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White Paper

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Alethea
[a-LAY-thee-uh] – noun
*from the Greek word meaning **"truth"***

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Worldly wisdom teaches that it is better for reputation to fail conventionally than succeed unconventionally.

- John Maynard Keynes

Beyond the Efficient Market Debate:

Utilizing Rational Beliefs to Capitalize on Market Opportunities

Introduction

In 1961, John Muth introduced the Rational Expectations Hypothesis and revolutionized the economics profession, ultimately leading to the Efficient Market Hypothesis (EMH). Though many of the EMH concepts are still helpful for understanding financial markets, a few key assumptions are flawed and must be updated to adequately navigate the marketplace. Unfortunately for the economics community, over a half century later far too many economic professionals continue to embrace the entirety of the stale hypothesis. Fortunately for us at Alethea Capital Management, we have formerly addressed the flaws in the hypothesis and embrace a more nuanced view via the Rational Beliefs Hypothesis. This has allowed us to capitalize on specific market inefficiencies and add substantial alpha to our client portfolios.

The EMH has had profound implications on a multi-trillion dollar investment industry. It is rooted in an overly simplistic assumption that all managers form their expectations *independent* of one another. Utilizing Game Theory, we argue that this is an erroneous assumption. In addition, we argue that the majority of money managers are not trying to actively outperform the market by the greatest margin, but rather are incentivized to protect their careers. Thus, career risk is the unassuming force that explains why more money managers do not outperform the market, not supreme market efficiencies.

We will then highlight what we believe to be a more realistic hypothesis called the Rational Beliefs Hypothesis, introduced by Mordecai Kurz in the 1990s. Unlike Rational Expectations, Rational Beliefs does not assume all expectations are independent and uncorrelated, but rather allows for various degrees of correlation in the distribution of market beliefs.

Efficient Market Hypothesis

The foundations for the Efficient Market Hypothesis were introduced by Eugene Fama in his dissertation paper in 1965 titled, "The Behavior of Stock Prices." The articles written on the topic today lack a proper definition of the EMH; instead, they focus on the conclusions rather than the assumptions and mechanisms that lead to the conclusions. Therefore, using the various papers by Eugene Fama, John Muth, Woody Brock, and other economists, we begin by presenting what we found to be the arguments of the EMH, including explaining the assumption of Rational Expectations.

A. Key Assumptions

After an exhaustive review of key literature, listed below are what we found to be the key assumptions of the Efficient Market Hypothesis (Lo 2007):

1. Individuals form expectations rationally ("Rational Expectations").
2. Markets aggregate information efficiently.
3. Equilibrium prices incorporate all available information.

B. Rational Expectations

The assumptions of the EMH are rooted in a theory known in academic circles as Rational Expectations. There is a misperception among investors today that Rational Expectations assumes that all market participants come to the same price projection of an asset, the price projection is the best possible prediction of the future value of the asset, and the price happens to be the closest to the intrinsic value based on the fundamental variables known at the time (Muth 1961). With this misperception, the theory has been assailed by investors who argue that individuals do not know how to perfectly price information and will often make mistakes. Therefore, at any point in time, the current market price can deviate from the intrinsic value which leads to an inefficient market.

In actuality, Rational Expectations in the EMH assumes that each individual will make an unbiased forecast based on the available information, and the forecast will be *independent* of other individuals' forecasts. However, they can *all* be wrong; the assumption is that they are wrong *independently*. We will call this the Independence Assumption. If this is true, then the market will take the forecasts and aggregate them efficiently so that the average of the market participants' forecasts is the closest to the best possible prediction of the future value of the underlying security. Hence, no elaborate algorithm or pricing model will give an investor an edge (Muth 1961).

Below is a graph of a normal distribution. The vertical line in the middle of the distribution represents the average of all market participants' forecasts. Each individual will have independent forecasts of price, and these forecasts will differ from the intrinsic value. For instance, some forecasts may be above the value and some below the value. Fama terms this "noise". Yet, as long as all of the forecasts are made independently, the average of the forecasts will be the best possible price given the publicly available information. For Fama, this "noise" nets out to zero around the intrinsic value assuming each individual forecast is independent.

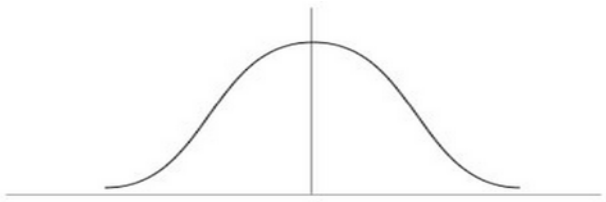

Image 1. Normal Distribution

C. Conclusion of Efficient Market Hypothesis

An important conclusion of the hypothesis is that an investor cannot consistently outperform the market on a risk-adjusted basis given the information available at the time of the investment without luck. More specifically, a market participant cannot use historical data (e.g. technical analysis) to gain an edge over the market to generate alpha, or outperformance, given that the information is already accurately priced into the market (Fama 1965). Therefore, active management and the fees assessed for such services is irrational (and some may argue immoral), because the net-of-fees return will be inferior to the overall market return.

However, if the market consists of rational participants, it begs the question as to why there are so many irrational people trying to beat the market – a supposedly impossible endeavor. Either the participants are irrational, which would suggest the market is not efficient based on the EMH, or the participants are rational, know the market is not efficient, and have a profit motive to work diligently to outperform it.

In addition, the EMH states that it is impossible to consistently outperform the market, yet there are a number of participants that have outperformed the market over decades and have amassed significant amounts of wealth because of it. The book series, *Hedge Fund Market Wizards*, is devoted to managers that have consistently generated massive excess returns on a risk-adjusted basis. As we will argue later, underperformance is not entirely a consequence of market efficiency, but, in part, the result of the incentive structure for managers to perform *conventionally*.

D. Problem with Efficient Market Hypothesis

The error in the Efficient Market Hypothesis can be boiled down to one key factor that any observant and experienced market participant can recognize: *the individual forecasts of the market participants are not formed independently of each other and are not uncorrelated*. Consequently, if participant views are correlated, the assumption that the market efficiently aggregates all of the errors (i.e. "noise") is deeply flawed. Since it is flawed, there is room for the market to inefficiently price securities, and this creates an opportunity for investors to generate excess returns.

It is not difficult to see how views can be correlated. In today's marketplace, technology has significantly changed the nature of investing. With the internet, CNBC, Bloomberg, 13F filings, Twitter, and the

finance blogosphere, it is effortless for investors to follow other top managers' views. Top managers will conduct sophisticated research on stocks or macro themes and then host public webinars to explain their views for anyone who wishes to listen – providing an opportunity for others to invest based not on independent research but on someone else's views.

Take, for example, when David Einhorn, a renowned hedge fund manager, divulges an investment thesis for shorting the company Athena Healthcare on May 5, 2014 after the close of U.S. market hours. When the stock opened for trading the next day, it declined over 13% and wiped out approximately $650 million of market capitalization. This is not a marketplace where views and beliefs are uncorrelated.

Recognizing that correlated views would create problems for his theory, Fama addressed this issue in his paper and presented a "plausible" market mechanism that would directly address these inefficiencies, thereby maintaining a near efficient market. He states:

> ***"Suppose now that the noise generating process in the stock market is dependent. More specifically assume that when one person comes into the market who thinks the current price of a security is above or below its intrinsic value, he tends to attract other people of like feelings and he causes some others to change their opinions unjustifiably. In itself, this type of dependence in the noise generating process would tend to produce 'bubbles' in the price series, that is, periods of time during which the accumulation of the same type of noise causes the price level to run well above or below the intrinsic value." [emphasis added] (Fama 1965, p.38)***

Before continuing, it is interesting to note that Fama acknowledges that, if such dependence did occur, it would produce price bubbles. But he argues that this will not occur because where there is an opportunity to make a profit, a trader will quickly bring the disequilibrium back to equilibrium. His intuition is:

> ***"If there are many sophisticated traders who are extremely good at estimating intrinsic values, they will be able to recognize situations where the price of a common stock is beginning to run up above its intrinsic value. Since they expect the price to move eventually back toward its intrinsic value, they have an incentive to sell this security or to sell it short…thus their actions will neutralize the dependence in the noise generating process and successive price changes will be independent." [emphasis added] (Fama 1965, p.38)***

In other words, market participants will quickly exploit the profit opportunity, and hence the opportunity will not remain present for long. However, is the presumption that "[sophisticated traders] have an incentive" an inescapable truism? We believe not. What Fama fails to discern is the natural tendency for investors to make decisions in their own self-interest and understand career risk as investment managers. It is obvious as market observers and portfolio managers ourselves that Fama is erroneous from both a practical and Game Theory perspective.

When presented with the question, "Why don't more money managers outperform the market?", the assumption made is that money managers are trying to outperform the market but cannot because the market is efficient. The truth is that the market is not only inefficient, but also the underperformance has more to do with portfolio managers caring more about job security than meaningfully

outperforming the market. We will illustrate how portfolio managers' predictable behavior is rooted in Game Theory.

Game Theory

A. Foundational Motivation

Before explaining directly how Game Theory can be used to contradict the Independence Assumption in Section B (above), a brief synopsis on the basics of Game Theory is necessary.

Game Theory is the study of decision making in competitive situations where the outcome of a participant's actions depends upon the actions of others. To motivate the topic, the classic "Prisoner's Dilemma" is described below.

"Big Tuna" Joe and "Two-Knife" Vinny are two mobsters that are arrested by the police, and each is thrown into solitary confinement for interrogation. The police will speak to each man individually and see if the mobster will either remain silent or sing like a canary and rat out the other man. Possible scenarios are listed below:

1) If both men betray each other, they will each serve 5 years in prison.
2) If Joe rats out Vinny and Vinny keeps his mouth shut, Joe will be set free and Vinny will serve 10 years in prison (and vice versa).
3) Finally, if both prisoners remain silent, they will each serve only 1 year in prison.

To understand the situation visually, the table below summarizes the payoff structure.

	Vinny stays quiet	**Vinny rats out Joe**
Joe stays quiet	Each serves 1 year	Joe serves 10 years Vinny goes free
Joe rats out Vinny	Joe goes free Vinny serves 10 years	Each serves 5 years

Table 1. Payoff Matrix – Prisoner's Dilemma

Table 1 shows that both would be best off collectively if they remained silent. Nevertheless, you can see from the analysis below that rational mobsters invested in their own self-interest will inevitably rat each other out. We see this as the rational outcome by viewing each prisoner's decision-making process individually. Let's start with Vinny's point of view. The policeman comes in and says that Joe may either rat him out or stay quiet. Without knowing beforehand what Joe will do, what would Vinny do?

1) If Joe rats out Vinny, Vinny can either stay quiet and serve 10 years or rat out Joe and serve 5 years. Thus, it would serve him best to rat out Joe.
2) If Joe stays quiet, Vinny can either stay quiet and serve 1 year or rat out Joe and go scot-free. Thus, it would serve him best to rat out Joe.

Notice that in both situations, not knowing what Joe will do in advance, it is best for Vinny to betray Joe. In addition, looking at it from Joe's perspective, the same conclusion applies. Even though they would both be better off cooperating with each other and keeping silent, when they are approached individually, they are incentivized to turn in the other mobster. Thus, the most logical outcome in this situation is for both mobsters to incriminate the other and for both to serve 5 years in prison. This should make intuitive sense since police authorities have been using these tactics for centuries to get results with criminals.

The point of Game Theory is to demonstrate that in many real world situations, one cannot make a decision without thinking about the possible decisions that others can make. After thinking through the decisions that others can make, an individual will choose the path that maximizes his/her payoff.

B. Application to Investments

Using this same framework, let us now examine payoff matrices to understand the best decision that a portfolio manager would make in different market environments.

The year is 1999, and Joe, Vinny, and the world of mobsters are no longer in the criminal enterprise, but rather the investment management world. Technology stocks are shooting stars, but doom lies in store in just the next year. Each mobster/portfolio manager can decide to either make a contrarian bet against what all of the other portfolio managers think, or "go with the flow" and invest with them. They also have the understanding that if they outperform the average portfolio manager, they will keep their job; if they perform as well as the average portfolio manager, they will also keep their job[1]; but if they underperform the average portfolio manager, they will lose their job. Finally, the benefits received by keeping their jobs far outweigh any benefits of losing their jobs[2].

Based on this setup, there are two possible worlds and two possible payoff matrices to examine: the year 1999 where the market rises to astronomic levels and any contrarian investment is incorrect, hurting the portfolio; and the year 2000 where the market crashes and the contrarian investment is correct, saving the portfolio.

[1] As long as the performance is within some random error term ϵ of the benchmark.

[2] More formally, each portfolio manager has a utility function $U(*)$ that incorporates the utility of keeping the job and losing the job. It is assumed for simplicity in this paper that we are dealing with large asset management firms where the portfolio manager's utility function is maximized by keeping his/her particular job. A more formal description is given in Appendix A to address situations where this is not the case (and also irrelevant to the conclusions of this paper).

i. *1999: Contrarian Investment Does Not Pay Off*

In the world where technology stocks are climbing ever higher and the contrarian investment does not pay off, thereby causing harm to the portfolio, the possible scenarios are listed below.

1) If both men invest in contrarian investments, they will both underperform the average portfolio manager and lose their jobs. After all, with the Nasdaq Composite rising 86% in one year, a losing investment would jeopardize any career.
2) If Joe is contrarian and Vinny invests like all other managers, Joe will underperform and lose his job (perhaps returning to the more lucrative mobster field). Vinny will keep his job, because he performed like all other managers in the industry. The reverse situation is also true.
3) Finally, if both men do nothing contrarian and invest like other portfolio managers they see, they will both keep their jobs since they did not underperform.

	Vinny is contrarian	**Vinny invests like others**
Joe is contrarian	Both lose their jobs	Joe loses his job Vinny keeps his job
Joe invests like others	Joe keeps his job Vinny loses his job	Both keep their jobs

Table 2. Payoff Matrix – Contrarian Investment Does Not Pay Off

Like the Prisoner's Dilemma, this situation must be viewed from each person's point of view, understanding that they do not know the other person's decision *ex ante*. Without knowing beforehand what Joe will do, what would Vinny do?

1) If Joe is contrarian, Vinny can either be contrarian and lose his job or invest like everyone else and keep his job.
2) If Joe invests like everyone else, Vinny can either be contrarian and lose his job or invest like everyone else and keep his job.

Notice that in both situations, not knowing what Joe will do in advance, it is best for Vinny to invest like everyone else.[3] Let us now turn to the world where the contrarian investment *does* pay off and in fact causes the portfolio manager to outperform his peers. Surely there are positive incentives to being contrarian…?

[3] Technically, Vinny's payoff does not directly relate to Joe's individual action but rather to what all money managers do collectively; this technicality does not alter the conclusions of this paper.

ii. *2000: Contrarian Investment Pays Off*

In the world where technology stocks crumble and the contrarian investment pays off, the possible scenarios are listed below.

1) If both men invest in contrarian investments, they will both outperform the average portfolio manager and keep their jobs. After all, avoiding the Nasdaq Composite's 39% decline is no small feat.
2) If Joe is contrarian and Vinny invests like all other portfolio managers, Joe will perform well and keep his job. Importantly, Vinny will also keep his job, because he performed like all other portfolio managers in the industry. Though he lost money, so did the next guy, so his clients stay with him. The reverse situation is also true.
3) Finally, if both men do nothing contrarian and invest like other managers, they will both keep their jobs since they did not underperform the average portfolio manager. How can anyone lose his job when everyone fared the same?

	Vinny is contrarian	**Vinny invests like others**
Joe is contrarian	Both keep their jobs	Both keep their jobs
Joe invests like others	Both keep their jobs	Both keep their jobs

Table 3. Payoff Matrix – Contrarian Investment Pays Off

Notice that, regardless of whether Joe or Vinny is contrarian, everyone keeps his job since no one underperforms the average portfolio manager.

C. Conclusion

Since a portfolio manager does not know beforehand whether making a contrarian investment will be correct and add value to a portfolio, the Game Theory payoff matrices above demonstrate that it is in the best interest of a portfolio manager who cares about his job security to invest like everyone else and "go with the flow". The downside of being incorrect with contrarian investments outweighs any possible upside so long as portfolio managers are interested in keeping their jobs. A portfolio manager investing like everyone else in 1999 and 2000 rode the stock market wave up and down, maintaining his job. A portfolio manager who was contrarian in both 1999 and 2000 *lost his job in 1999 and did not make it to 2000 to reap any rewards*.

Now to return to Rational Expectations and the Independence Assumption: note that since portfolio managers are humans who rationally care about their careers, it is in their best interest to view the investments of other managers, jump on the bandwagon, and take actions that are *dependent* on other actors.

Game Theory demonstrates the flaw in the Independence Assumption: views can be highly correlated, and bubbles can be created when a cycle enters a euphoria stage and the career risk of not participating is high. With the Independence Assumption debunked, we now turn to a new hypothesis that we believe to be more accurate – indeed, a hypothesis that maintains rationality of individuals but relaxes the assumption that views are independent and uncorrelated.

Rational Beliefs Hypothesis[4]

The Efficient Market Hypothesis assumed there was a normal distribution of expectations. Each individual's expectation was rational and independent of the other individual's expectation, which allowed for a normal distribution around the equilibrium price. In addition, if at any point current price deviated from the best price forecast of the asset, Fama argued that the "sophisticated trader," driven by profit opportunity, would correct this discrepancy, and price would quickly revert to its equilibrium value. Thus, market volatility results from new information that was not previously known.

This paper has already discussed the shortfall of the assumption that views are uncorrelated and independent from each other and that any price deviation will be quickly corrected by market participants because of profit opportunity. As we argued, views are far from uncorrelated, and Game Theory demonstrates that under a number of situations, a rational agent would not short a stock even when price was higher than the intrinsic value because of the credible threat of career risk. More strongly, we argued that sometimes the optimal decision is to purchase an overvalued momentum stock and participate in herd behavior rather than sit on the sidelines, as there is still some degree of career risk with underperformance. A great case study is the internet bubble when a number of managers identified the existence of the bubble itself but lost client assets during the phenomenon for not participating. As J.P. Morgan once stated, "There is nothing in the world which will so violently distort a man's judgment more than the sight of his neighbor getting rich."

We now propose a different hypothesis known as the Rational Beliefs Hypothesis (RBH). The assumptions of the RBH offer a more realistic characterization of the market place. The RBH assumes that each individual makes a forecast of the overall marketplace or an individual security, and this forecast is called a rational belief; it is a "belief" of what the market price will be. The market belief structure is the aggregation of these individual beliefs, also known as the distribution of beliefs. While the Efficient Market Hypothesis assumes the expectations are uncorrelated and the distribution is normal and centered on the equilibrium value, Rational Beliefs allows views to be correlated and the distributions to be non-normal, or skewed (Kurz 1999).

This section will be divided into four sub-sections to concisely explain a complex theory.

[4] The Rational Beliefs Hypothesis was first developed by the economist Mordecai Kurz of Stanford. Much of this section will be referencing his 1999 paper titled "Endogenous Uncertainty and Rational Belief Equilibrium: A Unified Theory of Market Volatility." In addition to Kurz's paper, we will reference a paper by renowned economist Woody Brock that develops the concept further and introduces a critical concept of Pricing Model Uncertainty and its role in generating equilibrium price over/undershooting.

1) Economic Structure – provides a background of how the hypothesis assumes the economy is structured.
2) Rational Beliefs and the Distribution – demonstrates how agents, within the specified economic structure, translate the information into beliefs and how the market aggregates the beliefs.
3) Pricing Model Uncertainty – shows how uncertainty in the pricing function of an asset increases the skew of a distribution.
4) Volatility – connects the hypothesis to what propagates market volatility.

Economic Structure

The Rational Beliefs Hypothesis begins with the foundation that our economy is a weakly stationary process, a concept that was developed nearly 30 years ago by mathematician R.M. Gray. The economy is driven by a process of technological and organizational changes coupled with innovation that dominates every aspect of life. This process is complex but has distinct characteristics: once a new technology or organizational structure is established, it remains in place for some time until a new one is developed to replace it. These structural changes are constantly occurring, and it is hard to predict exactly how they will play out before another occurs (Kurz 1999).

Below are two graphs that demonstrate the difference between a stationary economy and a weakly stationary economy (Kurz 1999; Brock 2007, 2013). The first is a stationary economy where the cycle perfectly repeats itself, and an investor knows the magnitude and timing of the cycle. The second is a weakly stationary economy where a market participant has historical data that provides very long run averages of an asset cycle for an economic variable going back 100 years but does not know when the cycle will mean revert (it may be decades).

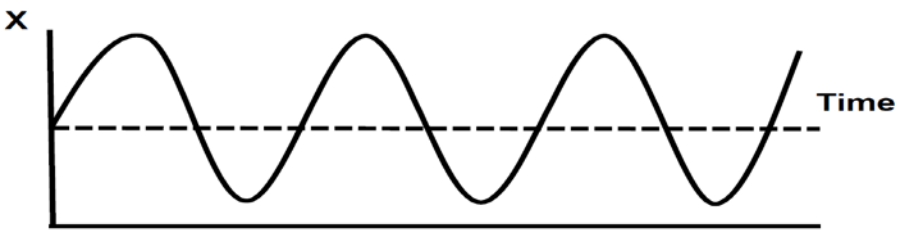

Figure 1. Stationary Economy

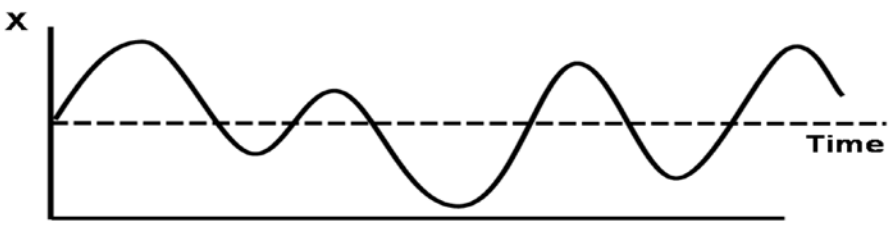

Figure 2. Weakly Stationary Economy

In a weakly stationary economy, the true average underlying the system cannot be learned completely, and even if an agent discovers it, he cannot be sure that it is the true average. Equally so, economic agents cannot learn the equilibrium map between market prices and those variables which determine prices (Pricing Model Uncertainty). Such a map may change over time. What agents do know is the empirical distribution of past data, which they can test theories and models against to develop a future forecast (Kurz 1999; Brock 2007, 2014).

Rational Beliefs and the Distribution

Because individuals do not have "structural knowledge" at the time of an investment decision, they must form a rational belief. A belief is considered rational if it is compatible with the empirical distribution of past data (Kurz 1999).

The marketplace is the aggregation of millions of individual beliefs and forms a distribution of beliefs. Recall that under Rational Expectations, this distribution is a normal distribution centered on the equilibrium price. Rational Beliefs does not assume that they are uncorrelated and centered on the equilibrium price. Rather, it assumes that beliefs can be correlated and skewed toward one side or the other of the equilibrium price.

The distribution of beliefs has a great effect on demand functions (think stock prices). If the distribution of beliefs is highly skewed bullish, the demand for a particular security will be high, and price will rise above the former equilibrium price. When sentiment shifts, the distribution will shift, and price will fall. Thus, the distribution is a propagation mechanism of price volatility. In fact, Rational Beliefs argues that the distribution of beliefs in the market is the most important propagation mechanism of economic volatility.

The magnitude of the skew of the distribution is related to the concept of career risk and Pricing Model Uncertainty (described below). When there is more uncertainty on how an asset should be priced, there is more opportunity for errors to occur. When the probability of being incorrect is higher, particularly relative to others, this behavior leads to increased correlation in beliefs, and the distribution is highly skewed to one side, pushing up the price.

In an environment where there is a high level of uncertainty and an asset has skyrocketed in value, many investors will jump off the bandwagon when negative news is released to avoid a steep decline. The collective action will violently shift the distribution to the negative side, causing a rapid swing in price. *This shift in the distribution is the single most important propagation mechanism for volatility*.

Pricing Model Uncertainty

A concept developed by Woody Brock called Pricing Model Uncertainty applies to Game Theory and the distribution of beliefs: when there is more uncertainty surrounding the pricing model of a specific asset class or security, there is more skew in the distribution (Brock 1995, 2007, 2014).

A pricing model is a model that an individual uses to take information and map it into a price for an underlying security. Two different individuals can view the same information yet price a security dissimilarly based on that information. Some markets have more uncertain pricing models than others. For example, the highly liquid U.S. treasury market has clear, distinct pricing relationships to well-known factors such as GDP and inflation. An obscure, small biotech stock has opaque underlying characteristics not well known outside scientific laboratories. Therefore, it is safe to assume that there is more pricing model uncertainty for this small biotech stock than for the U.S. treasury market.

Pricing model uncertainty connects closely with the discussion of Game Theory, because the greater the pricing model uncertainty, the greater the incentive to ride the trend rather than be contrarian. That is because there is an increased probability of being wrong by deviating from the crowd. In addition, the amount by which you deviate may be greater. This creates an incentive to stay with the trend when there is uncertainty, which consequently fuels the trend further.

As more individuals participate in a trend, their views become more correlated, and the trend will continue longer than otherwise would have occurred. This conduct can cause a pricing overshoot or undershoot, depending on the direction of the trend. The greater the pricing model uncertainty, the greater the overshoot and undershoot in any trend. Referencing the tech bubble again, internet stocks were extremely difficult to value given the dichotomy of companies being on the cutting edge of technology and innovation, which led to astronomical valuations, while producing negative earnings. This environment forced prudent managers into a “catch twenty-two”: either fight the prevailing trend and risk losing assets or buy into the craze and hope to sell before the bubble bursts. More managers joining the trend caused a massive overshoot in price from reality. The trends and overshoots/undershoots are what can cause both short-term and long-term cycles in specific asset classes.

Volatility

Within this new framework, what are the main drivers of market volatility, and how can that understanding be used to improve risk management within an investment process?

There are two components of volatility in the marketplace: exogenous and endogenous. Exogenous volatility is the volatility that arises from information that was not already priced into a security. The Efficient Market Hypothesis assumes all volatility results exogenously by non-forecastable data; i.e. unknown unknowns. Endogenous volatility refers to all other volatility that is not explained by the fundamentals; i.e. the volatility that arises during shifts in the distribution of beliefs. Given much has been written on exogenous volatility in the EMH debate, this section will focus on endogenous volatility and the shifts in belief distributions (Kurz 2001).

A key assumption to the Rational Beliefs Hypothesis is that the distribution of beliefs can be correlated depending on the magnitude of pricing model uncertainty for the asset. As a skewed distribution shifts from new information, uncertainty can cause the skew to have an amplification effect beyond what is justified by the new information.

An extreme example of this was the housing price crash in 2007. The distribution of beliefs was highly correlated to over optimism with home prices. Almost no one believed that home prices could ever fall, simply because they hadn't in the post WWII era. Once they began to fall, however, the entire distribution shifted to the other extreme, causing a large and violent decline with excessive volatility.

In 1981, Robert Shiller used a traditional model of equity valuation as a proxy for the efficient market hypothesis and demonstrated empirically that it could explain approximately 25% of observed equity market volatility over many decades. Interestingly, the lack of academic research to identify the source of the remaining 75% ultimately fueled the rise of behavioral finance and the theory of irrationality that has since dominated the debate. Furthermore, the vagueness of the theory itself made it arduous to substantiate. On the other hand, Mordecai Kurz, in validating his Rational Beliefs Hypothesis, was able to explain 95% of market volatility by utilizing models built from rational, heterogeneous beliefs. We believe this model is not only more realistic and applicable to the investment world, but is also more accurate in explaining market volatility.

How Alethea Capitalizes on the Rational Beliefs Hypothesis

At Alethea Capital Management, we believe that the Rational Beliefs Hypothesis forms a more appropriate foundation to the investment world than the Efficient Market Hypothesis. We believe that it is more important to examine portfolio managers as humans who care about their personal careers rather than emotionless robots attempting to beat arbitrary benchmarks. As such, we utilize Game Theory to examine the optimal decision making process of rational actors and find that they are incentivized to invest passively and to embrace benchmark-hugging strategies.

As portfolio managers are incentivized to duplicate investments of their competitors and hug the benchmark of interest, the prices of assets overshoot and undershoot their true values. The spread between the intrinsic value of an asset and the price at which it trades is determined in large part by Pricing Model Uncertainty. With larger levels of pricing uncertainty come stronger incentives to look at how everyone else is investing to obtain an estimate of the true value of the asset. In 1999, when professional investors were unsure as to how to price internet companies with no earnings but at the same time possessed a bountiful number of "clicks", they had little choice but to purchase the high multiple stocks just like their peers due to the pressures of career risk. Identifying such overshoots and undershoots provides abundant opportunities for alpha generation. At Alethea, we have created proprietary models to capitalize on these opportunities specifically in global large cap equities.

It is nearly axiomatic in the investment community that the large cap equity space is the most efficient space in which to invest since information is readily disseminated regarding the largest companies in the world. Certainly there is no additional piece of information that any particular investor may have that would provide for an opportunity to generate alpha. *Au contraire*! As you have learned from this paper, as more money managers turn off their minds and incorporate passive-esque strategies in a particular space, massive money flows occur simply to hug the "benchmark". Ironically, as more investors leave the large cap space to passive management, they are perpetuating the career risk

overshoot/undershoot cycle that creates opportunities for firms like Alethea to generate alpha via active management. Alethea's proprietary indicator maps each global large cap security in its own asset price cycle. The prices of these companies rise above and below their intrinsic values based upon investor herd behavior of jumping on and off the bandwagon. At any moment in time, the position of every company on its own price cycle map can be notated. Based upon the anticipated price movement of companies from this point forward, we construct a portfolio of companies to maximize the expected return/risk ratio. This methodology produces the most optimal and *stable* portfolios within any market environment.

Conclusion

The oft-heralded Efficient Market Hypothesis suffers from an egregiously simplistic Independence Assumption: the assumption that the market will aggregate the expectations of all individuals in an efficient and normally distributed manner. In reality, since market participants are humans that act rationally in the face of asymmetric information presented to them by other rational actors, they make decisions to maximize their personal payoff in life, choosing to maintain their personal careers by benchmark-hugging rather than investing in a contrarian fashion to risk their careers for the off chance of beating their peers.

In response, we presented a more realistic view of the market called the Rational Beliefs Hypothesis. The hypothesis, coupled with Game Theory and Pricing Model Uncertainty, assumes that beliefs in the marketplace can be correlated. These beliefs are aggregated into a distribution of beliefs, and as the distribution shifts, endogenous volatility arises.

When investors attribute portfolio manager underperformance against a benchmark to market efficiency, they are forming an incorrect conclusion. Instead, they should attribute portfolio manager underperformance to improperly aligned incentives in the marketplace (i.e. career risk). By shifting one's paradigm, proper focus can be placed on economic structural changes and cyclical amplifications that Pricing Model Uncertainty causes. It becomes conclusive that opportunities do indeed exist for achieving sizable outperformance for managers that are willing to be *unconventional*.

Appendix A

In this paper, the assumption was made that money managers have maximized utility functions when they keep their jobs. There are specific situations where this is not the case.

Generally, smaller money managers that are more entrepreneurial in nature do not fear the risk of losing their jobs as much as largely established money managers, because they know that they can always obtain jobs at large firms or try another entrepreneurial endeavor if performance is poor. Examples of these smaller managers would be start-up hedge funds, emerging managers, and newly created investment firms with a small capital base. Large, established money managers have a major disincentive to obtaining sub-par investment performance (e.g. PIMCO) and thus cannot make large market risks to try to produce significant alpha. It is for this reason that many endowments and foundations seek emerging managers and smaller firms for the opportunity they provide for alpha generation.

More formally, we construct the utility function of a money manager to be

$$U(*) \sim \frac{1}{\alpha} f(x) i_1 + g(y) i_2, \qquad (1)$$

where α measures the level of stability in a particular money manager's career position (e.g. manager is in a later stage in life where starting over makes no sense, manager has billions of dollars' worth of assets under management and has little incentive to stretch for outperformance). i_1 and i_2 are indicator variables, with $i_1 = 1$ and $i_2 = 0$ if a money manager is fired and $i_1 = 0$ and $i_2 = 1$ if a money manager is not fired. $f(x)$ is a concave function with different inputs $x_1, x_2, \dots, x_n$ affecting the manager's utility if that manager were fired and needed to obtain another job. $g(y)$ is a concave function incorporating all money management inputs $y_1, y_2, \dots, y_n$ if the manager were not fired and maintained his job.

Notice the α coefficient is inversely correlated with$f(x)$; thus, if a money manager is fired *and* has a very stable career position, any utility earned from the next best alternative diminishes. Conversely, if a money manager is able to take more career risk through alpha-generating investments and his α is less, the repercussions of losing his job are not negative enough to hinder contrarian market bets.

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