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Market efficiency

# Definition of market efficiency

A market is efficient if prices include all relevant information

**Weak form efficiency** Prices reflect information from past prices

**Semi-strong form efficiency** Prices reflect all publicly available information

**Strong form efficiency** Prices reflect all available information, including private information

# Asset returns

- ▶ Asset values are derived from the future income they generate, discounted to the present value
  - ▶ The future income is determined using the information available at the time
  - ▶  $P_t = \sum_{\tau=0}^{+\infty} \frac{E[D_{t+\tau}|\Omega_t]}{\rho^\tau} = D_t + \frac{E[P_{t+1}|\Omega_t]}{\rho}$
  - ▶ For short-term returns, we can neglect the future income and set  $E[d_{t+\tau}|\Omega_t] = 0$
- ⇒  $\rho = \frac{E[P_{t+1}|\Omega_t]}{P_t} = \frac{E[P_{t+2}|\Omega_{t+1}]}{P_{t+1}}$
- ⇒  $\rho = E\left[\frac{E[P_{t+2}|\Omega_{t+1}]}{P_{t+1}} \mid \Omega_t\right] \approx \frac{E[P_{t+2}|\Omega_t]}{E[P_{t+1}|\Omega_t]} = \frac{E[P_{t+2}|\Omega_t]}{\rho P_t}$
- ⇒  $\rho^2 = \frac{E[P_{t+2}|\Omega_t]}{P_t}$

## Serial correlation of returns

$$\begin{aligned} \blacktriangleright \text{Cov} \left[ \frac{\mathbb{E}[P_{t+1}|\Omega_t]}{P_t}, \frac{\mathbb{E}[P_{t+2}|\Omega_t]}{\mathbb{E}[P_{t+1}|\Omega_t]} \right] &= \mathbb{E} \left[ \frac{\mathbb{E}[P_{t+1}|\Omega_t]}{P_t} \frac{\mathbb{E}[P_{t+2}|\Omega_t]}{\mathbb{E}[P_{t+1}|\Omega_t]} \right] - \frac{\mathbb{E}[P_{t+1}|\Omega_t]}{P_t} \frac{\mathbb{E}[P_{t+2}|\Omega_t]}{\mathbb{E}[P_{t+1}|\Omega_t]} \\ &= \mathbb{E} \left[ \frac{\mathbb{E}[P_{t+2}|\Omega_t]}{P_t} \right] - \frac{\mathbb{E}[P_{t+1}|\Omega_t]}{P_t} \frac{\mathbb{E}[P_{t+2}|\Omega_t]}{\mathbb{E}[P_{t+1}|\Omega_t]} \\ &= \rho^2 - \rho\rho = 0 \end{aligned}$$

⇒ Returns are serially uncorrelated

# Random returns

- ▶ If returns are uncorrelated, they will fluctuate randomly around the expected return

- ▶  $\frac{P_{t+1}}{P_t} = \rho + \varepsilon_t$

- ▶ The error term will have a mean of 0 and a variance of  $\sigma_\varepsilon^2$

$$\Rightarrow \text{E} \left[ \frac{P_{t+1}}{P_t} \right] = \rho$$

$$\text{Var} \left[ \frac{P_{t+1}}{P_t} \right] = \sigma_\varepsilon^2$$

# Profitability of trading strategies

- ▶ If returns are unpredictable, then investors cannot make profits from any trading strategy
- ▶ In strong form efficient markets, even insiders could not make any profits
- ▶ In semi-strong efficient markets, fundamental analysis of assets cannot lead to profits
- ▶ In weak form efficient markets, technical trading could not be profitable



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