaned were reported in the *Wall Street Journal*. Jones and Lamont assembled time series of the interest rates charged on loans of stocks from 1926 to 1933, eight years of data on an average of 80 actively-traded stocks. They found that, after controlling for size, over this period the stocks that were more expensive to short tended to be more highly priced (in terms of market-to-book ratios), consistent with the Miller (1977) theory. Moreover, they found that the more expensive-to-short stocks had lower subsequent returns on average, again consistent with the Miller theory. Of course, their data span only eight years from a remote period in history, and so their relevance to today's markets might be questioned.

Why has there not been more data on the cost of shorting? Why did the loan crowd on the New York Stock Exchange disappear and the loan rates in the *Wall Street Journal* with it? Perhaps after the crash of 1929 the widespread hostility to short sellers (who were widely held responsible for the crash) forced the market to go underground. Jones and Lamont (2001) document a consistent pattern of political opposition to short sellers after 1929 and point out that J. Edgar Hoover, the head of the Federal Bureau of Investigation, was quoted as saying that he would investigate a conspiracy to keep stock prices low. By 1933, the rates shown on the loan list become all zeros, and the *Wall Street Journal* stopped publishing the loan list in 1934.

Fortunately, this long drought of data on the cost of shorting stocks may be over, and stocks should become easier to short. In 2002, a consortium of financial institutions established an electronic market for borrowing and lending stocks online via a new firm, EquiLend, LLC. The new securities lending platform at ⟨http://www.equilend.com⟩ exceeded $11 billion in transactions in its first two weeks, and daily availability posting exceed $1 trillion.

But the true cost of shorting stocks is probably much higher than the explicit interest cost of borrowing the shares, because of the psychological cost that inhibits short selling. Most investors, even some very smart investors, have probably never even considered shorting shares. Shorting shares is widely reputed to involve some substantial risks and nuisances. For example, the short-seller always stands the risk that the ultimate owner of the shares will want to sell the shares, at which time the short-seller is forced to return the shares. This detail may be little more than a nuisance, for the short seller can likely borrow them again from another lender, but it may figure largely in potential short-sellers' minds.

A more important consideration that may weigh on short sellers' minds is the unlimited loss potential that short sales entail. When an investor buys a stock, the potential loss is no greater than the original investment. But when an investor shorts a stock, the potential losses can greatly exceed the original investment. An investor can always terminate these losses by covering the shorts, but this action typically brings considerable psychological anguish. Deciding to cover one's shorts and get out of a short position after losses is psychologically difficult, given the evidence on the pain of regret. Kahneman and Tversky's prospect theory (1979) suggests that individuals are far more upset by losses than they are pleased by equivalent gains; in fact, individuals are so upset by losses that they will even take great risks with the hope of avoiding any losses at all. The effects of this pain of regret have been shown to result in a tendency of investors in stocks to avoid selling losers, but the same pain of regret ought to cause short sellers to want to avoid covering their shorts in a losing situation. People prefer to avoid putting themselves in situations that might confront them with psychologically difficult decisions in the future.

The stock market that we have today always limits the liability of investors. As Moss (2002) has documented, the idea that all publicly traded stocks should have limited liability for their investors was the result of experimenting with different kinds of stockholder liability in the United States in the early nineteenth century and the discovery of the psychological attractiveness of limited liability stocks. The debates in the early nineteenth century were concerned with the balancing of the agency costs of limited liability, which encourages businesses to take greater risks, against the benefits in terms of peace of mind to investors. Various alternatives were considered or experimented with, including unlimited liability, unlimited proportional liability (where individual investors in a company are limited to their proportionate share of the company's losses according to their share in the company), and double liability (where individual investors are accountable for the capital subscribed once again). By around 1830, it was apparent from experiments in New York and surrounding states that investors found it very appealing that they could put money down to buy a stock today, and from that day forward face no further losses beyond what they already put down. It allowed them, once having purchased a stock, to concentrate their emotions on the small probability of the stock doing extremely well, rather on the small probability that someone would come after them for more money. People have always been very attracted to lottery tickets, and the invention of limited liability, Moss concludes, turned stock investments psychologically into something a lot like lottery tickets. By the same theory, then, investors will not find shorting stocks very attractive.

Remarkably few shares are in fact sold short. According to New York Stock Exchange data, from 1977 to 2000 year-end short interest ranged from 0.14 percent to 1.91 percent of all shares. According to Dechow, Hutton, Muelbroek and Stone (2001), less than 2 percent of all stocks had short interest greater than 5 percent of shares outstanding 1976–1983. Given the obviously large difference of opinion about and difference of public attention to different stocks, it is hard to see how such a small amount of short selling could offset the effect on stock price of the extra demand of investors who develop an irrational fixation on certain stocks.

Conclusion

The collaboration between finance and other social sciences that has become known as behavioral finance has led to a profound deepening of our knowledge of financial markets. In judging the impact of behavioral finance to date, it is important to apply the right standards. Of course, we do not expect such research to provide a method to make a lot of money off of financial market inefficiency very fast and reliably. We should not expect market efficiency to be so egregiously wrong that immediate profits should be continually available. But market efficiency can be egregiously wrong in other senses. For example, efficient markets theory may lead to drastically incorrect interpretations of events such as major stock market bubbles.

In his review of the literature on behavioral finance, Eugene Fama (1998) found fault for two basic reasons. The first was that the anomalies that were discovered tended to appear to be as often underreaction by investors as overreaction. The second was that the anomalies tended to disappear, either as time passed or as methodology of the studies improved. His first criticism reflects an incorrect view of the psychological underpinnings of behavioral finance. Since there is no fundamental psychological principle that people tend always to overreact or always to underreact, it is no surprise that research on financial anomalies does not reveal such a principle either. His second criticism is also weak. It is the nature of scholarly research, at the frontier, in all disciplines, that initial claims of important discoveries are often knocked down by later research. The most basic anomaly, of excess volatility, seems hardly to have been knocked down, and it is in fact graphically reinforced by the experience of the past few years in the stock markets of the world. Moreover, the mere fact that anomalies sometimes disappear or switch signs with time is no evidence that the markets are fully rational. That is also what we would expect to see happen even in highly irrational markets. (It would seem peculiar to argue that irrational markets should display regular and lasting patterns!) Even the basic relation suggested by market inefficiency, that stocks whose price is bid up by investors will tend to go back down later, and stocks that are underpriced by investors will tend to go up later, is not a relation that can be easily tested or that should hold in all time periods. The fundamental value of stocks is hard to measure, and, moreover, if speculative bubbles (either positive bubbles or negative bubbles) last a long time, then even this fundamental relation may not be observed except in very long sample periods.

In further research, it is important to bear in mind the demonstrated weaknesses of efficient markets theory and maintain an eclectic approach. While theoretical models of efficient markets have their place as illustrations or characterizations of an ideal world, we cannot maintain them in their pure form as accurate descriptors of actual markets.

Indeed, we have to distance ourselves from the presumption that financial markets always work well and that price changes always reflect genuine information. Evidence from behavioral finance helps us to understand, for example, that the recent worldwide stock market boom, and then crash after 2000, had its origins in human foibles and arbitrary feedback relations and must have generated a real and substantial misallocation of resources. The challenge for economists is to make this reality a better part of their models.

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