

# Efficient Market Hypothesis

## 1 Efficient Market Hypothesis

The Efficient Market Hypothesis (EMH) applies Rational Expectations to the pricing of assets: When investors use all available information in forming expectations of future rates of return, the equilibrium price of the asset equals the optimal forecast of **fundamental values** based on the available information (i.e., the present value of expected future returns on the asset).

In an efficient financial market, all information currently available is reflected in the asset price. An implication of EMH is that asset price follows a random walk (or more generally, a martingale).

### 1.1 Random Walk and Martingale

If changes in stock prices caused by arrival of new information is random, then the level of stock prices follows a random walk:

$$p_{t+1} - p_t = \varepsilon_{t+1}.$$

To make full use of past stock price data, we can consider a more general form of EMH, that is, stock prices follow a martingale:

$$E(p_{t+1} - p_t \mid \Omega_t) = 0,$$

where  $\Omega_t = \{p_t, p_{t-1}, p_{t-2}, \dots\}$ . Martingales are random variables whose future variations are completely unpredictable given the current information set. In other words, the directions of the future movements in martingales are impossible to forecast.

Thus, the best forecast of tomorrow's stock price is today's price:

$$E(p_{t+1} \mid \Omega_t) = p_t.$$

## 1.2 Implications

1. Any change in market price from one period ahead will be completely accounted for by new information on market fundamentals which arrives between time  $t$  and  $t + 1$ . If the predicted price ( $E(p_{t+1} | \Omega_t)$ ) based on publicly available information is different from the current price ( $p_t$ ), there exists an arbitrage opportunity. If the market is efficient, investment will rapidly bid on the stock so that the arbitrage opportunity will soon disappear. For example, if an announcement, such as a merger, is already publicly made, the news has already been reflected in the prices. By the time the merger actually takes place, there will be little impact on the stock price. Stock prices respond to announcements only when the information is new and unexpected.

2. The more efficient a market is, the more random the prices can be. There is no reason why the asset price cannot be extremely volatile. News may radically alter the investors' assessment of the future prospect of a corporation and its stock price.

3. Trading strategies (technical analysis) designed to beat the market cannot be successfully profitable. An investor cannot earn above-normal profits over an extended period of time. This follows from the fact that for the martingale model, the probability that the price of a stock will rise in value tomorrow is the same as the probability that the price will fall.

3. The dominant investment strategy is a very simple one: buy and hold a diversified portfolio of assets. A "buy and hold" strategy is the most sensible strategy for small investors.

## 1.3 EMH and Volatility

How can EMH account for large fluctuations in individual asset price?

$$p_t = \frac{d_{t+1} + p_{t+1}}{1 + r_t},$$

where  $r_t$  is the required return on investing in equity (discount rate), and  $d_{t+1}$  is dividend paid at time  $t + 1$ . Suppose  $r_t = r$ . Iterating forward, we have

$$p_t = \frac{d_{t+1}}{1 + r} + \frac{d_{t+2}}{(1 + r)^2} + \dots + \frac{p_{t+\tau}}{(1 + r)^{\tau-1}},$$

Let  $\tau \rightarrow \infty$ , and  $\lim_{\tau \rightarrow \infty} \frac{p_{t+\tau}}{(1+r)^{\tau-1}} = 0$  (no bubble), then

$$p_t = \sum_{j=1}^{\infty} \frac{d_{t+j}}{(1+r)^j}.$$

The price of an asset equals the present value of expected future returns on the asset.

Suppose  $d_{t+1} = (1+g)d_t$ , for all  $t$ . then,

$$p_t = \frac{1+g}{r-g} d_t.$$

Let  $d_t = \$5$ ,  $r = 6\%$ ,  $g = 4\%$ , then  $p_t = \$260$ . Suppose a bad new hits and investors expect that the growth rate of dividends will fall to 3% *permanently*, then  $p_t = \$171.7$ , declining by 34%. Similarly, if the required rate of return (interest rate) is raised by 0.25% *permanently*, then  $p_t = \$231.1$ , declining by 11%. Thus, a big rise or crash in asset prices can be consistent with EMH under which investors have rational expectations.

Caution: The result depends on whether investors perceive the change in fundamentals is *temporary* or *permanent*. Larger volatility in prices occurs only if the investors perceive the change in fundamentals is more permanent.

## 1.4 Evidence in Favor of EMH

1. Compare the performances of some stocks recommended by investment advisers with a group of stocks chosen by throwing darts. They perform roughly equally.

2. Mutual funds do not perform better than the market on average either.

3. To test for the random walk hypothesis, researchers have used (1) past stock price data and (2) other publicly available data to see if tock prices are predcitable. In general, these tests confirm that US stock market follow a random walk.

4. Tests on the performance of technical analysis by evaluating the profits from following the timing of buying and selling suggest that technical analysis does not outperform the overall market.

## 1.5 Evidence Against EMH

1. Small-firm effect

2. January Effect
3. Market Overreaction: overshooting
4. Excessive Volatility: Volatility of security prices seems much too high to be justified by changes in market fundamentals (Robert Shiller (1981)).
5. Mean Reversion
6. New information is not always immediately incorporated into stock prices: in response to an unexpected profit announcement, the stock price may continue to rise or fall for some time.

## 2 Factors that Affect Short-term Movement of Asset Prices

While it is widely acknowledged that long-term movements in securities prices correspond to changes in fundamentals, they argue that short-term fluctuations are caused by shifts in market psychology or perhaps even by events that have no direct bearing on business prospects or economic conditions.

### 2.1 Irrational Exuberance, Fads, Fashions, Herding, Market Psychology, Sunspot, Noisy traders

Expectations play an important role, no matter one is for or against the EMH, in driving waves of optimism and pessimism which sometimes may not be justified by fundamentals.

A **bubble** is defined as any deviation of an asset's price from its fundamental value. We can think of an asset's price as consisting of two components: one associated with market fundamentals and the other representing the bubble. The bubble theory suggests that securities may go through periods of under- and overvaluation relative to fair-market values. Certain types of bubbles can be difficult to explain in a sensible way.

Bubbles may reflect investors' reactions to factors unrelated to fundamental economic and business conditions (it is like reacting to sunspots). Hypothetically, individual investors may rush into the stock market because they believe everyone else is making

money in the market. In this case, they prefer to buy stocks immediately rather than miss a profitable buying opportunity. As a result, the anticipation of rising prices becomes a **self-fulfilling prophecy**, and market participants enjoy profits that may not necessarily reflect favorable business prospects.

They are similar to **Ponzi schemes** and **chain letters** in that participants will benefit from the game as long as others can be found who are eager to play the game. Of course, Ponzi schemes crash as soon as individuals believe it will be difficult to find others willing to participate. Similarly, some types of bubbles imply that dramatic declines in security prices are the result of investors finally realizing that rising prices may never be justified on economic grounds. At that point, investors try to sell their assets and prices drop: the bubble bursts.

Some traders may not be not fully rational and their actions and beliefs are subject to systematic biases that are decoupled from the actual fundamentals. These traders are termed as “noisy” (uninformed followers). Psychological experiments as well as various market survey results suggest that such noise traders have **trend chasing** tendencies that are decoupled from fundamentals. For example, a bad news available to the market participants have been reflected in the prices, but the uninformed noise traders may chase the downward trend by keeping selling, forcing the prices to decline further. This leads to overreactions and excess volatility in market prices relative to changes in fundamentals.

Q: Were the crashes of stock market inconsistent with EMH? Market prices may not always reflect market fundamentals at any time, but this does not mean that rational expectations do not hold. Rational Expectations hold as long as stock prices remain unpredictable.

## 2.2 Rational Bubbles

While certain types of bubbles seem to be inconsistent with rational behavior, there is a class of bubbles called rational bubbles. A rational bubble reflects a self-fulfilling belief among rational investors that an asset’s price depends on variables unrelated to market fundamentals. In this context, a rational investor is an individual who efficiently uses relevant information for assessing the value of a security. Within the bubbles framework,

the fact that investors are rational means that while bubbles can exist, obvious profit opportunities cannot exist.

Rational investors may want to hold a security with a price higher than its fundamental if they believe that someone else will be willing to buy the security for that or a higher price in the future. Thus, an asset price can deviate from its fundamental value for some time because the bursting of the bubble can not be predicted and thus there is no unexploited profit opportunity.

## **2.3 Trading Mechanisms**

### **2.3.1 Program Trading**

When prices fall by a pre-specified percentage, computer-generated orders will be automatically executed. These stop-loss orders is believed to have made the 1987 Black Monday crash worse (Oct.19, 1987 on the Black Monday DJIA fell 508 points (22.6%), far surpassed the 13% (fell from 2208 to 1700) crash on Oct. 28, 1929. By the way, the biggest crash was the NASDAQ crash in March 2000 fell from around 5000 to around 1500 in 2001-2002, a decline of well above 60%).

Bradley Report (1987) suggests **circuit-breakers** to put a halt to a panic selling and computer trading programs. The advocates of circuit breakers insist that periods of suspension of the market will allow time for the investors to consider what their next move will be and how to overcome this large price move.

Yet, investors will sit and contemplate the reasoning behind the drop in points is unlikely. Most are apt to become nervous and anxious as they consider what the market will do when it resumes. During the short period when trading is halted, the flow of information is interrupted. Lack of information may further raise the uncertainty faced by investors. It is a question whether this alleviates or exacerbates the crisis.

### **2.3.2 Margin Calls**

Financial institutions (banks or brokers) that make loans to investors for investing in equities (buying on margin). But how much can you borrow? The Federal Reserve Board's Regulation T states that you may borrow up to 50% (60% in Taiwan) of the cost

of the new position. For example, \$100,000 of cash can be used to buy \$200,000 (\$250,000) worth of equities. Thus, the equities are purchased on margin and the securities serve as collateral for the loan.

The net value, i.e., the difference between the value of the securities and the loan, is initially equal to the investor's own funds. This amount which is deposited in the margin account has to stay above a **minimum margin requirement**. This is to protect the broker against a fall in the value of the securities to the point that they no longer cover the loan.

If the value of the customer's holdings drops below the minimum margin requirement, then the brokerage house or the bank issues a **margin call** on the account holder. If the account holder doesn't meet the margin call, then the equities will be liquidated.

The liquidation of margin holders' equities at a time when the stock market has gone under tends to precipitate the downfall of the stock market.