Cap 1 Campbell, Lo, and Mackinlay 1996

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1.5 Market Efficiency

- The efficient market hypothesis (EMH) can be traced back to:
  1) First works: Bachelier (1900) and Cowles (1933)
  2) Modern works: Samuelson (1965)
     ↳ informationally efficient markets ≠ pareto efficient
     ⇒ prices must be unforecastable if information is unexpected
- Fama (1970) summarizes this view: "A market in which prices always "fully reflect" available information is called "efficient""
- Malkiel (1992) expands this definition by saying:
  1) "A capital market is said to be efficient if it fully and correctly reflects all relevant information in determining security prices"
     ↳ Resembles Fama definition
  2) "formally, the market is said to be efficient with respect to some information set... if security prices would be unaffected by revealing that information to all participants"
     ↳ Market efficiency can be tested by revealing information to the market participants and measuring the reaction of security prices
  3) "Moreover, efficiency with respect to an information set... implies that it is impossible to make economic profits by trading on the basis of [that information set]"
     ↳ Market efficiency can be tested by measuring the profits that can be made by trading on information → formation of almost all empirical work on market efficiency
- 3) has been used in two different ways:
  (1) Many researchers have tried to measure the profits earned by market professionals
  (2) Test whether hypothetical trading based on an explicitly specified information set would earn superior returns
- To implement approach (2) one must choose an information set ①
- The classic taxonomy of information sets was given by Roberts (1967):
  a) Weak-form efficiency: The information set includes only the history of prices and returns
  b) Semistrong-form efficiency: The information set includes all information known to all market participants (publicly available)
  c) Strong-form efficiency: The information set includes all information known to all market participants (private available information)
- After choosing the information set, one must specify a model of normal returns ②
- The classic assumption is that the normal returns are constant over time
- Finally, abnormal returns are computed as the difference between the return on the security and normal returns, given the defined information set ③

Efficient Markets and the law of iterated expectations

- Many people think that an efficient market should be smooth rather than random
- Black (1971) wrote:
  1) "A perfect market for a stock is one in which there are no profits to be made by people who have no special information"
  2) "... [A perfect market] is one in which its difficult even for people who have special information to make profits"

  ⇔ prices adjust rapidly as information become available

  ⇒ "... we would like to see randomness in the prices of successive transactions, rather than great continuity"
- Sometimes the smoothness hypothesis of asset prices come from the belief that a market that is determined by discounting future cash flows cannot be random
- The discounted present-value model of a security price is entirely consistent with randomness in security returns

Law of iterated expectations Let X be a random variable, and $\mathcal{F}_t$ be the information set at the same time. By the law of iterated expectations we have that:

$$\mathbb{E}[X|\mathcal{F}_t] = \mathbb{E}[\mathbb{E}[X|\mathcal{F}_{t+1}]|\mathcal{F}_t]$$

$$\Leftrightarrow \mathbb{E}[X - \mathbb{E}[X|\mathcal{F}_{t+1}]\,|\,\mathcal{F}_t] = 0$$

↳ We are never able to predict the forecast error having only limited information

- This law applies to the case where:

$$P_t = \mathbb{E}[P^*|\mathcal{F}_t] \quad \text{and} \quad P_{t+1} = \mathbb{E}[P^*|\mathcal{F}_{t+1}]$$

$$\overset{\text{LIE}}{\Rightarrow} \mathbb{E}[P_t - P_{t+1}|\mathcal{F}_t] = 0, \quad \mathcal{F}_t \subseteq \mathcal{F}_{t+1}$$

which means that realized changes in prices are unforecastable given information in the set $\mathcal{F}_t$.

Is market efficiency testable?

- Difficulties with the EMH:
  1) Any test of efficiency must assume an equilibrium that defines normal security returns. If efficiency is rejected, this could be because the market is truly inefficient or because the equilibrium model is wrong
     ↳ Abnormal returns in markets where there costs of gathering and processing information.
  2) Even in theory, as shown by Grossman and Stiglitz (1980), perfect efficiency is unrealistic. In this context it would make more sense to talk about **Relative efficiency**, which is to test efficiency between markets and against the ideal

     ⇒ Measuring efficiency rather than testing for it

Martingale vs Random walk

- Martingale: $\mathbb{E}[P_{t+1}|\mathcal{F}_t] = P_t \Rightarrow \mathbb{E}[R_{t+1}|\mathcal{F}_t] = 0$
- Random walk: $P_{t+1} = \delta_{t+1} + P_t + \varepsilon_{t+1}$

  δ_{t+1}: deterministic component
  ε_{t+1}: white noise component