Maria Rosa Borges

Efficient market hypothesis in European stock markets

The European Journal of Finance 2010, 16:7, 711-726
Efficient market hypothesis ...

• Research idea: measuring the weak-form efficiency of some European stock exchanges using data with different time steps between 1993-2007.
• Methodology: runs test & joint variance tests for conformity with
• EMH = Efficient Market Hypothesis.
• a martingale is a model of a fair game where knowledge of past events never helps predict the mean of the future winnings and only the current event matters. In particular, a martingale is a sequence of random variables (i.e., a stochastic process) for which, at a particular time in the realized sequence, the expectation of the next value in the sequence is equal to the present observed value even given knowledge of all prior observed values.
Efficient market hypothesis ...

Methodology

Strict weak form market efficiency implies that returns are random walk:

\[ x_{t+1} = \mu + \phi x_t + \varepsilon_t, \varepsilon_t \sim i.i.d. \]

Where

\[ x_{t+1} = \log \text{ of the asset price at time } t \]

\[ \mu = \text{a drift constant} \]

\[ \varepsilon_t \sim i.i.d. \text{ is a random disturbance term } E[\varepsilon_t] = 0, E[\varepsilon_t\varepsilon_\tau] = 0 \text{ for } t \neq \tau. \]

To refute the RW hypothesis the variance of \( x_{t+1} - x_t \) is computed for different t and compared to the corresponding result with uncorrelated \( \varepsilon_t \)
Efficient market hypothesis ...

- Empirical data rarely meet the strict conditions of the RW hypothesis. The i.i.d. requirement is relaxed in the Martingale hypothesis:
  \[ E[x_{t+1} | \{x_t, x_{t-1}, \ldots\}] = x_t \]
- Present and past \( x_t \) are useless to forecast \( x_t \).
- This is the key condition in weak form market efficiency. Thus the Martingale hypothesis can be adopted as a basis for testing EMH.
- Several EMH-tests assume i.i.d returns – not valid when observed returns exhibit anomalies like heteroskedasticity.
- Borges uses tests that are valid under ARCH-effects, focusing on the martingale hypothesis instead of RW.
Efficient market hypothesis ...

• RUNS-test: checking whether the successive price changes are random. The test statistic is $\sim N(0,1)$ and its components can be directly computed.

• Variance Ratio (VR) test using return (Lo & Mackinlay [1988]):

$$VR(k) = \frac{\sigma^2(k)}{\sigma^2(1)},$$

where $\sigma^2(k) = \frac{1}{Tk} \sum_{t=k}^{T-q} (y_t + \ldots + y_{t-k+1} - k\hat{\mu})^2$

and $\hat{\mu} = \frac{1}{t} \sum_{t=1}^{T} y_t$
Efficient market hypothesis ...

- Lo & MacKinnley [1988] derive a statistic robust under \textit{heteroskedasticity robust} from the above that is asymptotically standard normal– thus the null can be tested using the standard normal table:

$$M_2(k) = \frac{VR(k) - 1}{\varphi^*(k)^{1/2}}, \text{ where } \varphi^*(k)^{1/2}$$  \hspace{1cm} (9)

is specified in Borges formulae 10-11. The test statistic is directly computable with observed data. It is structurally analogous to $M_2(k)$ (8) valid under homoskedasticity.

The statistic $M_2(k)$ must be computed for several $k$ – may hundreds or thousands. Borges calls this an \textit{oversized testing strategy}.

To overcome the problem with oversized testing Borges suggests the use of the Chow-Denning [1993] test.
Efficient market hypothesis ...

• The Chow-Denning test statistic is based on $M_1(k)$ and $M_2(k)$ of Lo and Mackinley:

• CD$_1$ (12) using $M_1(k)$ and CD$_2$ (13) using $M_1(k)$

CD$_1$ is valid under homoskedasticity and CD$_2$ under heteroskedasticity. The generic form of the statistics is not complicated:

$$CD_j = \sqrt{T} \max_{1 \leq i \leq m} |M_j(k_i)|$$, where $j = 1 \lor 2$
Efficient market hypothesis ...

Both Chow-Denning statistics $CD_1$ and $CD_2$ follow the Studentized maximum modulus (SMM) distribution with $m$ and $T$ degrees of freedom.

$$CD_j = \sqrt{T} \max_{1 \leq i \leq m} |M_j(k_i)|, \text{ where } j = 1 \lor 2$$

For hypothesis testing, the critical values and be transformed to the standard normal distribution.
Let $\alpha^* = 1 - (1 - \alpha)^{1/m}$.

If the statistic is greater than the $[1-(\alpha^*/2)]$ percentile of the standard normal distribution, then the Null hypothesis of random walk is rejected at the $\alpha$ level of significance.
The above tests are based on asymptotic theory. No guarantee they work with small samples. Other test procedures for determining whether the market is weak form efficient under EMH:

- Bootstrapping by resampling from the observations, each time calculating $CD_2$ (Kim [2006]). A robust non-parametric test – making no assumptions of homoskedasticity.

- Variance ratio tests using ranks and signs. These can also be determined directly from the data. To avoid problems with over rejecting the null hypothesis, e.g. Kim & Shamsuddin [200] suggested a joint test analogous to $CD_j$ above.
Empirical results

• Mixed evidence
• E.g. France & UK show strong mean reverting weekly returns, stronger during recent years.
• German is efficient but superseded by Spain
• Borges suggests replications with more recent data
Further studies

• Formulate a research project based on Borges results and suggestions. Could the research be replicated with Nordic data for example?

• Summarize the discussions in your group on one page consisting of a summary of your research idea consisting of the paper title along with your names, (5-10 rows of text) and a list of ~8 topics that represent the structure of your intended study, where you anchor your thoughts in Borges report and what you just heard about research methods in the lecture.

• Deliver your research idea to me by Thursday 27.4.2017 at 16.15 through email.