EC-371 Economics Analysis of Asset Prices

Term Paper

Adaptive Market Hypothesis: A Substitute for Efficient Market Hypothesis?

---Identify the distinctive characteristics of "Adaptive Market Hypothesis" compared with "Efficient Market Hypothesis" and assess their respective strengths and weaknesses

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Ⅰ Introduction

In the financial market, all investors hope to earn as many profits as possible. With the development and improvement of fundamental analysis and technical analysis, investors seem to discover some plausible and feasible ways to evaluate the asset prices.

However, the proponents of the Efficient Market Hypothesis (EMH) may tell you that all your efforts are in vain. Here is the joke about a finance professor and his student. They wander around the street and see a $100 bill lying on the ground. When the student is about to pick it up, the professor prevents him and says, “if it were really a $100 bill, it would not be there”. The ivory-towered story tells us that the professor believes all passengers are rational and markets are always efficient. If it is the real bill, others should have picked it up. This is the simplest implication of the Efficient Market Hypothesis: everyone in the market is rational and there is no such thing as a free lunch.

However, in the early twenty-first century, many behavioural economists researched with psychologists and reckoned that asset prices are somewhat predictable. They believed that investors could **adapt** to the market environment. According to the principle of survival of the fittest, the market will eliminate those who are unable to adapt to the market environment. And the principle is called the Adaptive Market Hypothesis (AMH) and its proponents claim that it is more realistic than the Efficient Market Hypothesis.

But does it mean the AMH is more accurate than the EMH? Should we substitute the former for the latter? It this paper, we will try to solve these questions.

This paper aims to identify the main characteristics of the AMH and the EMH by examining the differences in the underlying assumptions and evaluating their implications for informational efficiency. We will begin with the origins, assumptions, and forms of the EMH and will also use empirical analysis to test the market efficiency in the U.S. stock market. Then we will discuss some challenges that the EMH faces and some asset market anomalies. Thirdly, we will introduce the origins, assumptions, and implications of the AMH. Finally, we will make comparisons between the two and put forward some opinions.

Ⅱ Efficient Market Hypothesis

The research of the EMH is based on the random walk hypothesis. Broadbent and Kendall (1953) analyze the price volatility of wheat futures market and find that there exists a stochastic trend in wheat futures prices. Similarly, Fama (1965) examines the distribution of excess stock returns and concludes that the stock price satisfies the random walk hypothesis and it could not make meaningful predictions concerning the future price of the stock. Meanwhile, Samuelson (1965) derives the theory of rational expectation and points out that rational investors compete in seeking and using the information to affect asset prices. Therefore, under the assumption of risk-neutral probabilities, price changes should be unforecastable if the information and expectations of all market participants are fully anticipated. In 1970, the EMH was firstly proposed by Fama (1970) who defines the "efficient" market as the market in which security prices could "fully reflect" all available

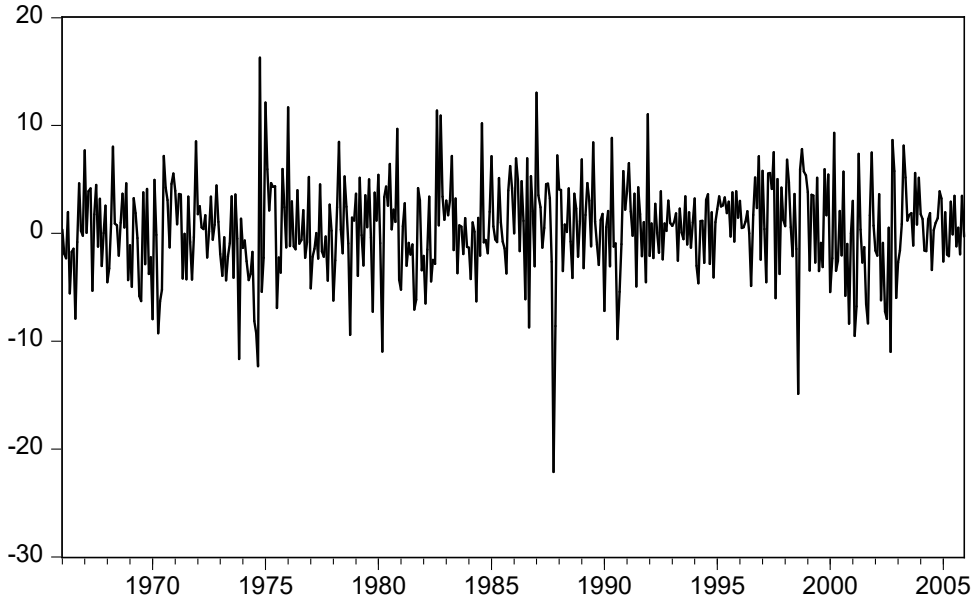
information. In the efficient market, important information could be obtained by investors at the same time without incurring some costs simply by observing prices. Fama (1970) also classifies the information set into three levels in order to be precise about the term "relevant information": if prices reflect all current and historical price information, the market is Weak Form Efficiency; if prices reflect all publicly available information, the market is Semi-Strong Form Efficiency; if prices reflect all information including private or inside information, the market is Strong Form Efficiency. Nevertheless, Malkiel (2003) gives a slightly different explanation about the term "efficiency". He thinks that the market is efficient if investors cannot earn above-average returns without exposing above-average risks. To formulate it in the CAPM model: $r_j = \alpha_j + \beta_j(r_m - r_o) + \varepsilon_j$, the term α_j is equal to zero if the market is efficient. So, he claims that market could still be efficient even though there exist valuation errors (ε_j), or market investors are quite irrational. In the late 1970s, a neoclassical version of the EMH came out and expanded to accommodate risk-averse investors (Lo, 2004). Nowadays the contemporary version of the EMH is summarized by Lo and Mackinlay (2002), stating that asset prices conform to the principle of supply and demand; demand curve and supply curve are derived from investors' and entrepreneurs' preference, and both could face uncertain costs or business conditions.

Actually, although the EMH has been constantly developed and innovated, the key points are unchanged. Firstly, all individual investors have rational expectations. Investors use fundamental analysis (the analysis of financial information such as dividend yields, earnings per shares, etc.) to earn a higher return than those who just select the

securities randomly or do a buy-and-hold strategy. Secondly, markets aggregate and disseminate information efficiently. Once the new information is spread to the public, asset prices fluctuate and fully reflect all relevant information.

However, how to use empirical analysis to test whether the market is efficient ? Bailey (2005) proposes that judging the market efficiency depends on the criteria we choose. For example, markets might be efficient according to one set of the criteria, but they might be inefficient according to another. Here is one example to test the weak form efficiency. Figure 1 depicts the monthly excess stock returns (S&P500 returns minus the risk-free rate - typically three-month interest rate) between January 1966 to December 2005 from Yahoo Finance Website. The data has 480 observations and the model we choose is the random walk model.

Figure 1: Excess Return on S&P 500 Index from 1966M1 to 2005M12



source: Yahoo Finance

Then we test the efficiency of the excess return. The null hypothesis states that the autocorrelation of excess return at time t and its previous value is equal to 0; the alternative hypothesis states that the autocorrelation of excess return at time t and its previous value is NOT equal to 0. That is to say:

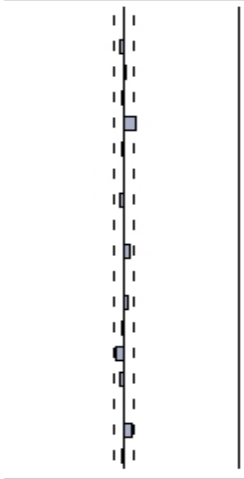
$$Ho: corr\ (r_t\ ,\ r_{t-k})=0$$

$$H_A: corr\ (r_t\ ,\ r_{t-k})\neq 0$$

Figure 2 represents the sample excess returns correlogram. From the figure, the absolute values of autocorrelation were less than 0.11 at any lag, so we cannot reject the null hypothesis. In conclusion, it is evident that there exists weak form efficiency in the stock market. However, this method merely tests the weak form efficiency. Testing semi-strong form efficiency and strong form efficiency may have the same procedure but the model we choose might be different.

Figure 2：Excess Stock Returns Correlogram

Date: 01/17/18 Time: 22:31
Sample: 1966M01 2005M12
Included observations: 480



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.006	0.006	0.0188	0.891
		2	-0.029	-0.029	0.4189	0.811
		3	0.015	0.015	0.5243	0.914
		4	-0.024	-0.025	0.8082	0.937
		5	0.105	0.106	6.1696	0.290
		6	-0.017	-0.021	6.3080	0.390
		7	-0.008	-0.000	6.3382	0.501
		8	-0.040	-0.046	7.1297	0.523
		9	-0.005	0.002	7.1411	0.622
		10	0.045	0.031	8.1324	0.616
		11	-0.001	0.003	8.1330	0.701
		12	0.033	0.035	8.6850	0.730
		13	-0.011	-0.004	8.7417	0.792
		14	-0.071	-0.070	11.265	0.665
		15	-0.031	-0.041	11.743	0.698
		16	0.002	0.000	11.746	0.761
		17	0.072	0.068	14.367	0.641
		18	-0.019	-0.016	14.547	0.693

In the 1980s, with the development of behavioural finance, the EMH faces huge challenges. Theoretically speaking, the critics of the EMH argue that information cannot be gathered and expanded to all investors instantly. Grossman (1976) and Grossman and Stiglitz (1980) argue that if asset market is fully efficient, nobody is willing to gather information and there is no reason to trade. Empirically speaking, when we test the market efficiency, we assume the model we use is correct. So, if the result indicates that the market is inefficient, we may think that it is the problem of the model we choose since they have their own weaknesses. For the reason that the validity of the EMH completely relies on empirical analysis, some asset market anomalies have a strong impact on the EMH. For instance, Thaler (1987) finds the January effect –the shares of small firms have a higher possibility to experience above-average return in the first half of January; Lo and Mackinlay (2002) find that the short-run serial correlations of stock returns are not equal to zero and stocks which have above-average return tend to move in the same direction, which was called as Momentum Effect and initially found by Jagadeesh and Titman (1993); Hirshleifer and Shumway (2003) find that asset prices are negatively related to cloudy weather. Therefore, the existence of financial anomalies implies that technical analysis (using some trading rules to exploit the profitable opportunities) could be effective, and investors could earn above-average profits. Not only that, the EMH fails to explain the financial crisis. Thus, the weaknesses of the EMH promote the development of behavioural finance and establish a new hypothesis –the Adaptive Market Hypothesis (AMH).

Ⅲ Adaptive Market Hypothesis

In the late 1980s, economists try to use behavioural approaches to analyze investors' behaviour and judge whether asset prices are predictable. Some of them connect the evolutionary principles with investors' behaviour. They demonstrate that people in the financial market are akin to organisms in the ecosystem. Through generations of natural selection, only those investors who successfully adapt to the environment can survive in the financial markets. Andrew Lo (2004) firstly proposes the Adaptive Market Hypothesis (AMH) in the paper <The Adaptive Market Hypothesis – Market Efficiency from an Evolutionary Perspective>. He makes several assumptions of the AMH in this paper: Firstly, he agrees with bounded rationality proposed by Simon (1955). Investors are not always seeking optimization because optimization is costly and not all investors are smart to pursue optimization. Contrarily, they merely prefer to be satisfactory or at least survival. That is to say, investors are "bounded in their rationality" (Lo, 2004). Secondly, investors are not quite intelligent to make correct reactions when the new information influence the market. Lo admits that investors could make mistakes in the financial market because either some information are misleading or cannot obtain instantly. Even if they are aware of the changing information, they still need time to adjust and learn. Therefore, the heterogeneity of investors contributes to the competition： investors revise strategies from their mistake in order to avoid elimination. Smart investors also learn from the actions of others to achieve above-average returns because the profit opportunities in the financial market are similar to the natural resource in the ecosystem, competition between investors promotes adaptation and affects asset price ultimately. Lo (2004)

considers that under the AMH, environmental conditions and investor's adaptations have a significant impact on asset prices. In particular, psychological variables are highly correlated with market events even for skilled securities traders (Lo and Repin, 2002). Similarly, Rolls (2000) finds that emotions form a mechanism which pushes the process of "natural selection" in the financial market. After incurring the loss, unsuccessful investors are eliminated from the population.

Despite that the AMH has more realistic and intuitive assumption, today's stock market is faster and more diverse than any other time, it cannot be valid without critical implications. Therefore, it is significant to illustrate some practical implications of the AMH for portfolio management. The most important one presented by Lo (2012) is that the trade-off between risk and rewards is not stable over time but determined by the number of market participants and the regulatory environment. Because the aggregate risk preferences are not constant all the time: when investors fear the market, they are willing to put more money in the bank rather than hold risky assets, which decrease the average return on risky assets, and vice versa. Also, when it comes to the populations of market participants, through the force of natural selection, unsuccessful investors are likely to be eliminated to the market and the aggregate risk preference will change as well. The second implication states that arbitrage opportunities exist from time to time. The classical efficient market hypothesis implies that since information is available to individuals simultaneously, it is impossible to make risk-free profits for risky investors. Nevertheless, the proponents of the AMH argue that there exists asymmetry information and asset price cannot adjust promptly. In fact, arbitrage opportunities accelerate the price

equilibrium of financial markets. The third implication implies that investment strategies will perform well in some circumstances but badly in others. Lo (2004) finds that the rolling first-order autocorrelation of monthly returns on stock index might be larger in the early period of the sample and become smaller as the stock market becomes efficient. However, in the context of random walk model, the EMH implies that the autocorrelations of stock be strictly equal to zero in theory. The fourth implication states that survival is the primary objective and innovation depends on survival. Because risk and reward relationships vary from time to time, innovation is necessary for investors to adapt to changing market conditions.

IV Will the AMH substitute for the EMH?

Since we have discussed the EMH and the AMH separately, is there any relationship between the two? In one word, the EMH highlights the unbounded rationality and the availability of relevant information, people cannot earn the above-average return in the market; the AMH considers that asset markets are impossible to be always efficient and changing in the market environment can affect investors' behaviour. For Lo's perspective, eventually after investors have made all adaptations to the existing environment and nobody was eliminated, asset market achieve efficiency, thus the EMH is an idealization to describe the markets. But the speed of adaptations is uncertain, nobody can predict the accurate time of efficiency.

In macroeconomics, we learn the knowledge of adaptive expectations. If we use

adaptive expectations to predict the macroeconomics variables such as consumer price index or GDP growth rate, we may suffer from systematic forecast error which continuously makes mistake. Does the same problem occur in the adaptive market hypothesis? From my point of view, it will incur error temporarily, but it is the error that make risky investors earn risk-free profits. Because they need time to learn from the error and those who failed to learn the lesson from the mistake may just exit. Eventually, after the last less successful investor gives up, the AMH will no longer suffer from error.

Although the AMH is close to the reality, it could not be considered as a substitute for the EMH. Because in my opinion, the significance of the EMH is not to judge whether the market is fully efficient. Instead, the EMH resembles the foundation in the research of the financial market and it provides important enlightenment for further research. Overall, what we need is a correct approximation rather than a precise answer.

V Conclusion

This paper presented the EMH and AMH to analyze the asset market efficiency. In section Ⅱ, we focus on the development of the EMH. The EMH suggests that asset prices are unpredictable, all investors have rational expectations and all the relevant information are available to investors. In addition, we also distinguished three forms of efficiency: weak form efficiency, semi-strong form efficiency, and strong form efficiency. We used the empirical analysis to test the efficiency of U.S. stock market and we discussed some challenges the EMH faces as well as some anomalies which cannot be explained by the

EMH. In section Ⅲ, we explained that the behavioural economists apply ideas from evolutionary principle to the study of investor's behaviour and claimed that the financial market also exists the theory of "the survival of the fittest". Then we discussed assumptions and implications of the AMH, indicating that the AMH is more realistic to the asset market. In section Ⅳ, we understood that under the AMH, after adaptation are made completely, the EMH is a good approximation to the markets. Although the AMH is more realistic, we failed to say that the AMH is a substitute for the EMH because the EMH provides important inspirations for further research.

VI Bibliography

Bailey, R.E., 2005. The economics of financial markets. Cambridge University Press.

Broadbent, S.R., and Kendall, D.G., 1953. The random walk of Trichostrongylus retortaeformis. Biometrics, 9(4), pp.460-466.

Fama, E.F., 1965. The behavior of stock-market prices. The Journal of Business, 38(1), pp.34-105.

Fama, E.F., 1970 and Malkiel, B.G. Efficient capital markets: A review of theory and empirical work. The Journal of Finance, 25(2), pp.383-417.

Grossman, S., 1976. On the efficiency of competitive stock markets where trades have diverse information. The Journal of finance, 31(2), pp.573-585.

Grossman, S.J. ,and Stiglitz, J.E., 1980. On the impossibility of informationally efficient markets. The American economic review, 70(3), pp.393-408.

Hirshleifer, D. and Shumway, T., 2003. Good day sunshine: Stock returns and the weather. The Journal of Finance, 58(3), pp.1009-1032.

Jegadeesh, N. and Titman, S., 1993. Returns to buying winners and selling losers: Implications for stock market efficiency. The Journal of finance, 48(1), pp.65-91.

Lo, A.W. and MacKinlay, A.C., 2002. A non-random walk down Wall Street. Princeton University Press.

Lo, A.W. and Repin, D.V., 2002. The psychophysiology of real-time financial risk processing. Journal of cognitive neuroscience, 14(3), pp.323-339.

Lo, A.W., The Adaptive Markets Hypothesis: Market Efficiency from an Evolutionary Perspective. 2004

Lo, A.W., 2012. Adaptive Markets and the New World Order (corrected May 2012). Financial Analysts Journal, 68(2), pp.18-29.

Malkiel, B.G., 2003. The efficient market hypothesis and its critics. The Journal of Economic Perspectives, 17(1), pp.59-82.

Rolls, E.T., 2000. On the brain and emotion. Behavioral and brain sciences, 23(2), pp.219-228.

Samuelson, P.A., 1965. Proof that properly anticipated prices fluctuate randomly. IMR; Industrial Management Review (pre-1986), 6(2), p.41.

Simon, H.A., 1955. A behavioral model of rational choice. The quarterly journal of economics, 69(1), pp.99-118.

Thaler, R.H., 1987. Anomalies: The January effect. The Journal of Economic Perspectives, 1(1), pp.197-201.