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Decision-making under Market Indeterminacy

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ABSTRACT

The Efficient Markets Hypothesis (EMH) is the focusing topic in the past 50 years of financial market researches. Many empirical studies are then provided that want to test EMH but have no consensus. The perception of EMH determines the attitude and strategy of participants and regulators in financial market. One perception of EMH argues that investors' behavior of seeking abnormal profits and arbitrage drives prices to their ''correct'' value. Investigating the "correct" value derives the concept of "market indeterminacy". It means the inability to determine whether stock prices are efficient or inefficient. Market indeterminacy pervades stock markets because "correct" prices are unknown because of imperfect information and model sensitivity. Market indeterminacy makes arbitrage risky and makes event studies unreliable in some policy and litigation applications. The concept of market efficiency is needed to be re-recognized considering the mechanism of price formation. In order to further research and practice in law and financial market, there needs a view from the "jumping together" of disparate disciplines. Adaptive Markets Hypothesis(AMH) that using the evolutionary principles in financial market is a new viewpoint on cognitive decision and deserves to be paid more attention to.

1. Introduction

The Efficient Markets Hypothesis (EMH) is the focusing topic in the past 50 years of financial market researches. Eugene F. Fama summarized EMH in 1970 that prices fully reflect all available information [1]. The concept of informational efficiency classified on various information sets available to market participants has a deductive meaning that the more efficient the market is, the more random and unpredictable the price fluctuation is. The economic explanation is financial traders try to profit from their information and the profit opportunities are quickly eliminated when investors trade in the market on analyzing their information. Just like the old saying that nobody would leave the money on the table. Rational expectations and market equilibrium become the foundation of modern financial economics.

As a hypothesis, EMH is tested by many empirical studies but have no consensus.

The earlier empirical studies tested whether prices of financial assets do fully reflect various types of information, and several tests (for example, the papers in Cootner, 1964 and Lo1997) have also studied the probabilities of price volatility. But the main critiques of the EMH test revolve around the preferences and behavior of market traders. The expected utility theory with the standard model of investors' preferences considers that investors optimize additive time-separable expected utility functions from certain parametric families, e.g., constant relative risk aversion. However, economists using psychological and experimental theories and methods find a lot of cognitive and behavioral biases

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of investors that departure from the original decision-making paradigm under uncertainty [2-5], which include loss aversion (Kahneman and Tversky, 1979; Shefrin and Statman,1985; Odean, 1998), psychological accounting (Tversky and Kahneman, 1981), miscalibration of probabilities (Lichtenstein et al., 1982), overreaction (DeBondt and Thaler, 1986), overconfidence (Fischoand Slovic,1980; Gervais and Odean,2001; Barber and Odean, 2001), regret (Bell, 1982; Clarke et al., 1994), hyperbolic discounting (Laibson, 1997), and herding (Huberman and Regev, 2001). These studies set forth different viewpoints of investors' behavior from the EMH and argue that investors are irrational even if not always. Then there comes the concept of Inefficient market coined by Andrei Shleifer (1999). We seemingly have the way to predict the market behavior according behavioral finance theory.

The supporters of the EMH have responded to the evidences and ideas of behavioral finance and insist that no rules have been found that can always beat the market.

There are also some empirical studies provided by complex researchers. Edgar Peters (1991) put forward the Fractal Market Hypothesis that the securities markets have the character of positive feedback mechanism and nonlinear structure [6]. Zhuang (2001, 2004) analyzed the scaling and fractal structure in Chinese stock market applying autocorrelation index, Hurst index and scaling index on the basis of detrended fluctuation analysis (DFA) algorithm [7]. These studies demonstrate the market price is not random-walking but an evolving process.

Tonis Vaga proposed the Coherent Market Hypothesis (CMH) in his book 'Profiting From Chaos' (1994). The CMH considered the financial markets are complex systems containing investor expectation, government policy, technological and financial innovation, and other factors changing over time, which run as complex dynamic progressions similar to those explained by chaos theory. According to CMH, there are four types of markets emerge during different phases of economic cycle: steady state random walk, unstable transition, chaotic dynamics, or coherent cycles.

A comprehensive thought suggests that the EMH and perspectives supporting market inefficiency are opposite sides of the same coin.

Andrew W. Lo proposed in his articles (2005,2012, 2017,2019) the Adaptive Markets Hypothesis (AMH) that reconciled market efficiency with behavioral alternatives. He extended Herbert Simon's thought of bounded rationality and satisficing principle and analyzed financial markets applying the principles of competition, adaptation, and evolution in financial market dynamics [8-11].

The perception of EMH determines the attitude and strategy of participants and regulator of financial market. But how should we understand the contradiction among so many study results?

When doubting on the EMH, we focus an argument that competition and interaction between investors seeking abnormal profits drives prices to their "correct" value. Look through what is the "correct" value and then we may have a clearer viewpoint.

2. Market Indeterminacy

Through deep investigation of "correct" value, there comes the concept of "market indeterminacy". It means market efficiency is not determined by some certain factors and can not be tested or is changing because financial markets are dynamic evolutionary systems. Till now, we can not verify EMH by accurate evidence and whether successful investments are derived from skill or lucky. Market indeterminacy pervades asset markets, because financial markets are open systems with dissipative structures. So that, we lack reasonably precise models of "fundamental value", or "correct" prices sometime called, against which investors identify the difference between current price and its true value.

2.1 Uncertainty of Intrinsic Value

2.1.1 Valuation Model with Imperfect Information

"Correct" value is often referred to the intrinsic value or fundamental value. Intrinsic value can be derived from dividend discounted model (DDM) (Williams,1938) based on present value theory [12]. In stock valuation, it is

$$\begin{aligned} V_0 &= \frac{D_1 + P_1}{1+r} \\ &= \frac{D_1}{1+\mathrm{r}} + \frac{D_2}{(1+r)^2} + \ldots\ldots + \frac{D_H + P_H}{(1+\mathrm{r})^H} \\ &= \frac{D_1}{1+\mathrm{r}} + \frac{D_2}{(1+\mathrm{r})^2} + \frac{D_3}{(1+\mathrm{r})^3} + \ldots\ldots \end{aligned} \tag{1}$$

Where, V_0 is the intrinsic value at present, D_H is dividend in year H, P_H is the stock price at the end of year H, r is the expected return. Here we find the big problem. Although the model is accurate, there is no accurate solution because we haven't definite input data for the model. Dividend per share and the traded price in the future are unknown at present. The stocks haven't a fixed year to maturity. Even the expected return is changing with investors' sentiment. To solve the problem, there must be some assumptions. For example, let $D_1 = D_2 = \ldots\ldots D_n,\ n \to \infty$, or investment horizon is one year and $P_1 = V_1 = V_0$, then Equation (1) turns to be

$$V_0 = \frac{D_1 + P_1}{1+\mathrm{r}} = \frac{D_1 + V}{1+r}, \quad \text{or}$$

$$V_0 = \frac{D_1}{1+r} + \frac{D_1}{(1+r)^2} + \ldots\ldots + \frac{D_1}{(1+r)^n}, n \to \infty$$

In both cases, there comes

$$V_0 = \frac{D_1}{r} \tag{2}$$

Unfortunately, V_0 has little usefulness though it is a definite value because the assumptions are far from the reality. So the difficulty of applying the valuation model comes from the imperfect information about the future.

Now there is a puzzle in valuation model. It is difficult to make a trade-off between accuracy and applicability.

A reason to use simplified model is fluctuation can be screened by averaging the data. Then, can the valuation model be useful? The answer is no.

2.1.2 Sensitivity of Stock Prices

For more reasonable design, we consider the constant growth Gordon model combining the growth factor. It captures the intuition of more complicated rational stock pricing models that price stocks as the present value of future cash flows. In the model, stock price at time t, $P_{t\text{-}1}$ is given by

$$P_{t\text{-}1} = \frac{D_t}{r - g_{t\text{-}1}} \tag{3}$$

where r is the annual expected rate of return demanded by investors, D_t denotes next year's dividend, g_{t-1} is the annual growth rate of dividends. For simplicity, we assume the expected return is constant. Variables known to investors prior to the event are denoted with a subscript $r-1$ and subsequent to the event by subscript t.

On date t, assume there is news about the growth rate of dividends g, which is the unexpected "event". We will focus on errors in expected returns, not errors in cash flow forecasts, so assume that the market accurately revises its expectations from g_{t-1} to g_t. Let Δg denote this change. The typical "abnormal return", AR, observed on the event day is approximately the percent change in the stock price given by:

$$AR = \frac{P_t}{P_{t-1}} - 1 = \frac{\Delta g}{r - g_t} \tag{4}$$

Now we concern about what if r is wrong? Expected return errors may create very large mispricing effects even when they are "small" that can be seen in Table 1. We fix the growth rate of dividends g_{t-1} at 4% and calculate the resulting percentage errors in price. In the Gordon growth model, the size of these errors depends on the difference $r - g$ in the denominator.

Table 1. Sensitivity of Stock Prices to Errors in Expected Rate of Return

	r	8%	10%	12%	14%
	P_{true}	25.00	16.67	12.5	10.00
Induced error in expected return:	-5%	---	500	167	100
	-4%	---	200	100	67
	-3%	300	100	60	43
	-2%	100	50	33	25
	-1%	33	20	14	11
	0	0	0	0	0
	+1%	-20	-14	-11	-9
	+2%	-33	-25	-20	-17
	+3%	-43	-33	-27	-23
	+4%	-50	-40	-33	-29
	+5%	-56	-45	-38	-33

Errors in expected returns also affect event day abnormal returns. The percentage change in AR with respect to small expected return error is given by:

$$\frac{dAR}{dr} \cdot \frac{1}{AR} = -\frac{\Delta g}{(r - g_t)^2} \cdot \frac{1}{AR} = -\frac{1}{r - g_t}$$

Therefore, if the expected return is incorrect by Δr, the resulting percentage change in the AR is approximately given by

$$\frac{\Delta AR}{AR} = -\left(\frac{1}{r - g_t}\right)\Delta r \tag{5}$$

Like the error in prices, the error in the event-day abnormal return increases in the difference between investors' discount rate and the presumed new growth rate, holding constant the expected return misspecification, Δr.

Here, we simply point out with simulation evidence that undetected inefficiencies can result in prices and price reactions that are incorrect. Prices CAN react "quickly" to news in the short run, but there is no guarantee that the price reaction is a correct or reasonable measure of the true value due to the change in growth rate. If expected returns are incorrect, because of business cycle, then all stocks affected by those expected returns may be mispriced.

Sensitivity of stock prices also manifests the market indeterminacy.

2.2 Market Efficiency Tests Lack Power

Eugene F. Fama (1998) reviewed empirical tests on EMH in his paper "Market efficiency, long-term

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returns, and behavioral finance" and made the following conclusion "Some anomalies do not stand up to out-of-sample replication. The long-term negative post-event returns of dividend-omitting firms also seem sensitive to sample period. The long-term return anomalies are fragile. They tend to disappear with reasonable changes in the way they are measured". Considering the contradiction of different test results, we should not make conclusions in haste upon any of the test, but think over whether the test itself is right. When a test finds the market inefficient, there are two possibilities. One is the market is inefficient and investors are irrationality, the other is the market is right and people have not used suitable model to reflect the reality and make a logical interpretation. This is the paradox on market efficiency test [13]. EMH emphasizes the information efficiency which is different from the allocation efficiency. There is a lot of information besides accounting data that can incorporate in the price. We can not gather all information and incorporate it into an accurate valuation model to test the efficiency. A test using part of the whole information set is definitely inaccurate. On the other hand, the empirical tests lack power because they are from the perspective of looking backward. They use historical data to test the valuation of securities which is in fact determined by the future. This methodology of test is wrong on the earth, especially for stock pricing test. The right way to test ought to use the present value theory based on future data. But the future is unknown. From the valuation model, we see we can not know the""correct value". The price has no target to converge. Thus market efficiency is untestable and indeterminate.

3. Implications

3.1 Market Efficiency is Needed to be Understood Thoroughly

There is a paradox on market efficiency and profit opportunities. Grossman (1976,1980) argues that if markets have perfectly informational efficiency, there is no profit to gather information, in which case there would be little reason to trade and markets would eventually collapse.

From this paradox, we recognize that the concepts of market efficiency and market equilibrium on the basis of price's converging to a "correct" value are static and do not match the market dynamics. An alternative perspective is that the stock market is in an evolution process of value discovery incorporating all available information. In this process, market efficiency can be interpreted that the market is a self-adaptation system. Thus market efficiency can exist concurrently with profit opportunities and market efficiency does not mean random-walking and unpredictable.

3.2 Analysts and Arbitrageurs Face the Risk of Market Indeterminacy

Professors Asquith, Mikhail, and Au study a thousand investment reports written by analysts who were members of the All-America Research Team [14]. This study suggests that analysts have no sophisticated models of their own for fundamental value, but use rule-of-thumb approaches to derive their "target price" when they make the value estimation with financial data. And the analysts often price assets comparing the prices of other assets, namely do pricing on a "relative" basis.

From the valuation model, we can see the intrinsic value can not be accurately calculated and may be changing. Nobody knows the "correct value" at any time. Thus we can understand why analysts use rule-of-thumb approaches. Consequently, it is completely risky to believe that such relative pricing heuristics will drive prices to "correct" absolute levels. Arbitrageurs face the risk of market indeterminacy. The story of Long-Term Capital Management (LTCM) , which is the famous hedge funds collapsed in 1998, is a lesson of ignoring the risk of market indeterminacy.

3.3 It is Hard to Distinguish Fraud Cases on Market Efficiency

Because of market indeterminacy, the change in "fundamental value" at the time of an event can not be measured accurately. So, there is insufficient scientific basis to judge the fraud or manipulation in financial market on the conception of market efficiency. It is still a problem to set up rational criterion for market regulation and policy.

4. Conclusions

There are many implications of market indeterminacy and market efficiency that need to be discussed.

The practical and meaningful question is not that the market is efficient or not, but to evaluate the degree of market efficiency.

The characteristics of investors' behavior are derived from market indeterminacy. Investment decision-making is based on the analysis and judgement of the economic prospect in the future. So it depends on professional skills for economic perception but inevitably faces the risk coming from market indeterminacy. Investors' behavior contains bounded rationality and sentiment because they don't know the price right or not. This feature is just the nature of securities market. Market indeterminacy determines the existence of risk along with returns.

Because models of fundamental value are excessively

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imprecise, investors spend most of their time using relative (not absolute) valuation measures. Such is the view of Lawrence Henry Summers, former Director of the White House's National Economic Council, writing in the 'Journal of Finance' in 1985. He related the ketchup economics as"They have shown that two quart bottles of ketchup invariably sell for twice as much as one quart bottle of ketchup except for deviations traceable to transactions costs … Indeed, most ketchup economists regard the efficiency of the ketchup market as the best established fact in empirical economics."

While relative valuation is the common rule in economies, financial markets might be highly volatile since a small amount of news for one set of securities may create systematic risk and lead to revisions in stock prices in the whole market. This is the butterfly effect in complex system, where the systematic risk may be very hard to quantify or hedge.

Considering the mechanism of price formation, we should understand that price incorporates not only fundamental information but also investors' perception on the information. Investors' sentiment, optimism or pessimism, also inspires prices greater volatility. George Soros set out his perspective like this with reflexivity theory in his book "The Alchemy of Finance"(1994).

Understanding the mechanism of price formation, market regulation should focus on two aspects. One is to regulate the revelation of fundamental information including information of listed companies, macroeconomic dynamics and government policy. The aim is to guarantee the information reflecting the reality. The other aspect is to constitute and carry out a stabilization policy for securities market just like monetary policy for money market and the whole economy.

For investors' decision-making, it is more important to pay attention to value estimation than price speculation. Price fluctuation is actually unstable because of investors' non-rationality. Investors who keep the idea of long-term value investing in mind and set it up as their belief can earn money. Long-term value investing, although can not outperform price speculation at any time under market indeterminacy, stands on the basis of value creation and sharing in the real economy, and can gain profit and resist the risk eventually, especially avoid involving in a Ponzi scheme or speculation trap which is a castle in the air described by Meynard Keynes.

It will be very useful to remember and respect the following sentences. One is an old chinese saying, "Only when you bear your dream in mind can you possibly realize it and reach your destination". Another is the famous saying by John Meynard Keynes also Warren Buffet, "I would rather be vaguely right than precisely wrong". When market indeterminacy is studied and understood, the sentences above become meaningful.

For theoretical thinking, time arrow is a key factor for investment analysis. Decision-makings based on analysis in the ex ante or ex post are different. So, the differences between uncertainty and risk, possibility and probability, CAPM and DCF model etc, are all needed to be investigated. Strict uncertainty emphasized by Frank Knight in his book "Risk, Uncertainty and Profit"(1921) is corresponding to the environment of market indeterminacy in real economy.

Economics can serve the economy only if economic researches go into the reality and respect the market.

In order to further research and practice in law and financial market, we should get deep known of the mechanism of price formation where investors' behavior plays the central role. So there needs a view from the "jumping together" of disparate disciplines such as psychology, the cognitive neuroscience, economics and finance, even studies on social morality and cultural tradition. Thus, the Adaptive Markets Hypothesis (AMH) is a promising viewpoint on cognitive decision and market dynamics, which deserves to be paid more attention to.

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