STRATEGIC ECONOMIC DECISIONS

Leaders in the Economics of Uncertainty

PROFILE

March 2014

Number 125

RESOLVING THE MARKET EFFICIENCY PARADOX

– The Fama/Shiller Nobel Prize of 2013 –

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RESOLVING THE MARKET EFFICIENCY PARADOX

– The Fama/Shiller Nobel Prize of 2013 –

The great Danish physicist Niels Bohr once asserted, "The opposite of a profound truth may well be another profound truth… How wonderful that we have met with a paradox. Now we have some hope of making progress." Hmmm. That takes some thinking. Consider four examples where truth and anti-truth commingle and yield paradoxes in science. Each of the following statements can be demonstrated as a theorem:

(i) To state that "markets are efficient because of investor rationality" is also to state that markets are inefficient because of investor rationality. **(ii)** To claim that "light consists of particles and not of waves" is equivalent to claiming that light consists of waves and not of particles. **(iii)** To state that "the axioms of arithmetic are mutually consistent" is logically equivalent to stating that they are not mutually consistent, since the truth of both of these assertions can never be known (Gödel's celebrated Impossibility Theorem of 1931). **(iv)** To claim that "scientific progress has been achieved by better understanding which variables depend on which other variables in some field" is logically equivalent to claiming that progress has been made by better understanding which variables do *not* depend upon which other variables. To restate this, the more rigorously we posit what is *not* true, the more we learn what *is* true.[1]

This essay focuses on the first of these paradoxes, the one concerning the ambiguous concept of market efficiency. Many have observed how unique it was in the history of the Nobel Prize that last year's economics prize was awarded to two scholars who had advanced theories directly opposed to one another.[2] Even more bizarre was the fact that both had successfully

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[1] The least known of these examples is number **(iv)**. Its truth depends upon the algebraic role of "irreducible symmetry groups" in serious theory construction. For an in-depth discussion of this proposition applied to five different branches of science, see "Game Theory, Symmetry, and Scientific Discovery" by H. W. Brock, an invited essay appearing in *Rational Interaction*: *Essays in Honor of John C. Harsanyi,* Ed. Reinhard Selten, Springer-Verlag, Berlin, 1992. John Harsanyi and Reinhard Selten shared the 1994 Nobel Prize with John F. Nash, Jr.

[2] We shall have nothing to say about the third 2013 Laureate (Professor Lars Hansen) since his contribution was to statistical theory and did not bear on the efficient market debate.

made use of commonly available data to support their views. Are we living in a world of two realities? Is Truth schizophrenic? A paradox is indeed lurking here — one we shall resolve.

PART I briefly sets forth the seemingly opposing views of Eugene Fama on the one hand, and Robert Shiller on the other. Our discussion of these views is deliberately sketchy in nature. This is because neither of these Nobelists is (or professes to be) a proper economic theorist. Rather, their research was strictly empirical — mining the data to test theories that were *ad hoc* at best. As a result, neither was able to convincingly explain what their data really demonstrated. Thus, nearly fifty years later, half of us believe that markets are quite efficient, and half believe that they are inefficient and exploitable. By extension, many choose to index, whereas many others embrace active management in hope of earning excess returns.

Nonetheless, both Fama and Shiller scored very good points, with each offering data in support of their views. Moreover, both have been widely influential in the financial community. Thus their ideas merit respect and analysis. And from our perspective in this essay, their ideas play point-counterpoint within the paradox we wish to resolve.

PART II delves into the all-important issue of *definitions*, for example the meaning of "market efficiency," "rational," "act-rational," "belief-rational," "behavioral," of "psychological," "forecast mistakes," "rational mistakes," "market equilibrium," etc. A hallmark in the philosophy of science is that in order for the quality of a theory to improve over time, definitions must become more rigorous and less ambiguous. The same subtleties that led Einstein and Minkowski to fundamentally reconceptualize the concepts of space and time as "space-time" mirror the subtleties that led modern decision theorists (starting with John von Neumann) to redefine and demystify the confusing concept of "rationality."

In both disciplines, professionals took *decades* to absorb the new theories that resulted from these redefinitions. In hindsight, the claims of antecedent theories seem ridiculous. But they did not seem problematic at the time they were first challenged. It is for this reason that, as the old adage goes, "science advances one funeral at a time." New paradigms tear up the old resumés of "distinguished professors." This engenders fierce resistance to progress, as the philosopher of science Thomas Kuhn taught us in his celebrated 1962 book, *The Structure of Scientific Revolutions.*

PART III contains the principal results of the paper. We demonstrate how to reconcile the disagreements between the two scholars. Proposition 1 sets forth the precise conditions, *including an assumption of rationality*, under which Fama's theory holds true. Proposition 2 sets the precise conditions, *including a different assumption of rationality*, under which Shiller's (and Behavioralists') opposing theory holds true. Proposition 3 offers quantitative evidence that the concept of "irrationality" central to Behavioral Finance scholars is not required to explain excess market volatility. Indeed, 95% of total observed volatility can be explained in a world where all investors are completely rational. <u>These three Propositions turn conventional financial market wisdom on its head, and resolve the paradox we set out to analyze.</u>

PART IV: In this brief final section, we link our analysis to the related question of how an investor can *legitimately* outperform the market.

In achieving all this, we place Fama's and Shiller's contributions into a different and deeper perspective. Our method is standard in the philosophy of science. *First*, we utilize very rigorous definitions. *Second*, we relax the excessively restrictive assumptions underlying classical rationality-based theories of finance. In doing so, we ascend to a higher level of generality. From that vantage point the views of both scholars are seen as correct — *but only when each of the two theories is applied within an appropriately restricted "domain of applicability."* Outside of those specific two domains, they are both false.

An analogy: Newton's Laws governing the physics of falling elevators work perfectly in the domain where all elevators are restricted to fall at different yet constant velocities; but his laws do not work in more general domains where accelerations are permitted. On the other hand, Einstein's laws of gravity (the general theory of relativity of 1916) work in all domains. Thus they are said to be "more general" than Newton's laws.

I. A Sketch of the Basic Debate

The Two Key Issues: One reason why this topic is confusing is that there are two different and *seemingly* unrelated dimensions of the debate*. First,* there is the "it's hard to beat the market" issue central to Fama's case. *Second,* there is the "excess market volatility" issue central to Shiller's case. The link here is that, were markets truly efficient, then not only would it be impossible for one investor to outperform others (except by luck), but also markets would exhibit no excess volatility at all. We shall of course explain why this linkage is true.

Fama: Eugene Fama is best known for his insistence that, due to market efficiency, it is almost impossible to beat the market except by luck. He has tested this proposition successfully with data covering various periods and markets. Fama, of course, advanced what he felt to be a persuasive *theory* for his view — a theory central to those who believe in indexing and passive management. This theory proposed that markets efficiently (correctly) absorb new information relevant to an asset's price the moment it is revealed. To restate this, he would claim that markets are highly efficient at "pricing in" all new information, assuming that the information is simultaneously available to all people.

> But if it is, how can some money managers claim to outperform the market other than by luck? At a superficial level, this cannot happen and their claim is bogus. But at a deeper level, Fama's theory is very problematic. It inexplicably sidesteps the reality that market efficiency requires not only a "pricing in" of all new *information* but also a pricing in of a *correct* <u>*interpretation*</u> *of all news*. Should some investors interpret the news better than others, they will indeed add alpha — and it will not be due to luck. Most supporters of the Efficient Market Theory (EMT) still do not understand this all-important distinction between information and its interpretation.

For the record, Fama's views were popularized by Princeton Professor Burton Malkiel in his celebrated 1973 book, *A Random Walk Down Wall Street*.

In real life, Fama's behavior as an investor implies he might have doubts about some aspects of Efficient Market Theory (EMT). For example, he apparently admits the reality that market trends and "overshoots" exist and can be exploited to reap excess returns. In admitting that, he acknowledges that "the trend is your friend." But this view is of course completely inconsistent with *proper* Efficient Market Theory as developed by scholars such as Robert Lucas, Jr. and Thomas Sargent. Lucas is a very mathematical University of Chicago *theorist* who earned the Nobel Prize years ahead of Fama for developing the formal theory of market efficiency now known as "Rational Expectations" (RE). This is not the right place to discuss RE, except to note that it implies that market trends and market overshoot will never occur.

To conclude, Fama should be viewed as a scholar who focused on one strand of EMT, namely the difficulty of beating the market under conditions of symmetric information. In doing so, he never developed a proper explanatory theory (as will be seen), but rather advanced plausible reasons why it is very difficult — if not impossible — to outperform the market. This was a message well worth hearing, and heard it was.

Shiller: Shiller too is an empirical economist, not a theorist. He has made important contributions to many branches of applied economics. His best known paper was published in 1981 and introduced an ingenious way of testing the efficient market hypothesis, and in so doing, found its predictive value in explaining stock market *volatility* to be very poor. Let me cite Jeremy Grantham who summarized Shiller's contribution very effectively in a recent GMO Quarterly Letter (November 2013):

> "Shiller proposed a simple test of market inefficiency. He assumed total clairvoyance and asked the question: What were markets worth back in, say, 1880, 1915, 1961, etc., if you knew both the long-term market return, or the discount rate (in the 6% to 7% range after inflation), and more importantly, you also knew the complete and accurate future stream of dividends? …..Upon testing, the S&P 500 lies within 19% of its (fundamentals-based) trend two-thirds of the time! This is almost ridiculous volatility, 19 times more than is really justified by the underlying fundamentals."

What Shiller did in effect was to attack the EMT by demonstrating that real world stock-market volatility is many times greater than an efficient market dividend discount model would have predicted — assuming clairvoyance about future dividend streams. This discovery would lead several years later to the 1985 Prescott-Mehra "paradox" that the equity risk premium of stocks implied by the EMT was about *one-sixth* of what it had actually been, that is a theorical premium of about 1% versus 6% historically. In defense of the EMT, since it (erroneously) predicts very low stock-market volatility, it likewise predicts a very low-risk premium on stocks compared to bonds. Thus the EMT is *internally consistent* as regards asset market volatility. The problem is that its predictions of volatility and of the risk premium, while consistent, are wrong: both values are far too low.

Why is this so? Explanations abound — virtually none of which are grounded in serious theory. In general, it is claimed that the excess volatility is due to "behaviorally-motivated irrational" investors — whatever this is supposed to mean. Jeremy Grantham is more specific in offering his own favorite explanation that "individual investors are driven by behavioral factors that result in 'herding.'" These behavioral factors include the psychological discomfort of being wrong *alone* (which happens when an investor departs from the herd) and adverse incentives that impact the relationship between investment managers and clients, etc. It is, of course, assumed that all such behavioral factors somehow constitute "irrationality" — herding in particular.

All this implies that the EMT must be fundamentally wrong since it is predicated on the assumption of completely rational behavior by all agents. As will be shown below, all these assertions have little or no meaning — even if they are superficially appealing. The fundamental problem stems from total confusion about the meaning of "rationality." We will clarify this in Section II.4 below.

Largely because of the lack of proper *theory* of Behavioral Finance, should it be any surprise that, after three decades of trying, no internally consistent behavioral model has ever been constructed that *predicts* the real-world level of market volatility? This is what good theories are supposed to do. Note the irony here: Just as EMT failed to make sense of excess volatility in the real world, so did its successor theory. Is there an alternative theory that does succeed in doing so? Yes.

II. Fundamental Definitions and Concepts

In order to make sense of all this, and to reconcile two seemingly reasonable yet opposing theories, we must now become rigorous and introduce a host of definitions and conceptual distinctions which will not be familiar to many readers. Is it worth persevering? Yes. These concepts are *required* for the paradox of market efficiency to be resolved. Longstanding readers of SED's ***PROFILES*** will have encountered several of these concepts from past SED reports dating from a decade ago.

II.1. The "Law of Motion" of an Economy and its Markets – *Stationary* versus *Stable* Random Processes –

Law of Motion is a term economists now use to describe the laws governing the *dynamics* of an economy. The first thing to understand is that today, virtually all laws of motion are random processes that incorporate uncertainty about the future. Technically, such laws of motion are known as "stochastic processes." Usually, such laws have cyclical properties. Thus, just as there are random processes governing the weather that exhibit cyclicality and mean reversion, so are there laws of GDP growth and of stock market behavior exhibiting the same properties: Over the past century, mean temperature in Massachusetts is 51 degrees, and the mean S&P500 P/E ratio is 14.8 (when measured in the traditional manner).

There are three principal types of stochastic processes, and the failure of financial economists to distinguish between them has caused enormous confusion.

Stationary Processes: Here the dynamic pattern — whatever it is — repeats itself forever over time: the dynamics never change. Formally, the joint distribution of the relevant variables never changes over time. The weather here in Massachusetts is an example of a stationary process.

> What is most important about stationary processes is that historical data reveal the correct and non-changing amplitude and periodicity of any cyclical behavior. That is, (as with a cosine function) we will always know *how far* a value will deviate from its mean, and we will know *when*. In the case of the weather, we know (up to a fixed probability) the deviation of temperature and indeed of rainfall from its mean on any day, and we know this for all dates.

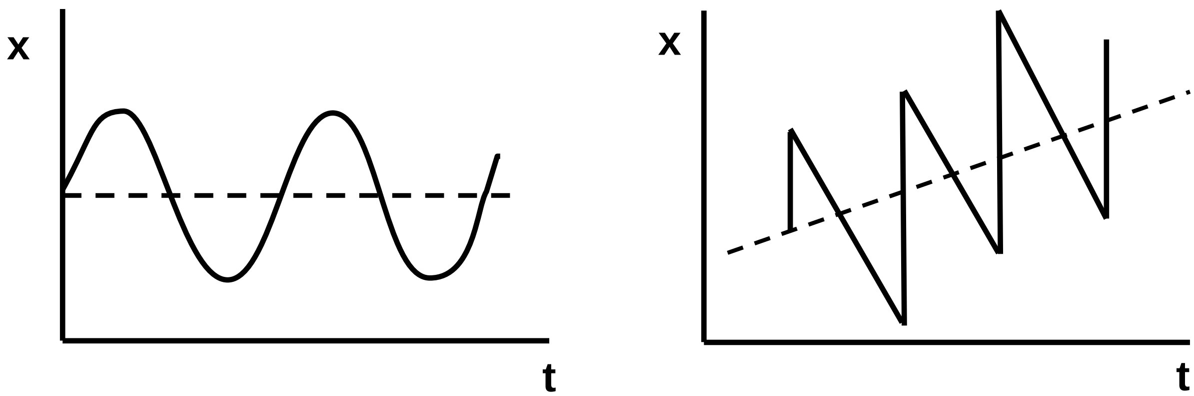
Because of these properties of stationarity, it is possible to accurately predict the probabilities of all future events at all times solely by relying on historical data and good econometrics.

Non-Stationary Processes: At the other end of the spectrum are processes where little if anything of the past repeats itself. Such processes are rarely discussed for the simple reason that non-stationarity implies a *complete* inability to utilize historical data in forecasting the future. Forecasts must be completely subjective — and that is anathema in academia!

Stable Processes – and "Sloppy Mean Reversion": These are a *halfway house* between the first two types of process. To understand "stochastic stability," think of history as a stripper who never fully undresses during the performance. That is, while historical data tell you *something* about the future, they do not reveal that much. In the case of financial markets or economies that are stable processes (as indeed they are), by crunching longer and longer samples of historical data, you learn the true time-invariant mean and variance of the process — but no more.

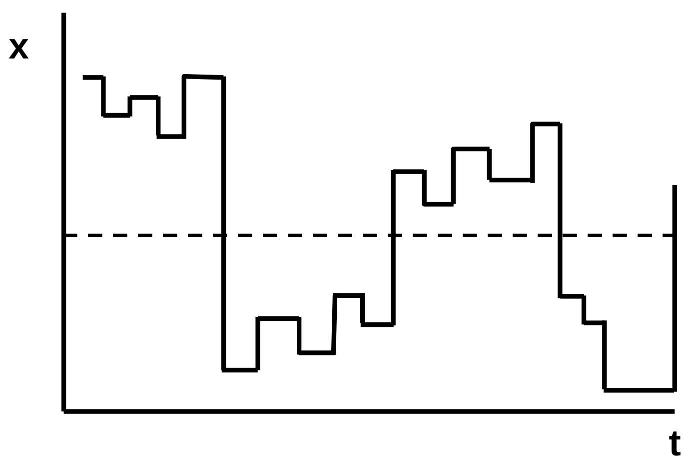
> This suggests that you can learn from the data the long-run mean and variance of equity returns, of P/E cycles, of business cycles, etc. But no amount of historical data analysis will reveal the amplitude and/or periodicity of the cycle. That is, you cannot learn when and by how much the market will deviate from its mean. *Dynamic patterns are thus non-knowable.* The result might best be called "sloppy mean reversion." For this reason, forecasts based upon historical data become highly problematic in the case of stable processes.

FIGURE 1: Stationary Versus Stable Laws of Motion



<u>Both these textbook processes are stationary</u>

The dynamics of each never change. By studying historical data you will learn the “true” future mean, variance, and exact dynamics of each random process. The *timing* of ups versus downs in markets will thus be known by all investors.



<u>This Process is Stable – The Real World</u>

Historical analysis reveals the “true” mean of the process, but not the dynamic pattern of deviation from the mean. Thus the data are silent on the *timing* of the bull/bear markets. The total areas of deviation above and below the mean must be equal in order for mean reversion to exist.

Source: SED

Conclusion: Since stable processes were only discovered thirty years ago by the mathematician R. M. Gray and were first applied to economics by M. Kurz twenty years ago, scholars have almost always assumed that the economic and financial laws of motion were stationary. This embarrassingly restrictive assumption is almost never made explicit. Further complicating matters is the fact that the modeling of stable (as opposed to stationary) processes is mathematically demanding.

II.2. The Meanings of "Forecasts," and "Beliefs about the Future"

In theoretical economics, a forecast is typically dynamic in nature. Specifically, a person's "forecast" of some event **X** in the future takes the form of his subjective probabilities (betting odds) of the future values of **X**, specifically of the vector $\mathbf{X_1, X_2, X_3, \ldots X_n}$ over **n** periods of time. His "beliefs" about the future represent the collection of all of his forecasts. This is sometimes called his "personal belief structure." There are important distinctions to be made among different kinds of forecasts and belief structures.

Forecasts that are Objective: A forecast that is objective is one based upon generally available historical data. But even when historical data are plentiful, they should only be utilized in arriving at a forecast if the random process generating the data is *stationary*. For in this case, we know that the patterns and probabilities of the past will be those of the future. If there is doubt as to stationarity, say, because of the prospect of structural changes that will alter future patterns, then it is *invalid* to identify a historically based forecast as "objective," much as it may be comforting to take refuge in historical data and pretend that what is actually subjective is in fact objective.

Forecasts that are Subjective: Forecasts are subjective to the extent that **(i)** there are no historical data relevant to the forecast at hand (e.g., how well a brand-new product will be received), or else when **(ii)** there are plenty of historical data available, but these were generated by a random process that is not thought to be stationary. Many wonder whether valid "subjective" probabilities exist for cases like this, and if so, how they can be assessed. The answer is that, for any given person, there will always exist a *single* probabilistic forecast that is logically consistent with his/her information and preferences. Moreover, this forecast can be accurately assessed. This result is the celebrated Anscombe-Aumann Theorem lying at the heart of modern decision theory.[3]

Market Belief Structures: The collection of all individuals' belief structures in a given market is called the *market belief structure*. It is all-important in explaining market behavior. Of particular importance (as will be seen) is the degree to which individuals' beliefs are *correlated,* with most investors possessing similar forecasts. Shifts in the *distribution of beliefs* over time play the dominant role in propagating market volatility, as will be seen.

II.3. Goals and Preferences

One of the building blocks of all economic models is the stipulation of agents' preferences. This can take the form of preference orderings over consumer goods (he prefers coffee to tea; she prefers chocolate to vanilla, etc.). It requires specification of agents' rate of time preference — his/her "impatience" or discount rate. It also requires specification of agents' risk tolerance. In the case of investors, a specification of preferences permits the modeling of some agents with long-term goals, and others with very short-term goals — as in the case of day-traders.

The important point here is that economic theory does not impose restrictions on these various dimensions of "preference." In particular, we never speak of "rational preferences." *For any preference ordering passes muster.*

II.4. The Meaning of "Rationality"

As was hinted at above, the lion's share of blame for the confusion surrounding the EMT lies in rampant confusion about the meaning of rationality. Broadly speaking, the concept of rationality concerns the consistency of a person's acts with respect to his preferences and his beliefs.

[3] The existence of the probability measure is derived axiomatically. See "A Definition of Subjective Probability," by Anscombe, F. J., and Aumann, R.J., *Annals of Mathematical Statistics,* Vol. 43, No. 1, 1963. Their theory was based upon the earlier theory of L. J. Savage. Properly understood, this result obviates Frank Knight's celebrated distinction between "risk" and "uncertainty."

Act-Rationality: It is best to think of the word "rational" as an adjective modifying an act or decision of a person in a given set of circumstances. Generally, given my preferences (including my risk tolerance), my impatience factor, my beliefs (forecasts), and a set of actions (one of which I must take), then there will be one and only one act in this set that is demonstrably consistent with my goals and beliefs. This of course will be the act that maximizes my "expected utility," as was first proven by the mathematician John von Neumann in 1947. That is, choosing this act will be rational.

> To assume that people are rational in this sense of act-rationality is simply to assert that they act as goal-seekers. Nothing more. Rationality in this sense is a very important concept *regardless* of whether people in reality are always rational and act so as to maximize their expected utility. For despite the mistakes we make along the way, most of us are indeed goal-seekers.

To see how important this point is, consider the concept of *agent-rationality*. Suppose I am trying to decide whom I should pay to manage my money, or to execute my will. While I personally may frequently fail to observe high standards of rational behavior, as is the case when I choose to get drunk, I will certainly expect my nominated advisor to adhere to high standards. He is paid to act rationally on my behalf, that is, to act in a manner consistent with *my* goals and beliefs.

In the case of judging the degree of act-rationality of individuals in their own right — absent any principal/agent problem, it is easy to conclude that people are highly irrational when in fact they are not. As Kenneth Arrow and others have pointed out, there are many situations where being textbook-rational entails costs that far outweigh the benefits. In this case, *it is rational not to act in a textbook-rational manner*. Why should I spend valuable time and money to dot every **i** and cross every **t** when there is little benefit from being so precise? It is rational *not* to do so.

Belief-Rationality: In the early days of decision theory, individuals were assumed to have used their own subjective probabilities about future events in arriving at their forecasts. Sometimes these would be "objective" probabilities as when history provided them with sufficient data generated by a stationary random process to compute the forecasts. But from the start, *these were viewed as very special cases.* In general, forecasts were subjective: *You* could have your own forecast of the economy and the market and *I* could have a different forecast. Little was said about the quality of such forecasts.[4] But this would change radically with the advent of EMT in financial economics. Assumptions about beliefs became very strong. We can distinguish between two types of belief structures.

The Two Important Kinds of Belief Structures

Type 1 "Rational Expectations": In order for scholars such as Lucas, Muth, and Sargent to make the EMT rigorous (and to make their models workable) it was necessary to introduce the extremely restrictive assumption that all investors possessed Rational Expectations about the future. More specifically, by crunching appropriate historical data that was assumed to be available to all investors, everyone would arrive at one and the same forecast — which was the "true" probabilistic forecast. As we have seen, this requires an assumption that the random process generating the data is strictly stationary.

For example, given current interest rates levels, earnings levels, and GDP growth, everyone could compute the correct conditional probabilities of all future prices of stocks and bonds. Jeremy Grantham in his paper cited above joins legions of others who consider Rational Expectations to be arrant nonsense. Yet while this is so, it paved the way for the EMT to be transformed over time into a rigorous, logically consistent model that made concrete, testable predictions. This was an important advance. But as noted above, the predictions of such models did not fare well in the real world. Such models could explain no more than a third of real-world market volatility.

Type 2 "Rational Beliefs": Mordecai Kurz at Stanford University dramatically weakened this very restrictive assumption in developing a new theory of market behavior *and* a logically consistent model that can explain 95% of market volatility. He espouses "Rational Beliefs" as opposed to "Rational Expectations." A Rational Belief Structure is a set of forecasts that differ between people. Despite the standard assumption that all investors share the same historical data and news updates, *they arrive at diverse forecasts — all of which must be partially subjective.* Yet while these forecasts differ, they are all *Rational Beliefs* in Kurz's sense because their forecasts are assumed to satisfy the following condition*: Every person's forecast of the future must be non-contradictable-by-the-data.* What does this mean?

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[4] For example, in the Arrow-Debreu state-preference model, consumers are assumed to hold their own subjective forecasts of future states of the world.

The fundamental justification for Kurz's new concept was the realization that the Law of Motion of the economy and the markets is a *stable* stochastic process, not stationary. That is, while the historical data shared by everyone reveal *some* truths about the longer-run future (e.g., long-run means and variances of P/E ratios, GDP growth, etc.), the same data are silent on the timing and the magnitudes of deviations from the mean. *Those "dynamic patterns" that investors think they can learn from the data cannot, in fact, not be known.* This is a theorem.

Thus you might end up with a belief that a bull market will prevail for the next four years, after which a deep bear market will prevail for two years, and so on. Yet I for my part might hold the belief that a three-year bear market will be followed by a four-year bull market, etc. As long as both of our forecasts share in common those long-run means and variances that the stable process shows to be "true," then our divergent forecasts are said to be *non-contradictable-by-the-data*, or "rational" in Kurz's sense.

Kurz's new concept of Rational Beliefs permits far more flexibility and realism than the straightjacket of Rational Expectations wherein everyone is assumed to be able to learn and agree on the truth about everything. But exactly how can his model make predictions that are accurate when tested against reality? How can it explain almost all market volatility, predict the correct value of the Equity Risk Premium during the past century, and also explain the value of the "forward discount" in foreign exchange markets? The answer lies in the concept of *rational mistakes* that is central to Kurz's theory. Before considering the new concept of mistakes, let's apply his concept of rationality to the phenomenon of "herding."

Case Study – The Alleged "Irrationality" of Herding Behavior

In his comments cited above, Jeremy Grantham stressed the importance of herding in explaining real-world market behavior — behavior that is ruled out by the EMT. Herding behavior is of course widely deemed "irrational," not only because "trends" (serial correlation) cannot exist in efficient markets, but also because the term herding connotes a flock of lemmings heading straight for a cliff. The blind follow the blind. What could be more irrational than behavior like this? Well, herding behavior actually *is* rational in many circumstances.

Consider the following theorem: In a market whose Law of Motion is stable (not stationary), where investors are belief-rational, and where there is symmetric information, herding behavior is act-rational. An informal proof proceeds as follows. Investors know from the data that trends (both up and down) regularly occur. They observe that trending behavior ("the trend is my friend") generates excess returns, especially in bull markets. Suppose now that a trend has begun, say an incipient bull market. Each investor will have his/her view of when to get off the bandwagon. I may believe that a P/E ratio of 23 signals the right time to bail out, while you may believe that "this time," the market will peak at a P/E of 28. *Ex post,* one of us will earn higher returns than the other, but this is irrelevant to our argument.

What matters is that, since the Law of Motion is assumed to be stable, not stationary, neither investor can know the amplitude or the timing of the bull/bear cycle playing out. *For in a stable system, the pattern and timing of deviations from a long-term mean are non-knowable.* Thus both of our forecasts are necessarily subjective. But they are both belief-rational to the extent that (as assumed) we both have long-term forecasts which, when smoothed out over the long run, conform with those long-run average means and variances revealed by the data generated by a stable Law of Motion.

Under these conditions, it will be act-rational (i.e., utility maximizing) for all investors who believe they are in a bull market to buy into the market, and in so doing to accelerate the trend — which in turn will attract other bystanders to do the same. *Neither belief-irrationality nor act-irrationality is presupposed by the decisions investors make when herding*. The case for the act-rationality of herding will be even stronger if **(i)** investors are evaluated according to relative performance, (**ii**) if there is Pricing Model Uncertainty, and **(iii)** if hedging markets are incomplete. This is true because each of these conditions can be shown to *amplify* the magnitude of market swings, and thus to amplify the opportunities to add alpha by exploiting the serial correlation of returns.

II.5. The Concept of Forecasting Mistakes

Recall that a forecast is always stated in terms of probabilities of future events. A *correct* forecast is one where the probabilities are correct and never need to be revised. A *mistaken* forecast is one where we look back *ex post* and say "If only I had known that the structural change (e.g., global warming) was occurring, then I would *not* have used historical data to arrive at my probabilistic forecast of the future. I was wrong and must revise my probabilities."

In this regard, if you look in the index of any textbook on modern financial theory for the words "mistakes" or "forecasting mistakes," you will not find any. For investors in the stationary world of the EMT do not make mistakes. Ever. The probabilities they ascribe to all future events are

"God's probabilities," as Christopher Sims at Princeton said three years ago when he received the Nobel Prize for his own contributions to EMT finance.

Mistake-free forecasts could only exist in a world with a *stationary* Law of Motion where the dynamics of economies and markets never change. As stated above, in this case we all would arrive at the same and the correct probabilistic forecast of the future. But this is not the case in Kurz's theory of Rational Beliefs. Here, we have divergent forecasts — although each forecast is rational in the weak sense described above. Thus, since there is only one "true" forecast *ex post*, most investors end up mistaken to some extent. Thus a new and all-important variable arises: *the distribution and correlation of investors' mistakes.*

Explanation of Volatility: How does this concept of mistakes help explain high levels of market volatility in the real world? Consider the US housing market crash of 2007–2010. The distribution of investors' bets on future house prices in January 2007 was highly correlated: Over 90% of homeowners and investors believed that house prices would not decline. But they did. Moreover, investors in real estate are usually highly leveraged, and in 2007, leverage was sky high. What happens to house prices when investors are all wrong in the same direction *and are highly leveraged?* A perfect storm of "excess volatility" results as investors panic and prices collapse. House prices would never have exhibited such volatility had **(i)** investors in 2007 shared one and the same correct forecast, or **(ii)** had the "representative investor" amongst a group of investors held the correct forecast.[5]

It is in this way that the theory of Rational Beliefs can explain the emergence of "excess volatility" in a manner that the mistake-free EMT cannot.

Rational versus Irrational Mistakes: There are mistakes and then there are mistakes. If we live in an environment that is stochastically *stationary*, then no probabilistic mistakes are made. For by processing historical data, all agents end up with the one and only true forecast of future events. In this environment, any other forecast is clearly belief-irrational. However, in an environment that is stochastically *stable*, belief-rational agents will have different forecasts,

[5] This is a weaker form of an EMT model which allows for diverse beliefs. In a representative agent context, the forecasts of agents can *differ* from that of the representative agent, but they must be evenly distributed above and below the forecast of the representative agents whose forecast is assumed to be correct. This is a very restricted form of "belief diversity." Here is how it works: If the representative investor's forecast is correct, as it always is, and if half of the other agents are bullish investors with a forecast value **X%** higher than the rep's, and the other half are **X%** lower in their forecasts, *then the "mistake structure" is self-canceling.* For there will be as many agents selling as buying when news breaks, *and price will therefore not change*. There will be no mistakes-driven volatility even though everyone except the representative agent is mistaken.

and most all will end up having been wrong (since there is only one truth). Nonetheless, if their mistaken forecasts are all non-contradictable-by-the data in Kurz's sense, then their mistakes can be said to be *belief-rational mistakes*. If on the other hand, certain agents have forecasts whose long-run means and variances do not conform to history's verdict, then their mistakes are *belief-irrational*. For example, a forecast which sees the long-run mean P/E forecast rising from a traditional mean of 14.8 to a new mean of 50 would be irrational.

II.6. Asset Price Forecasting When Pricing Model Uncertainty Exists

There is one final way in which the EMT is overly restrictive in a manner which causes it to predict much less asset market volatility than exists in the real world. Consider the nature of asset-price forecasting, as opposed to, say, corn-price forecasting. Assume that changes in the price **P** of an asset depend upon two variables: first, news **X** that emerges and that must be "priced into" the market; second, a model **M** that maps news **X** into the **P**. That is, **M** specifies what the new price will be *given* any news about fundamentals. Then an investor's price forecasting model will take the form of **P = M(X).** In all classical financial theory, the following two very strong assumptions are made. First, the Rational Expectations assumption that all investors know and agree upon the "true" probability distribution **{X}** of future news events **X**. Second, they all know and utilize the same "true" price forecasting model **M**.

*But suppose they do not know and agree upon **M***? Suppose there is a divergence of opinion as to how the bond market will price news about the introduction of QE, that is to say, there is Pricing Model Uncertainty. As we have demonstrated in numerous past reports utilizing advanced game theory, the result will be far greater asset-price volatility when investors do not know **M** than when investors do know **M**.[6]

Thus, the high magnitude of market volatility we observe in the real world reflects the role of **(i)** correlated forecast mistakes about the news, *and* **(ii)** Pricing Model Uncertainty. Both of these generators of market risk are ruled out by the extremely strict assumptions of EMT finance.[7]

[6] The author is responsible for developing the concept of Pricing Model Uncertainty in his normative theory of how Kurz's new theory makes it possible to outperform the market. Kurz and his colleagues' work is "positive" as opposed to "normative," and they conflate the twin risks of mistaken forecasts of *events* and mistaken forecasts of the market's *pricing* of events.

[7] Going beyond Pricing Model Uncertainty, volatility will be even higher as **(i)** the more investors are *leveraged*, and **(ii)** to the extent that hedging markets are "*incomplete*" as they are in reality. But to discuss these issues here would unnecessarily complicate the discussion.

II.7. Exogenous and Endogenous Market Risk

All this relates to the meaning of market risk in finance. As is customary, we define market risk to be volatility as measured in the standard manner. It turns out the *total volatility* (what we observe in the data) decomposes into the sum of two very different kinds of risk: exogenous, and endogenous. *Exogenous* risk is the only kind of risk allowed in classical EM financial theory. It represents the volatility in asset prices due to news about the fundamental drivers **X** of asset prices — under the assumption that everyone knows and agrees upon the pricing model **M**. This was the precise kind of risk that Shiller studied in his 1981 paper — in particular news about dividends. He found that changes in the news **X** could only explain about 10% of total observed volatility. Other models have explained up to 40% of observed volatility.[8] Henceforth, we shall (for simplicity) assert that approximately *one-third* of total volatility is exogenously determined.

Endogenous risk refers to all other risk not explained by news about fundamentals. That is, it is the arithmetic difference between total observed market volatility and volatility due to the news. It constitutes about two-thirds of total observed risk, depending upon the model utilized. We have already identified what gives rise to all this "excessive" volatility, in particular **(i)** correlated mistakes in investors' forecasts about the news, and **(ii)** Pricing Model Uncertainty about **M**. In classical finance, no endogenous risk exists since **(i')** investors never make mistaken forecasts, and **(ii')** Pricing Model Uncertainty does not exist.

All this sheds new light upon Shiller's original discovery: He demonstrated that only a small portion of total volatility is *exogenous* in nature. Of course, without the recent theory of endogenous risk due to Mordecai Kurz, he was not able to *explain* why classical theory fared so poorly when tested. He could only *describe* its shortcomings statistically. As happens so frequently in financial economics, we got Measurement without proper Theory.

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[8] The most general model that has tested the contribution of *exogenous* news to total volatility is a stochastic dynamic general equilibrium model, and it was able to explain 40% of observed volatility. See "Determinants of Stock Market Volatility and Risk Premia," by Jin, H., Kurz, M., and Motolese, M., *Annals of Finance*, 2005, pp. 109-147.

II.8. Economic "Efficiency" on Main Street versus on Wall Street

Main Street Efficiency: If the concept of rationality is badly confused in the financial literature, then so is the concept of market efficiency. By far the oldest and most important concept of efficiency, studied by all Econ 101 students, is that of Pareto Optimality. This concept of efficiency has to do with goods/services markets in the real economy. It has nothing to do with financial markets. The definition of efficient markets in this case runs as follows: Assume there is a perfectly competitive economy as studied in Econ 101. At equilibrium, supply will equal demand in all markets (corn, labor, hamburgers). The "invisible hand" of the price system sees to it that prices will adjust to equate supply and demand in all markets.

Then the resulting allocation of goods and services will be "efficient" in Pareto's sense. That is, there will be no waste in the economic system in the precise sense that no re-allocation of goods and services can make anyone better off without making someone else worse off. Conversely, in an *inefficient system*, matters can be rearranged so that some or even all households can be made better off without making anyone else worse off (i.e., there is slack, waste, or inefficiency).

Wall Street Efficiency: In financial economics, the concept of market efficiency is altogether different. As we know, efficiency in this context refers to the extent to which **(i)** all investors receive the same information (news) about market developments at the same time, and **(ii)** all such news is instantaneously and correctly "priced into" the market. Given efficiency, there is no way for any one investor to add alpha by outperforming other investors — except of course by luck.

II.9. Psychology-Based "Behavioral" Finance versus Rationality-Based Finance

Motivated by the failure of classical EMT to explain either volatility or the equity risk premium, various efforts were made to arrive at a new theory that could explain much more of total observed volatility than the EMT could, and also to clarify the ways in which certain investors in the real world can and indeed do outperform the market — without relying on luck.

What resulted was a mishmash of new models like "noise-trading theory" and "prospect theory," and dozens of new behavioral concepts like "framing biases." The entire enterprise became known as Behavioral Finance, and it was predicated upon one central belief: *The inability of classical EMT to be able to explain real-world magnitudes of market risk was due to the classical assumption that investors are rational.* That is, investor irrationality is the true culprit.

> Yet to date, this central tenet has not been substantiated. Even more ironically, its converse has been established: A model in which everyone is rational *can* explain 95% of real-world market volatility. Part 3 just below will substantiate these claims. But for the moment, how can this aberration in the history of science have occurred? More ironically, given that many of the findings of Behavioral Finance about the irrationalities of human beings are *true* and interesting, how can this new theory have failed to explain market volatility?

There are three reasons why.

First, scholars in this field restricted themselves to concepts of human rationality that are too strong, too restrictive. This is forgivable given the subtleties of the concept of rationality described above in Definitions 5 and 6 — the concept of rational mistakes in particular. After all, this is a concept that requires an understanding of stable as opposed to stationary random processes, and this distinction is new.

Second, as indicated above, when the costs of being textbook-rational are high (e.g., informational and computational costs), then what appear to be "mistakes" or "irrationalities" in human behavior often are not. Rather, such behavior is rational once such costs are taken into account. For example, am I irrational for not knowing that out of a group of fifty people, the probability of some pair of individuals sharing a common birthday is 98% versus the 8% most of us intuitively believe? And yes, this is a "bias" that 99.999% of us have. The answer is No, I am not irrational. It is not worth the time and the hassle to learn the inverse of Stirling's formula in combinatorial mathematics, along with the probability theory needed to compute the true probability. I am *rational* not to learn this given my goals and my value of time! It is rational for us all to be "biased."

Third, *and most important by far*, economics was never about whether people's beliefs (forecasts) — much less their preferences — were "rational" or not. Rather, economics was and is about the *implications* of individuals' beliefs and preferences *for* market prices, market quantities, and Pareto efficiency. Period. Please re-read this.

Peoples' beliefs and preferences are "primitives" that are taken as given in economics, just as "mass" is in pre-Einsteinian physics. This is not to say that psychologists should not study why my probability forecasts are biased, or, for that matter why I prefer chocolate to vanilla. They should. But economists confront an altogether different task. This point is virtually never made and has led to remarkable and unnecessary confusion.[9]

But now we have a problem: It turns out to be extremely difficult — both conceptually and mathematically — *for economics* to achieve the goal that it sets for itself. More specifically, to understand how changes in people's beliefs and preferences impact prices and quantities is exceedingly difficult. As one of the foremost mathematical economists in the world, Mordecai Kurz at Stanford was able to do this. No one else has. And in doing what he did, Kurz discovered that "mistakes" rather than "irrationality" are the key to understanding excess volatility in its many different forms: from long bull/bear market cycles, to momentary price overshoot when news is announced, etc. His theory of endogenous risk is the key to all this. We are making a strong set of statements here, and the interested reader is referred to a lengthy footnote defending them, and putting Kurz's achievement into proper historical perspective.[10]

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[9] It is interesting and paradoxical to the author that Behavioralists who study the irrationality of people's *beliefs* never investigate the irrationality of people's *tastes* and preferences. What does this tell you?

[10] To arrive at a proper theory of how beliefs and preferences impact market prices and cause volatility, a so-called "general equilibrium" (GE) model of market behavior is needed. This is a model in which everything that depends upon everything else is captured. In a partial equilibrium model of, say, the copper market, changes in copper prices are due to changes in the supply/demand curves for copper. But this partial analysis misses the point that the price of copper will also be impacted by the price of aluminum, since aluminum is a partial substitute for copper. A GE model is required to capture all this. But more is needed than merely a GE model. It must also be possible to *solve* the model so as to make falsifiable predictions of prices and quantities that can be tested against real-world data.

The first such model was that of Kenneth Arrow and Gerard Debreu in 1954. They restricted themselves to the simplest possible case in which there was no risk or uncertainty at all. Nor was the model dynamic. Yet even here, these two economists needed the new tools of fixed-point theorems from topology and of functional analysis to prove the conditions under which Adam Smith's Invisible Hand will actually exist. What they did not show was how to *solve* such a model for the values of the equilibrium prices and quantities of interest. To achieve this would require another twenty years when methods of algebraic topology were introduced by Herbert Scarf and others.

Years went by during which GE models were extended to include uncertainty as well as dynamics. The mathematics required became more burdensome, and strict assumptions had to be introduced to make such GE models "tractable." In particular, it had to be assumed that agents held Rational Expectations (i.e., all agents possess one and the same "correct" probabilistic forecast). Next came the theory of "representative" agents. Finally, Kurz saw the need to deal with heterogeneous beliefs — models in which we can all have different beliefs — but beliefs that satisfy his "non-contradictable-by-the-data" requirement of Rational Beliefs. Yet again, the mathematics required to construct GE models with rational, heterogeneous beliefs was demanding. It involved the development of a new kind of stochastic process (stable processes). But when all was said and done, his model worked. Using the method of simulations to test the model, Kurz and his colleagues could explain over 95% of observable market volatility, a huge improvement over earlier EMT models.

II.10. The Concept of Market Equilibrium

In microeconomics, the concept of market equilibrium refers to the state of the world whereby the prices of all goods, commodities, and financial assets are such as to equate the quantity supplied and demanded of each good. Most misunderstandings about the validity of the concept of equilibrium stem from a failure to understand that the equilibrium of a system can be dynamic as well as static. In a dynamic context, equilibrium refers to a *time-dated sequence of prices and quantities* with the property that, at each date, prices are such as to equate supply and demand. Importantly, no restrictions are placed by economic theory on how much movement there may be in either prices or quantities over time.

That is to say, there is no conflict between the phenomenon of excess volatility and markets being in equilibrium, contradicting what George Soros claims in his concept of "market reflexivity." We will clarify these confusions in an essay to appear later in the year.

III. Resolving the Fama/Shiller Paradox

The following three Propositions contain our principal results:

Proposition 1: Conditions under Which Fama is Correct that Markets Will Be Efficient and Will Properly "Price In" All New Information; Individual Investors Will Be Unable to Outperform the Market (except by luck); and Excess Volatility Will Not Exist:

Suppose we impose the following four conditions and clarifications on Fama's central claim. Let us assume that **(i)** the Law of Motion of the economy is *stationary*, so that by analyzing historical data alone, all agents will arrive at the one and only "true" probabilistic forecast of future events. As a result, all investors' forecasts are Rational Expectations and are thus belief-rational. Suppose additionally that **(ii)** Pricing Model Certainty exists, so that all agents will be able to *price* news correctly via their common knowledge of the true pricing model **M**. Suppose also that **(iii)** there is symmetric information in the sense that all agents receive the news at

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This is how science works. There are no shortcuts. Behavioral Finance theorists bet that discarding rationality would somehow permit an understanding of market volatility. They evinced little understanding of what this goal would require in proper economic terms. Not surprisingly, they failed in their poorly-defined mission.

exactly the same time. Suppose finally that **(iv)** when they make their investment decisions, all investors are act-rational in that they act so as to maximize their expected utility.[11]

Then if these four conditions are met, markets will be efficient in the Fama-Malkiel sense that all news will instantaneously and correctly have been "priced into" market prices. There will be no opportunity for some subset of investors to outperform the market as a whole except by luck. Additionally, since all investors agree upon the correct new price of an asset given each and every news announcement, there will be no excess volatility (no "overshoot/undershoot" of the news.) The proof of this assertion is standard in modern financial economics. It is frankly trivial because, given the extremely strong assumptions made, markets will be efficient virtually by definition. In this sense, the EMT is a weak theory.

Historical Note: Whereas Fama never clarified the distinctions required for his result to hold, Robert Lucas and his colleagues did to a certain extent in developing the concept of a Rational Expectations Equilibrium. However, Lucas omitted condition **(ii)** requiring Pricing Model Certainty. Also, he did not clearly distinguish the different kinds of rationality his theory logically required. Finally, he did not explicitly postulate a stationary Law of Motion, but simply assumed it. When the clarifications we have made are introduced, as in assumptions **(i) – (iv)** above, then the EMT holds true in its entirety. *Market volatility is very low; financial markets are efficient, and they are efficient* <u>*partly*</u> *because all investors are assumed to be both belief-rational and act-rational.* We stress "partly" here because the assumption of stationarity is far more important than that of rationality in explaining low volatility.

Proposition 2: Conditions under which Shiller and Behavioralists are Correct that Markets Will Exhibit Excess Volatility (compared to EMT predictions of volatility), and under which the Mispricing of Assets that Accompanies Excess Volatility Will Give Some Investors a Legitimate Chance to Outperform the Market:

Suppose first that **(i)** the Law of Motion is stable — not stationary; that **(ii)** all investors are both belief-rational and also act-rational; that **(iii)** there is Pricing Model Certainty; and that **(iv)** there is symmetric information whereby all agents receive the same news at the same time. Then the market will be inefficient in that new information will *not* be correctly priced into the market; market volatility will be much greater than it otherwise would be under EMT; and investors can, in principle, outperform the index and add alpha. A fully rigorous proof of this

[11] It is also assumed that a "complete" set of hedging markets exist, but we are ignoring this issue for simplicity.

proposition can be found in several papers discussing the new theory of Rational Beliefs at Stanford cited below. But a heuristic proof will be now sketched.

Note assumption **(ii)** here: This makes clear that no assumption of "irrationality" is required to arrive at the Behavioralist conclusion that the EMT is wrong in most all of its predictions. Since Behavioralists have *assumed* that irrationality is *why* the EMT theory is wrong, and why markets overshoot/undershoot, our heuristic proof must now demonstrate why irrationality is *not* required to explain market behavior that *seems* irrational.

Heuristic Proof: The critical assumption here is assumption **(i)**, namely that the Law of Motion of the markets is *stable* — not stationary. In such a world, investors will have diverse forecasts which can be both wrong *ex pos*t and highly correlated, as in any bull or bear market. These forecasts are belief-rational to the extent that agents' forecasts into the future are non-contradictable-by-such-data as are revealed by history. All it takes for markets to overshoot and *appear* to be irrational is the existence of belief-rational forecasts that are correlated but wrong (e.g., the widespread belief in early 2007 that US house prices would go up and not down).

This can occur when all agents are act-rational as well as belief-rational. In this regard, recall our proof that "herding behavior" is not necessarily irrational at all. And herding is a main reason for overshoot and undershoot. *In short, given the non-knowability that stems from a stable random process, markets will exhibit what has been called "inefficiency" even when all investors are both belief-rational and act-rational*.

To be sure, if we weaken assumptions **(ii)** and **(iii)** to allow agents to be belief- and act-*irrational*, and if we allow the true asset pricing model **M** to be unknowable (as it is in real life), then excess market volatility will be much *greater* than if these assumptions are not relaxed. One way of seeing this stems from a game theory theorem that, the greater the Pricing Model Uncertainty is for an asset, the greater the amplitude and duration of over/undershoot cycles will be. We have written about this result in past reports.

Historical Note on Shiller and Behavioral Economics: To be fair to Shiller, his original 1981 paper did nothing more than analyze historical data in a manner that revealed the market volatility predictions of the EMT to be very wrong. Shiller was in no way a Behavioralist at that time. Indeed, he was not a theorist of any kind. But his empirical verdict was correct and has stood the test of time: real-world equity markets are not efficient at all in the EMT sense. Assets are "mispriced" most of the time in the sense that stock prices are usually not what fundamentals imply they "should" be.

Over time, Shiller can be said to have joined ranks with Behavioralists whose principal tenet was that investor irrationality was responsible for market inefficiency. But wait: Suppose we accept the hypothesis that investors are often irrational in the ways in which Behavioralists define the term. Even so, does this assumption of irrationality *explain* real-world volatility, and in particular, why volatility is so much greater than implied by the EMT? Behavioralists have never developed a model capable of answering this question. More specifically, they have no explanation of *how much* of the total excess volatility is due to the existence of act- and belief-irrationality, as opposed to *other* violations of EMT assumptions such as stable versus stationary random processes, and Pricing Model Uncertainty.

For example, could the inability of investors to know the true probabilities of future news announcements (and thus to make forecast mistakes) be the principal cause of market inefficiency? To the extent this is true, then no assumption of irrationality need enter the picture. For non-knowability of the truth will hold true in any economy governed by a Law of Motion that is non-stationary but stable. [Think of the difficulties of forecasting the weather in the future given the advent of global warming — *confusion having nothing to do with irrationality.*]

What about Pricing Model Uncertainty? Won't this by definition cause investors to misprice the news and, in turn, to generate market inefficiency? Are investors to be deemed "irrational" because they do not know how to price in new information about, say, dot-com stocks, junk bonds, or currencies — much less government bonds in the presence of QE? Hardly.

Finally — The Big Question

Here is the question a true scientist would want answered in appraising the success of Behavioral Finance during the past quarter century: Quantitatively, what percentage of total market volatility can be attributed to act-and-belief irrationality? If there were a formal general equilibrium model that could explain **X%** of total volatility *without* assuming irrationality, then we could argue that **100% – X%** of volatility is due to irrationality. Is there such a model, and if so, what is the value of **X**?

Proposition 3: Assume That an Economy has a Stable Law of Motion; Assume That There is Symmetric Information; and Assume That All Investors are Act- and Belief-rational. Then a General Equilibrium Model of the Market Exists and Can Explain Approximately 95% of Total Volatility. This Would Imply a Rough Estimate of 100% – 95% = 5% of Total Volatility That Can Be Accounted for By Investor Irrationality Alone. In This Model, Exogenous Risk (due to shocks about fundamentals) Constituted about 40% of Total Risk, and Endogenous Risk Accounts for 55%. The Remaining Unexplained 5% Can (but need not) Be Ascribed to What is Sloppily Called "Irrationality."

Proof: See the paper "Determinants of Stock Market Volatility and Risk Premia," by Jin, H., Kurz, M., and Motolese, M., *Annals of Finance*, 2005, pp. 109-147. See also the many references cited therein. Almost all stock market volatility is explained from first principles via the method of simulation. The equity risk premium is derived. The forward discount on currencies is explained. GARCH phenomena are explained. And so forth. The paper is a tour de force, but it is difficult to read.

IV. How to Outperform the Market

In our February 2013 ***PROFILE*** "The Logical Basis for Outperforming the Market" we identified the three basic strategies which permit some investors to outperform others on a theoretically legitimate basis — without relying on luck. While this issue is tangential to the theme of this essay, the two issues are closely interrelated. To see this, recall that without market inefficiency, it is definitionally impossible to outperform the market except by luck. The first two of our proposed three strategies for outperforming the market are the most important.

Strategy 1: The first strategy is to exploit those *structural changes* that cause the Law of Motion in an economy to be stable as opposed to stationary. Historical data alone have a very limited ability to help an investor forecast the impact of structural changes. Should an active manager spend the time and money required to do so, he *can utilize deductive logic* (as opposed to inductive data-crunching) to arrive at a deeper understanding of structural changes than other investors do — *and he can do so earlier*. That is, he can, on average, end up less wrong than others and less wrong for the right reasons. This is a strategy most appropriate for investors making those longer-term time horizons during which structural changes play out.

Strategy 2: The second strategy is much shorter-term in nature. It lies in exploiting the "endogenous risk" (excess volatility) generated in a stable world where correlated mistakes —

amplified by leverage — cause markets to overshoot/undershoot the news about fundamentals. By expending the time and money necessary to do so, traders can exploit the new logic of endogenous risk and have a superior ability to know when and why different kinds of overshoot/undershoot occur.

In utilizing either or both of these strategies, there is no free lunch: time and money must be spent doing what is required. Could "all agents" end-up adopting these strategies, thereby removing the possibility of adding alpha? No, for implementing either or both of them requires very clear thinking of a kind that is ever-more unfashionable in today's era of "big data" and sloppy reasoning.[12]

V. Conclusion of Essay

To conclude this report, we have seen that markets can be perfectly efficient when all investors are fully rational, and also that markets can be highly inefficient when all investors are rational. For this and other reasons, investor irrationality is very much less important in explaining real-world market behavior than has been asserted by Behavioral Finance students in recent decades. Demonstrating this required that we introduce a host of new definitions that make previously fuzzy concepts much clearer.

The most important observation in all this is that *stable* random processes generate incomplete data such that most investors end up wrong in their inferences, no matter how much data they crunch. Their forecast mistakes can be highly correlated, as in the US housing bubble. Moreover, *shifts* in such belief structures can go a long way in explaining market volatility. Overshoot is made even worse by Pricing Model Uncertainty, by high leverage, and by "incomplete" hedging markets.

We have also seen that there is no fundamental conflict between the programmes of classical versus Behavioral Finance. Each is investigating different aspects of economic and market behavior. Both are legitimate fields of study. *But economists must never lose sight of their principal job*, which is to clarify the way in which changes in beliefs and preferences alter equilibrium prices and quantities — taking people's beliefs (forecasts) and tastes as given.

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[12] For a formal treatment of the three generic strategies for outperforming the market (of which we just reviewed two), see "The Logical Ability to Outperform the Market," by H. W. Brock, *Rivista Internazionale di Scienze Sociali,* Vol. CXV, 2007, pp. 365-402.

Finally, we have reviewed how the existence of endogenous risk (excess volatility) offers opportunities for active managers to add alpha in a theoretically defensible manner via two canonical strategies: first, by making investments that exploit structural changes in the environment earlier and better than others do; and second, by exploiting the new logic of endogenous risk in a short-term trading environment. Both these opportunities are ruled out by the assumptions underlying the EMT.