Module 4: Market Efficiency

(BUSFIN 4221 - Investments)

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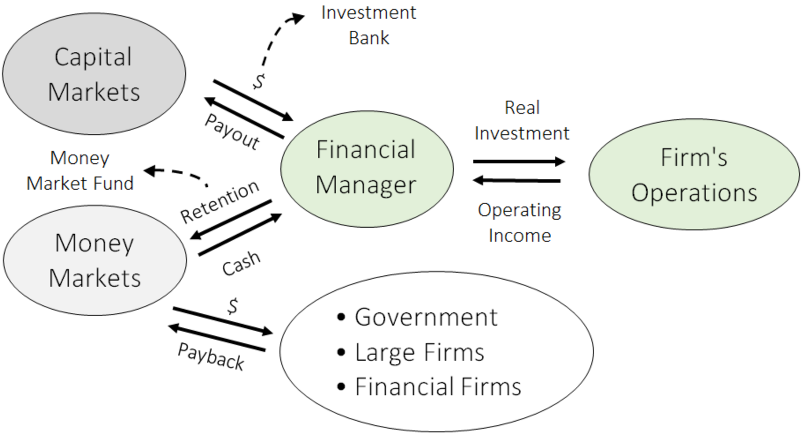
The Ohio State University

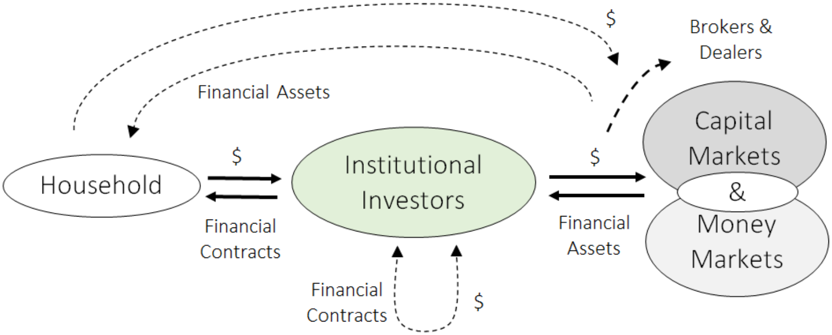
Fall 2016

Outline

Module 1 - The Demand for Capital



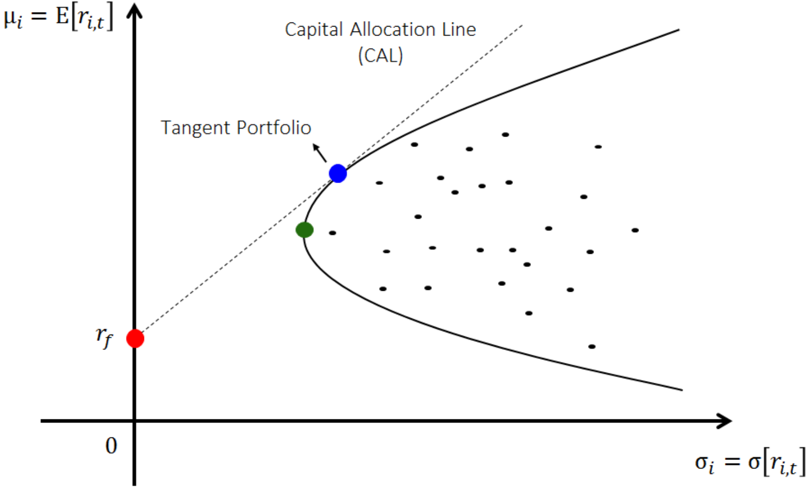
Module 1 - The Supply of Capital



Module 1 - Investment Principle

$$PV_t = \sum_{h=1}^{\infty} \frac{\mathbb{E}_t \left[CF_{t+h} \right]}{\left(1 + dr_{t,h}\right)^h}$$

Module 2 - Portfolio Theory



Module 3 - Factor Models

$$\mathbb{E}[r_i] = r_f + \beta_i \cdot (\mathbb{E}[r_M] - r_f)$$

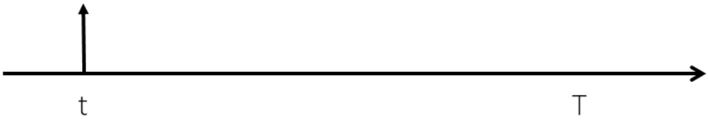
$$+ \beta_{i,A} \cdot \mathbb{E}[r_A - r_a]$$

$$+ \beta_{i,B} \cdot \mathbb{E}[r_B - r_b]$$

$$+ \ldots$$

This Module: Market Efficiency

Prices incorporate all
relevant information
available up to time t



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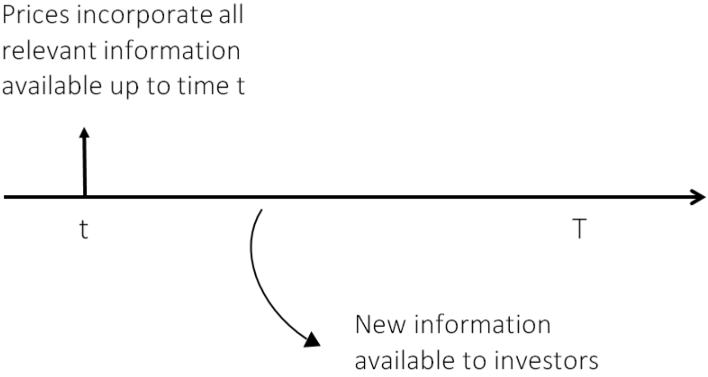

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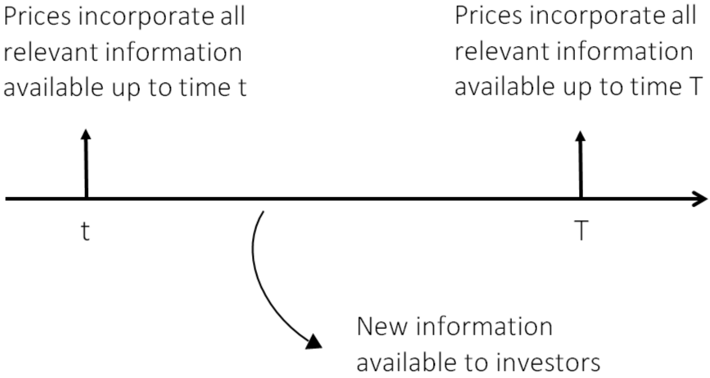

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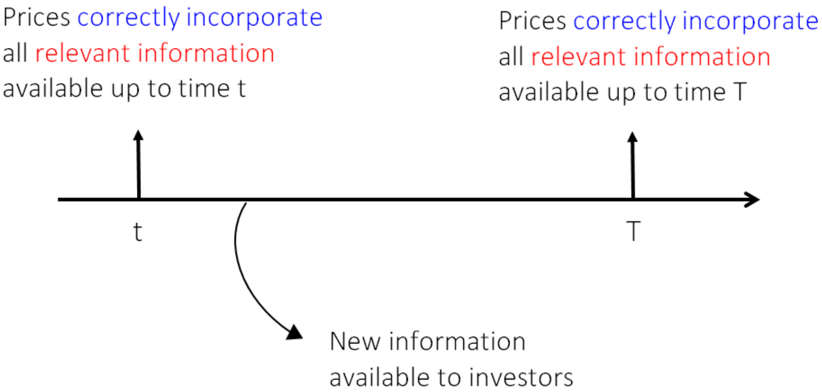
This Section: Efficient Market Hypothesis (EMH)



Prices are Intrinsically Linked to Information*

$$P_t = f\left(\text{Information available at time } t\right)$$

- Example: After the recent presidential debate, the peso (Mexican currency) appreciated by 2% relative to the dollar
- What is the $f(\cdot)$ function?
- What does it mean for $f(\cdot)$ to “correctly incorporate” all information?
- What information is relevant for prices?

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Correctly Incorporating Information: Valuation Identity*

- In your "introduction to finance" class you used the definition of an interest rate to find:

$$PV = \frac{CF}{1+r} + \frac{CF}{(1+r)^2} + \frac{CF}{(1+r)^3} + \dots$$

- From the definition of a "financial return", $r_t = \frac{(CF_t + P_t) - P_{t-1}}{P_{t-1}}$, we can isolate P_t and use recursive substitutions to show that (proof is in the appendix):

$$P_t = \frac{\mathbb{E}_t[CF_{t+1}]}{1+\mathbb{E}_t[r]} + \frac{\mathbb{E}_t[CF_{t+2}]}{(1+\mathbb{E}_t[r])^2} + \frac{\mathbb{E}_t[CF_{t+3}]}{(1+\mathbb{E}_t[r])^3} + \dots$$

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$$P_t = \sum_{h=1}^{\infty} \frac{\mathbb{E}_t\left[CF_{t+h}\right]}{\left(1+\mathbb{E}_t\left[r\right]\right)^h}$$

- dr_t is the discount rate or "required rate of return". It is determined by investors aversion to the given security
- EMH Holds: $\widehat{CF}_{t+h} = \mathbb{E}_t\left[CF_{t+h}\right] \implies \mathbb{E}_t\left[r\right] = dr_t$
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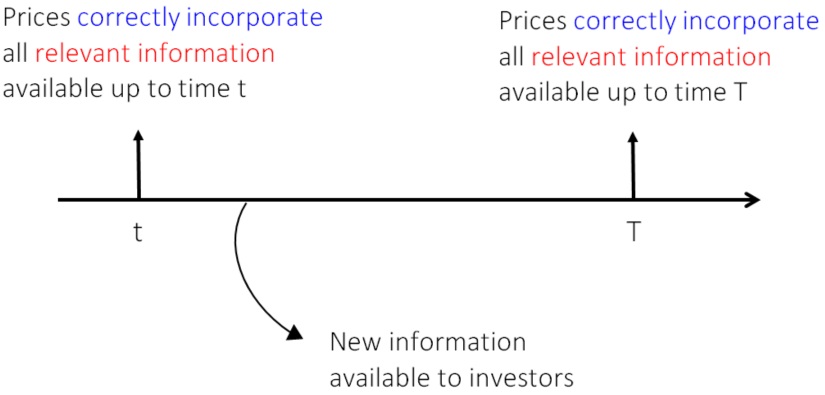

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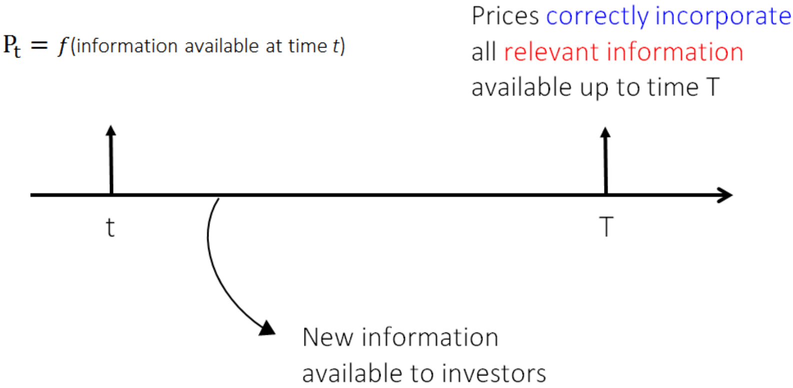

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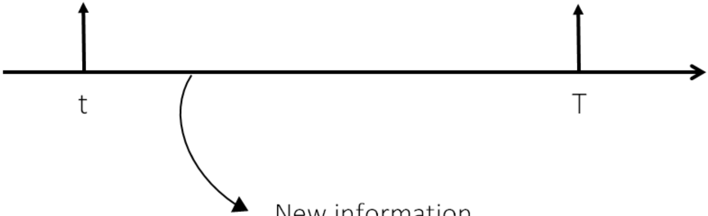

New information available to investors

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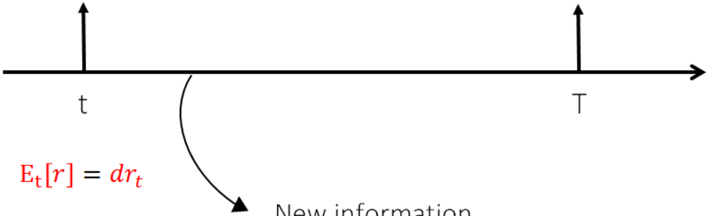

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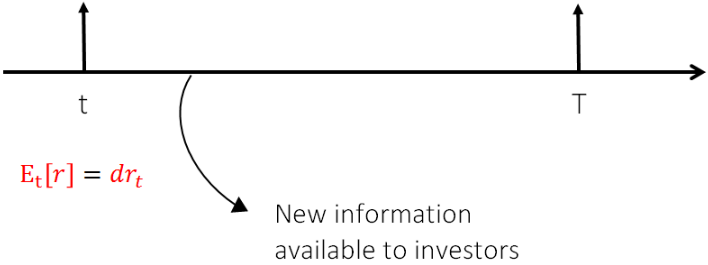

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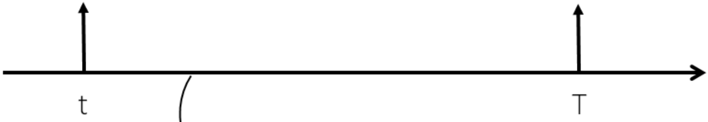

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New information
available to investors

Suppose investors forecast stock market dividend growth to be 6% per year. However, there is a new technology being introduced in the world and it will allow people to teleport from one place to another. This will make firms much more productive, which you know will induce a growth much higher than the 6% assumed by the market. What should you do?

a) Nothing, EMH must hold in this scenario and, thus, the best action is to be passive

b) You should increase your allocation to equities since they currently pay expected returns above market required rate of return

c) You should decrease your allocation to equities since they currently pay expected returns above market required rate of return

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Correctly Incorporating Information: Why should you care?

- If markets are efficient, then you can (correctly) expect to get the return you require when investing
- There is no way to "beat the market" consistently! If you find a security that is paying a great expected return, that is because markets dislike this security and, as such, require a high rate of return for holding it
- You should ask yourself what are the characteristics of a security that induce markets to dislike it (risk, illiquidity, ...??)
- Key implication for the practical world: you should not invest in active management
- Active managers cannot deliver returns above what you would require from them, but they charge high fees. Index funds provide a better alternative (low costs!)

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- There is no way to "beat the market" consistently! If you find a security that is paying a great expected return, that is because markets dislike this security and, as such, require a high rate of return for holding it
- You should ask yourself what are the characteristics of a security that induce markets to dislike it (risk, illiquidity, ...??)
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Correctly Incorporating Information: The Paradox

- Market efficiency requires smart investors to incorporate information into prices all the time
- But if markets are efficient, there is no benefit in doing so (you cannot beat the market)
- As such, if you are smart you should be a passive investor
- But if smart investors become passive, there is nobody incorporating information into prices! This implies markets cannot be efficient!
- It must be the case that markets have at least some degree of inefficiency (at least to justify the existence of smart investors incorporating information into prices)

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Relevant Information: the three versions of the EMH

$$P_t = \sum_{h=1}^{\infty} \frac{\mathbb{E}_t\left[CF_{t+h}\right]}{\left(1+\mathbb{E}_t\left[r\right]\right)^h} \qquad and \qquad \mathbb{E}_t\left[r\right] = dr_t$$

- Weak-form EMH:

  relevant information = trading data

- Semistrong-form EMH:

  relevant information = all publicly available information

- Strong-form EMH:

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Which of the following is a prediction of the Weak-form EMH?

a) Analyzing the financial information of firms and investing accordingly cannot deliver expected returns above required rates of return

b) If you work for Google and know that it will acquire Yahoo over the next year (which is a piece of information not released to the public yet), then there is no point in trading on this information (even if it was legal to do so)

c) Observing prices going down over the last month should not give you any information on how to trade

d) Cash flow estimates are identical to future realized cash flows, which rules out, for example, any possibility for surprises in earnings announcements

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EMH $\Rightarrow$ Returns are Unpredictable

- Some tests of the EMH assume that the required rate of return is time invariant: $dr_t = dr$. Under this assumption:

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- If this is true, the EMH is equivalent to returns being unpredictable. Hence, prices follow a "Random Walk"

- EMH test $\Rightarrow$ check whether returns are truly unpredictable

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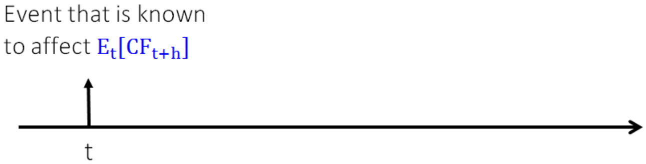
Event Studies: Logic



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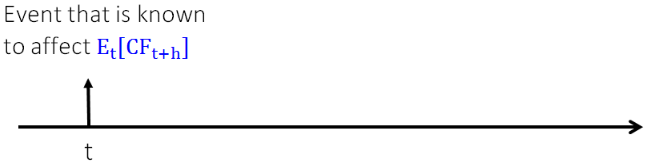

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EMH ➡ It incorporates instantaneously: <u>no predictability left</u>

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We can study returns after the event to see if there is any systematic pattern.

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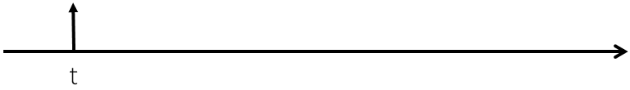

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Event Studies: Logic

We can study returns after the event to see if there is any systematic pattern.

If the answer is yes, then prices did not incorporate all information at time t

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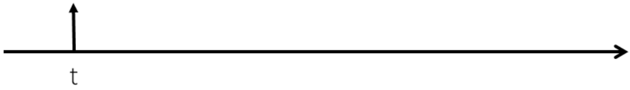

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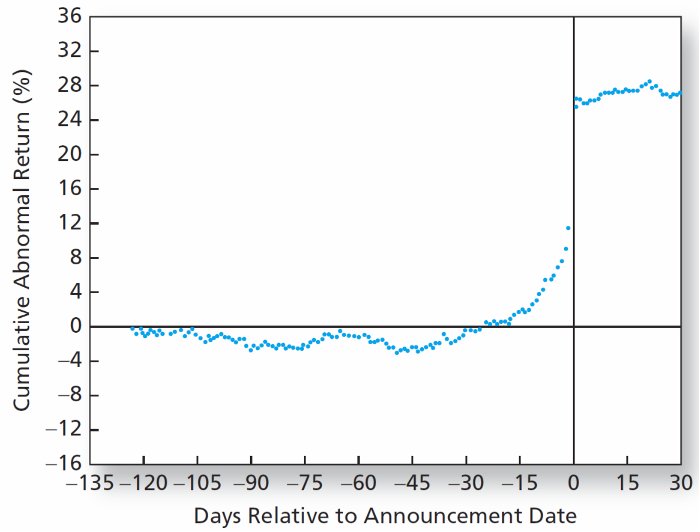
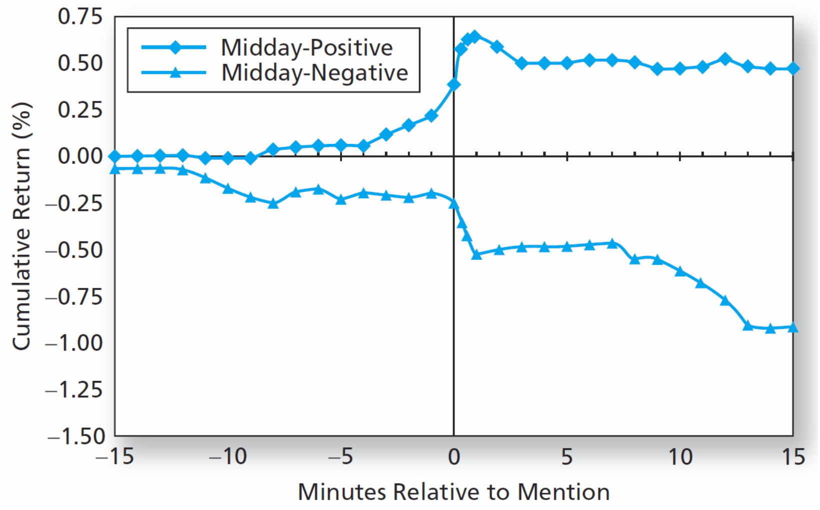
Event Studies: Takeover Attempts*



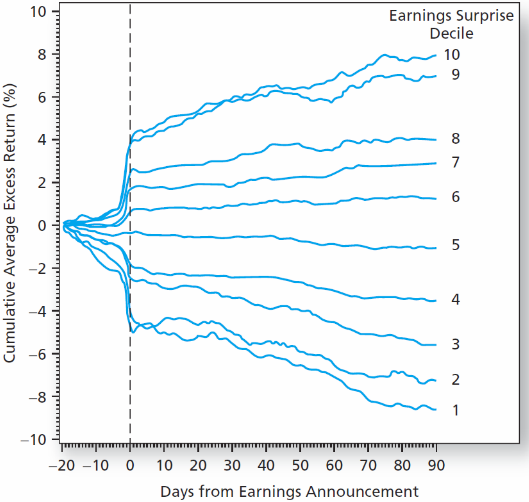
Source: Keown and Pinkerton (1981) - *Merger Announcements and Insider Trading Activity*

Event Studies: CNBC (Mentioned on "Midday Call")*



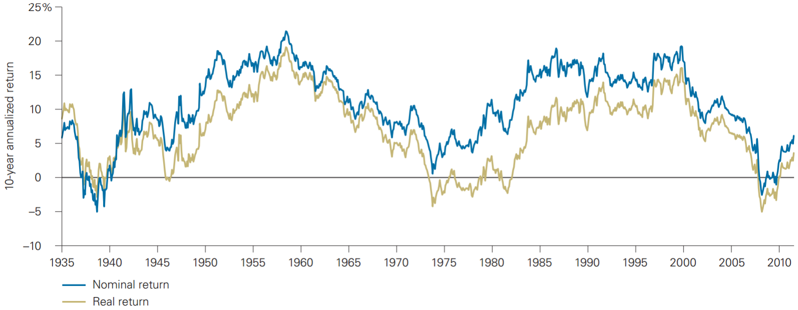
Source: Busse and Green (2002) - *Market Efficiency in Real Time*

Event Studies: Earnings Announcement*



Source: Rendleman, Jones and Latané (1982) - *Empirical Anomalies Based on Unexpected Earnings and the*

Systematic Return Forecast: Motivation



Source: Vanguard Group (2012) - *Forecasting Stock Returns: what Signals Matters and what do they say now?*

- This graph shows (at each point in time) the equity market average return over the previous 10 years
- It is clear that there is substantial variation in average returns
- This motivates us to check whether long-run returns are predictable by variables known ahead of time

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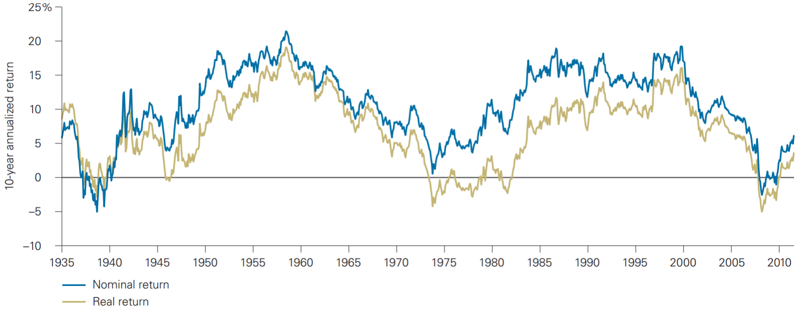

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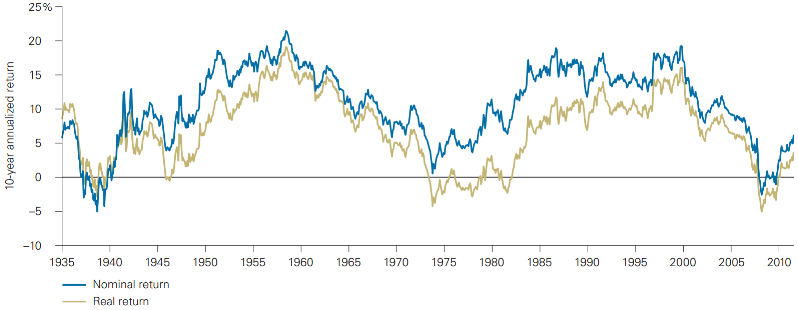

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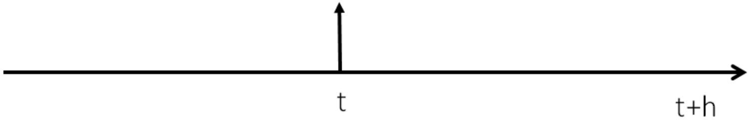

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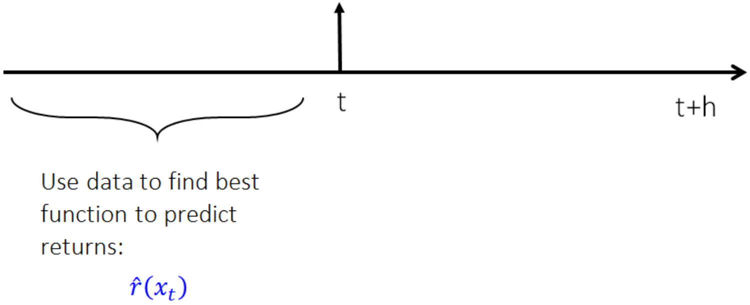

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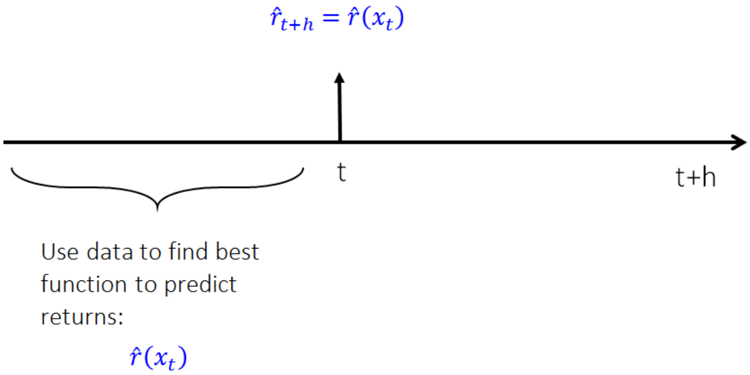

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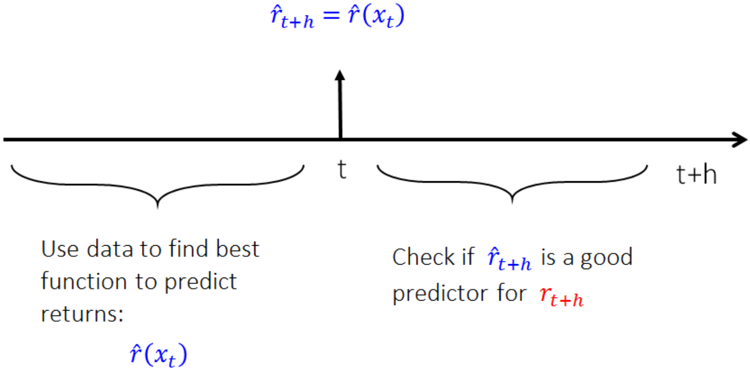
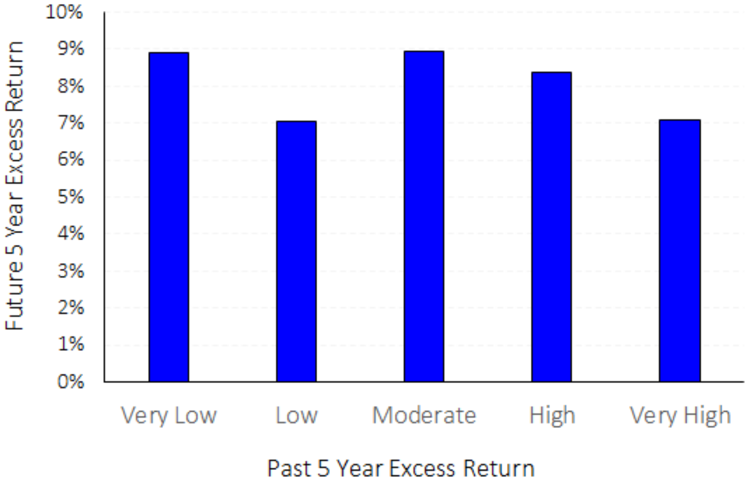
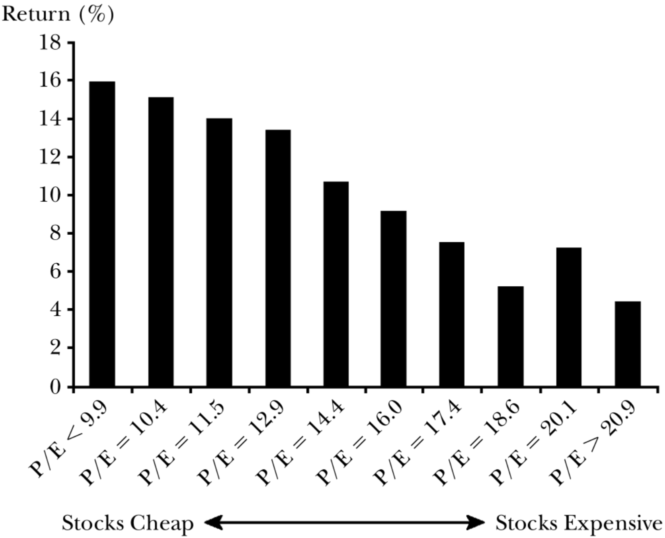


Systematic Return Forecast: Past Returns*



Systematic Return Forecast: Price-to-Earnings (P/E)*



Source: Malkiel (2003) - *The Efficient Market Hypothesis and its Critics*

Which of the following is valid?

a) All event studies presented provide evidence in support of the EMH

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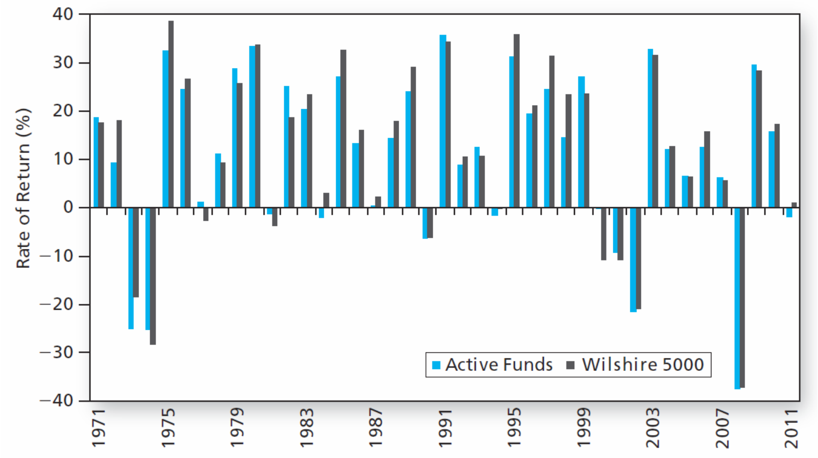

Source: Bodie, Kane and Marcus (10th ed) - *Investments*

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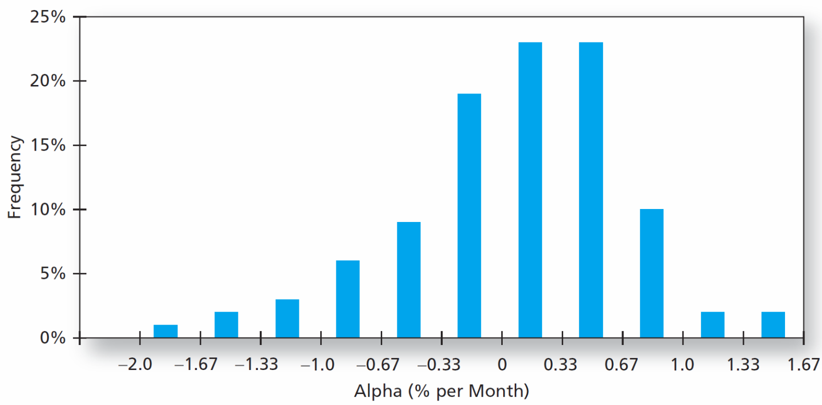

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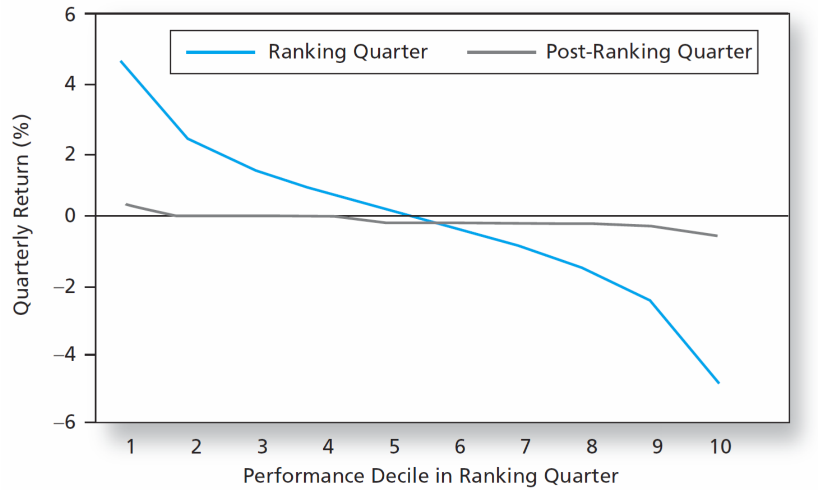
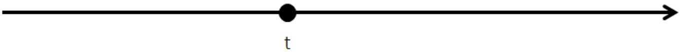
Mutual Funds: α Persistence*



Source: Bollen and Busse (2004) - *Short-Term Persistence in Mutual Fund Performance*

Dynamic Strategies ("Anomalies"): Logic



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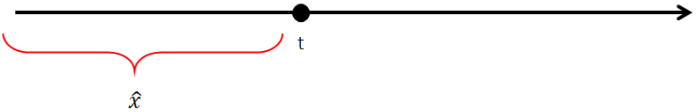

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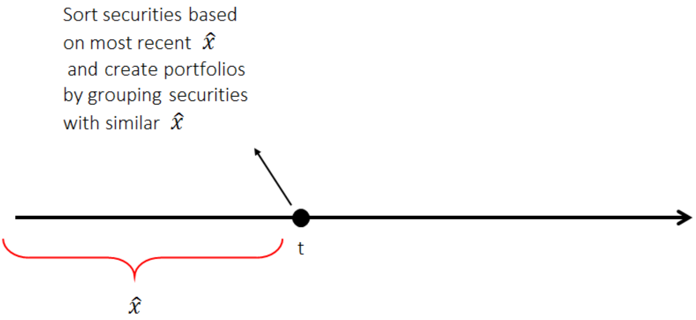

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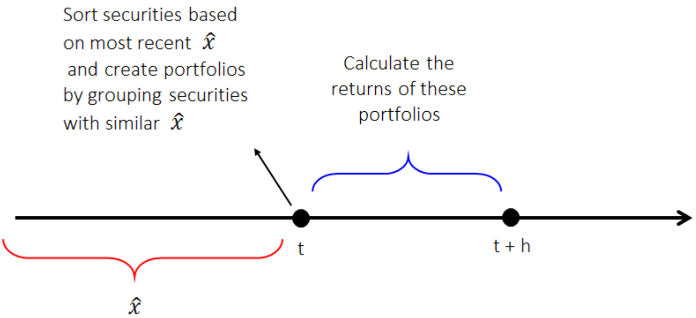

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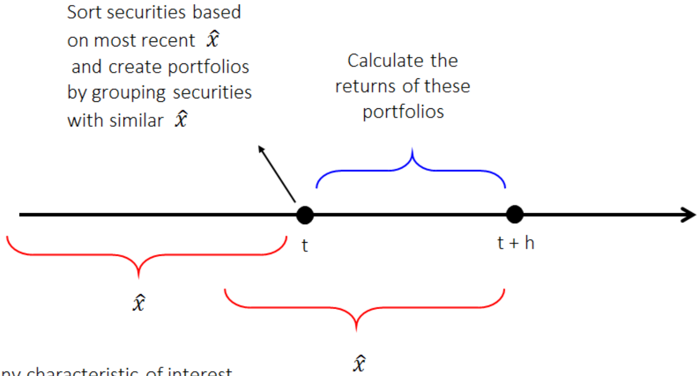

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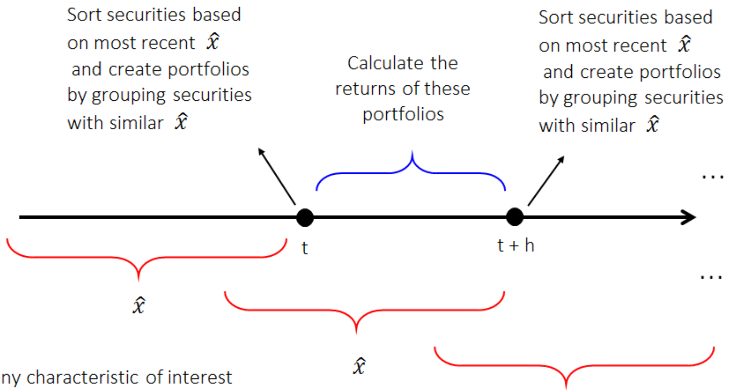

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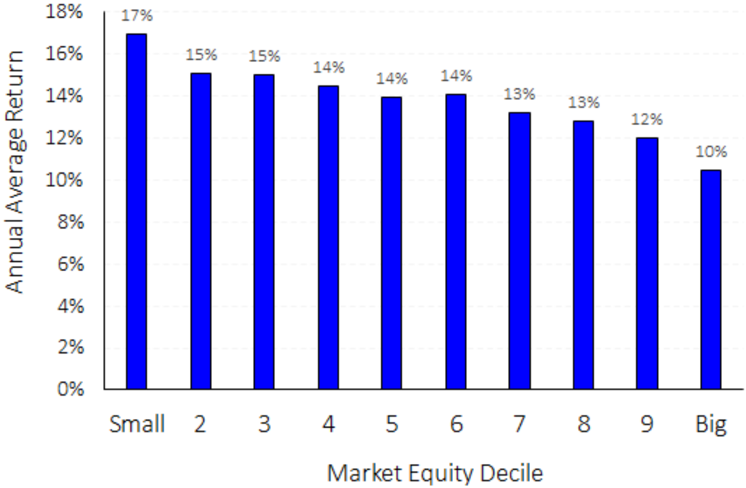
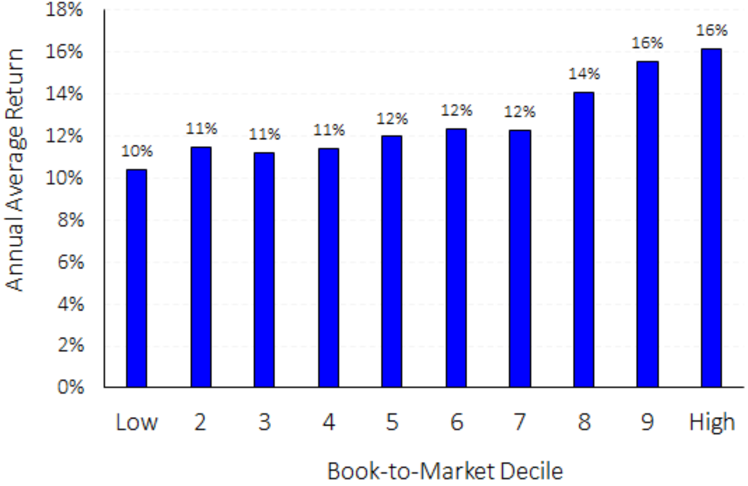
Dynamic Strategies (“Anomalies”): Size Effect*



Ken French’s data library at http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

Dynamic Strategies ("Anomalies"): Value Effect*



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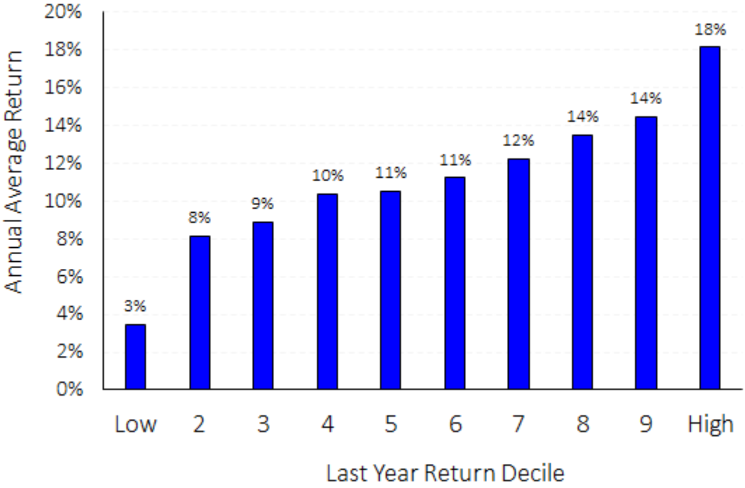
Dynamic Strategies ("Anomalies"): Momentum*



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Which of the following is valid?

a) If the Semistrong EMH is true, then any two strategies based on public information should have identical expected return

b) All versions of the EMH imply that nobody can generate α in financial markets no matter what information they use

c) Insider trading does not generate α, which is evidence in favor of the Strong-form EMH

d) Most actively managed mutual funds do not consistently generate α and this goes in favor of the EMH

e) There is substantial variation in expected returns across stocks and part of this variation can be captured with dynamic trading strategies. This is strong evidence against the EMH

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Outline

Systematic Mistakes + Limits to Arbitrage $\Rightarrow$ EMH fails

- EMH hypothesis says that investors compete until $\mathbb{E}_t\left[r\right] = dr_t$
- The EMH fails whenever $\mathbb{E}_t\left[r\right] \neq dr_t$
- For this to happen, investors need to make similar mistakes (if each investor makes a different mistake, they average to zero and prices are not affected)
- Moreover, smart investors must be unable to profit from the mistakes of other investors without taking a lot of risk (otherwise they would adjust prices)
- Behavioral Finance argues that both aspects are true in reality:

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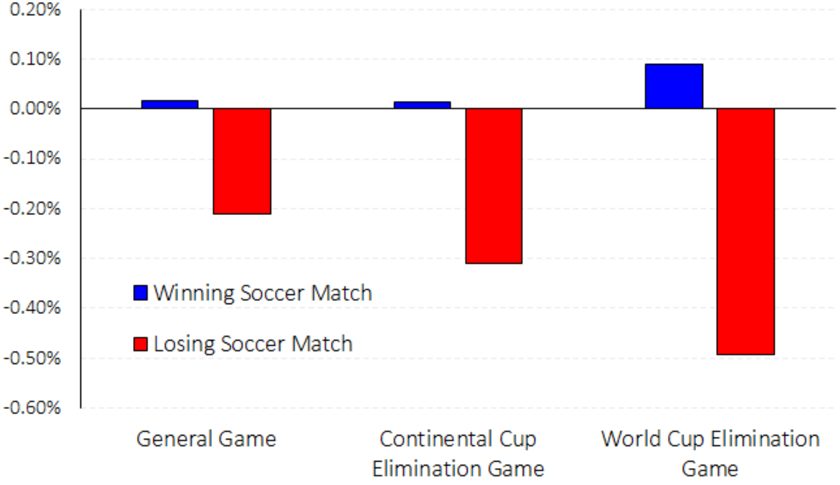
Evidence: Abnormal Return one Day after Soccer Match*



Source: Edmans, García and Norli (2007) - *Sports Sentiment and Stock Returns*

Evidence: Adding ".com" on Company Name*

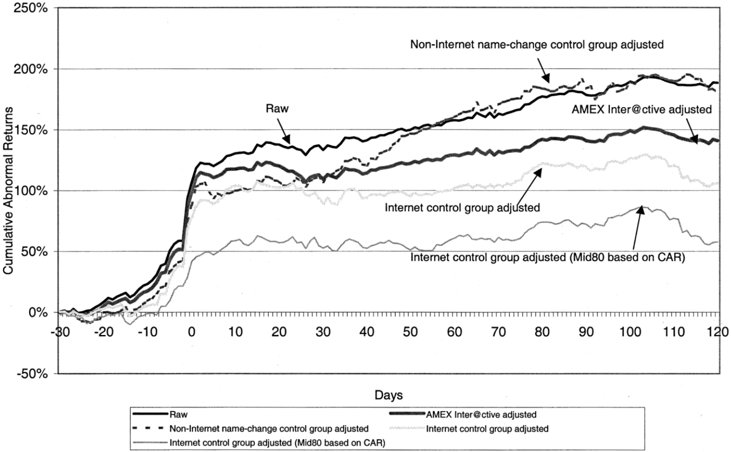
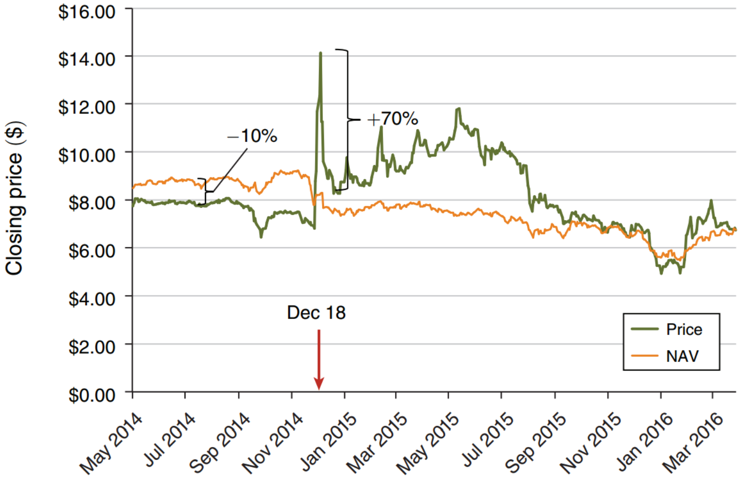


Figure 1. Cumulative abnormal returns earned around the announcement date by firms changing their names to dotcom names.

Source: Cooper, Dimitrov and Rau (2001) - *A Rose.com by any other Name*

Evidence: “CUBA” Fund*



Source: Thaler (2016) - *Behavioral Economics: Past, Present, and Future*

Systematic Mistakes: Mental Accounting

- Did your parents create a "College Fund" for you?

- Mental Accounting bias:

  "Tendency for people to separate their money into separate accounts based on a variety of subjective criteria, like the source of the money and intent for each account"

- Application to Investments:
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- Which is more likely:

  being killed by (i) a Shark or (ii) a falling vending machine?

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  "Probability is estimated by the ease with which similar instances or associations can be brought to mind"

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  - Malmendier and Nagel (2001) find that individuals experiences affect risk taking
  - Individuals are less willing to participate in stock market if they lived through the Great Depression

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- Choose 6 numbers from 1 to 60 to play in the lottery:

  (i) 1, 2, 3, 4, 5, 6 or (ii) 20, 32, 7, 43, 59, 12?

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  "The probability that event X belongs to set Y is judged on the basis of how similar X is to the stereotype of Y"

- Application to Investments:
  - If a given firm has characteristics similar to typical risky firms, then investors might believe the firm is very risky regardless of whether it really is. This can lead to $\mathbb{E}_t[r]$ being related to firm characteristics as oppose to firm risk

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Systematic Mistakes: Local Representativeness

- "Hot hand" fallacy in Basketball:
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Systematic Mistakes: Overconfidence

- Is your driving ability above median?
  - 50% should be below and 50% above
  - 93% of U.S. students estimate they are above median
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  "People overestimate the precision of their beliefs or forecasts. They are 'surprised' too often"
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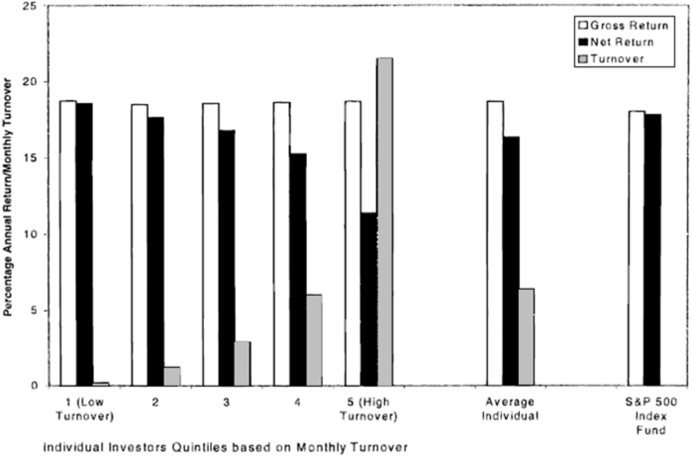
Systematic Mistakes: Trading Activity x Returns*



Source: Barber and Odean (2001) - *Boys will be boys: gender, overconfidence, and common stock investment*

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- Grinblatt et al (2011): High IQ investors are not as biased
- If "arbitrageurs" can easily take advantage of other investor's mistakes, then cognitive biases cannot have an effect on prices
- They can create very profitable strategies taking little risk: as they do it, prices adjust
- Three aspects of financial markets limit their actions:
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- EMH is clearly not a complete description of reality. The question is: how good is it?

- Proponents of behavioral finance argue that EMH completely ignores the way people act in reality and, thus, fails miserably

- EMH supporters indicate that most investors are better off if they act "as if" EMH were true (even though EMH is not literally true). Moreover, the "clear evidence" for mispricing is not systematic (they are more like anecdotes)

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Regarding systematic biases inherent in human psychology and their influence in investment decisions:

a) Mental accounting can induce investors to have biased probability estimates

b) Overconfidence can induce prices to be above fundamental value, but not below fundamental value

c) Availability can make investors to behave as if they are too risk averse even when there is no plausible justification for it. However, it cannot make investors to behave as less risk averse than they really are

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Appendix: Proof of Valuation Identity (Not Required)

$$1 + \mathbb{E}_t\left[r_{t+1}\right] = \mathbb{E}_t\left[\frac{P_{t+1} + CF_{t+1}}{P_t}\right]$$

$$\Downarrow$$

$$P_t = \mathbb{E}_t\left[\frac{CF_{t+1}}{1+\mathbb{E}_t\left[r_{t+1}\right]} + \frac{P_{t+1}}{1+\mathbb{E}_t\left[r_{t+1}\right]}\right]$$

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$$\vdots$$

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$$= \mathbb{E}_t\left[\frac{CF_{t+1}}{1+\mathbb{E}_t\left[r_{t+1}\right]} + \frac{CF_{t+2}}{\left(1+\mathbb{E}_t\left[r_{t+1}\right]\right)\cdot\left(1+\mathbb{E}_{t+1}\left[r_{t+2}\right]\right)} + \ldots\right]$$

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$$\Downarrow$$

$$\begin{aligned}
P_t &= \mathbb{E}_t\left[\frac{CF_{t+1}}{1 + \mathbb{E}_t\left[r_{t+1}\right]} + \frac{P_{t+1}}{1 + \mathbb{E}_t\left[r_{t+1}\right]}\right] \\
&= \mathbb{E}_t\left[\frac{CF_{t+1}}{1 + \mathbb{E}_t\left[r_{t+1}\right]} + \frac{1}{1 + \mathbb{E}_t\left[r_{t+1}\right]} \cdot \left(\frac{CF_{t+2}}{1 + \mathbb{E}_{t+1}\left[r_{t+2}\right]} + \frac{P_{t+2}}{1 + \mathbb{E}_{t+1}\left[r_{t+2}\right]}\right)\right] \\
&= \mathbb{E}_t\left[\frac{CF_{t+1}}{1 + \mathbb{E}_t\left[r_{t+1}\right]} + \frac{CF_{t+2}}{\left(1 + \mathbb{E}_t\left[r_{t+1}\right]\right) \cdot \left(1 + \mathbb{E}_{t+1}\left[r_{t+2}\right]\right)} + \frac{P_{t+2}}{\left(1 + \mathbb{E}_t\left[r_{t+1}\right]\right) \cdot \left(1 + \mathbb{E}_{t+1}\left[r_{t+2}\right]\right)}\right] \\
&\vdots \\
&= \mathbb{E}_t\left[\frac{CF_{t+1}}{1 + \mathbb{E}_t\left[r_{t+1}\right]} + \frac{CF_{t+2}}{\left(1 + \mathbb{E}_t\left[r_{t+1}\right]\right) \cdot \left(1 + \mathbb{E}_{t+1}\left[r_{t+2}\right]\right)} + \ldots\right] + \mathbb{E}_t\left[\frac{P_{t+\infty}}{\prod_{k=t}^{\infty}\left(1 + \mathbb{E}_k\left[r_{k+1}\right]\right)}\right] \\
&= \mathbb{E}_t\left[\frac{CF_{t+1}}{1 + \mathbb{E}_t\left[r_{t+1}\right]} + \frac{CF_{t+2}}{\left(1 + \mathbb{E}_t\left[r_{t+1}\right]\right) \cdot \left(1 + \mathbb{E}_{t+1}\left[r_{t+2}\right]\right)} + \ldots\right]
\end{aligned}$$

$$P_t = \sum_{h=1}^{\infty} \mathbb{E}_t\left[\frac{CF_{t+h}}{\prod_{k=t}^{t+h-1}\left(1 + \mathbb{E}_k\left[r_{k+1}\right]\right)}\right]$$

Appendix: Proof of Valuation Identity (Not Required)

$$1 + \mathbb{E}_t\left[r_{t+1}\right] = \mathbb{E}_t\left[\frac{P_{t+1} + CF_{t+1}}{P_t}\right]$$

$$\Downarrow$$

$$\begin{aligned}
P_t &= \mathbb{E}_t\left[\frac{CF_{t+1}}{1+\mathbb{E}_t\left[r_{t+1}\right]} + \frac{P_{t+1}}{1+\mathbb{E}_t\left[r_{t+1}\right]}\right] \\
&= \mathbb{E}_t\left[\frac{CF_{t+1}}{1+\mathbb{E}_t\left[r_{t+1}\right]} + \frac{1}{1+\mathbb{E}_t\left[r_{t+1}\right]} \cdot \left(\frac{CF_{t+2}}{1+\mathbb{E}_{t+1}\left[r_{t+2}\right]} + \frac{P_{t+2}}{1+\mathbb{E}_{t+1}\left[r_{t+2}\right]}\right)\right] \\
&= \mathbb{E}_t\left[\frac{CF_{t+1}}{1+\mathbb{E}_t\left[r_{t+1}\right]} + \frac{CF_{t+2}}{(1+\mathbb{E}_t\left[r_{t+1}\right]) \cdot (1+\mathbb{E}_{t+1}\left[r_{t+2}\right])} + \frac{P_{t+2}}{(1+\mathbb{E}_t\left[r_{t+1}\right]) \cdot (1+\mathbb{E}_{t+1}\left[r_{t+2}\right])}\right] \\
&\vdots \\
&= \mathbb{E}_t\left[\frac{CF_{t+1}}{1+\mathbb{E}_t\left[r_{t+1}\right]} + \frac{CF_{t+2}}{(1+\mathbb{E}_t\left[r_{t+1}\right]) \cdot (1+\mathbb{E}_{t+1}\left[r_{t+2}\right])} + \ldots\right] + \mathbb{E}_t\left[\frac{P_{t+\infty}}{\prod_{k=t}^{\infty}\left(1+\mathbb{E}_k\left[r_{k+1}\right]\right)}\right] \\
&= \mathbb{E}_t\left[\frac{CF_{t+1}}{1+\mathbb{E}_t\left[r_{t+1}\right]} + \frac{CF_{t+2}}{(1+\mathbb{E}_t\left[r_{t+1}\right]) \cdot (1+\mathbb{E}_{t+1}\left[r_{t+2}\right])} + \ldots\right]
\end{aligned}$$

$$P_t = \sum_{h=1}^{\infty} \mathbb{E}_t\left[\frac{CF_{t+h}}{\prod_{k=t}^{t+h-1}\left(1+\mathbb{E}_k\left[r_{k+1}\right]\right)}\right]$$

Appendix: Proof of Valuation Identity (Not Required)

$$1 + \mathbb{E}_t\left[r_{t+1}\right] = \mathbb{E}_t\left[\frac{P_{t+1} + CF_{t+1}}{P_t}\right]$$

$$\Downarrow$$

$$\begin{aligned}
P_t &= \mathbb{E}_t\left[\frac{CF_{t+1}}{1+\mathbb{E}_t\left[r_{t+1}\right]} + \frac{P_{t+1}}{1+\mathbb{E}_t\left[r_{t+1}\right]}\right] \\
&= \mathbb{E}_t\left[\frac{CF_{t+1}}{1+\mathbb{E}_t\left[r_{t+1}\right]} + \frac{1}{1+\mathbb{E}_t\left[r_{t+1}\right]} \cdot \left(\frac{CF_{t+2}}{1+\mathbb{E}_{t+1}\left[r_{t+2}\right]} + \frac{P_{t+2}}{1+\mathbb{E}_{t+1}\left[r_{t+2}\right]}\right)\right] \\
&= \mathbb{E}_t\left[\frac{CF_{t+1}}{1+\mathbb{E}_t\left[r_{t+1}\right]} + \frac{CF_{t+2}}{\left(1+\mathbb{E}_t\left[r_{t+1}\right]\right)\cdot\left(1+\mathbb{E}_{t+1}\left[r_{t+2}\right]\right)} + \frac{P_{t+2}}{\left(1+\mathbb{E}_t\left[r_{t+1}\right]\right)\cdot\left(1+\mathbb{E}_{t+1}\left[r_{t+2}\right]\right)}\right] \\
&\vdots \\
&= \mathbb{E}_t\left[\frac{CF_{t+1}}{1+\mathbb{E}_t\left[r_{t+1}\right]} + \frac{CF_{t+2}}{\left(1+\mathbb{E}_t\left[r_{t+1}\right]\right)\cdot\left(1+\mathbb{E}_{t+1}\left[r_{t+2}\right]\right)} + \ldots\right] + \mathbb{E}_t\left[\frac{P_{t+\infty}}{\prod_{k=t}^{\infty}\left(1+\mathbb{E}_k\left[r_{k+1}\right]\right)}\right] \\
&= \mathbb{E}_t\left[\frac{CF_{t+1}}{1+\mathbb{E}_t\left[r_{t+1}\right]} + \frac{CF_{t+2}}{\left(1+\mathbb{E}_t\left[r_{t+1}\right]\right)\cdot\left(1+\mathbb{E}_{t+1}\left[r_{t+2}\right]\right)} + \ldots\right]
\end{aligned}$$

$$P_t = \sum_{h=1}^{\infty}\mathbb{E}_t\left[\frac{CF_{t+h}}{\prod_{k=t}^{t+h-1}\left(1+\mathbb{E}_k\left[r_{k+1}\right]\right)}\right]$$

Appendix: Proof of Valuation Identity (Not Required)

$$1 + \mathbb{E}_t[r_{t+1}] = \mathbb{E}_t\left[\frac{P_{t+1} + CF_{t+1}}{P_t}\right]$$

$$\Downarrow$$

$$\begin{aligned}
P_t &= \mathbb{E}_t\left[\frac{CF_{t+1}}{1+\mathbb{E}_t[r_{t+1}]} + \frac{P_{t+1}}{1+\mathbb{E}_t[r_{t+1}]}\right] \\
&= \mathbb{E}_t\left[\frac{CF_{t+1}}{1+\mathbb{E}_t[r_{t+1}]} + \frac{1}{1+\mathbb{E}_t[r_{t+1}]}\cdot\left(\frac{CF_{t+2}}{1+\mathbb{E}_{t+1}[r_{t+2}]} + \frac{P_{t+2}}{1+\mathbb{E}_{t+1}[r_{t+2}]}\right)\right] \\
&= \mathbb{E}_t\left[\frac{CF_{t+1}}{1+\mathbb{E}_t[r_{t+1}]} + \frac{CF_{t+2}}{(1+\mathbb{E}_t[r_{t+1}])\cdot(1+\mathbb{E}_{t+1}[r_{t+2}])} + \frac{P_{t+2}}{(1+\mathbb{E}_t[r_{t+1}])\cdot(1+\mathbb{E}_{t+1}[r_{t+2}])}\right] \\
&\vdots \\
&= \mathbb{E}_t\left[\frac{CF_{t+1}}{1+\mathbb{E}_t[r_{t+1}]} + \frac{CF_{t+2}}{(1+\mathbb{E}_t[r_{t+1}])\cdot(1+\mathbb{E}_{t+1}[r_{t+2}])} + \ldots\right] + \mathbb{E}_t\left[\frac{P_{t+\infty}}{\prod_{k=t}^{\infty}(1+\mathbb{E}_k[r_{k+1}])}\right] \\
&= \mathbb{E}_t\left[\frac{CF_{t+1}}{1+\mathbb{E}_t[r_{t+1}]} + \frac{CF_{t+2}}{(1+\mathbb{E}_t[r_{t+1}])\cdot(1+\mathbb{E}_{t+1}[r_{t+2}])} + \ldots\right]
\end{aligned}$$

$$P_t = \sum_{h=1}^{\infty}\mathbb{E}_t\left[\frac{CF_{t+h}}{\prod_{k=t}^{t+h-1}(1+\mathbb{E}_k[r_{k+1}])}\right]$$

Appendix: Proof of Valuation Identity (Not Required)

$$1+\mathbb{E}_t\left[r_{t+1}\right]=\mathbb{E}_t\left[\frac{P_{t+1}+CF_{t+1}}{P_t}\right]$$

$$\Downarrow$$

$$\begin{aligned}
P_t &= \mathbb{E}_t\left[\frac{CF_{t+1}}{1+\mathbb{E}_t\left[r_{t+1}\right]}+\frac{P_{t+1}}{1+\mathbb{E}_t\left[r_{t+1}\right]}\right]\\
&= \mathbb{E}_t\left[\frac{CF_{t+1}}{1+\mathbb{E}_t\left[r_{t+1}\right]}+\frac{1}{1+\mathbb{E}_t\left[r_{t+1}\right]}\cdot\left(\frac{CF_{t+2}}{1+\mathbb{E}_{t+1}\left[r_{t+2}\right]}+\frac{P_{t+2}}{1+\mathbb{E}_{t+1}\left[r_{t+2}\right]}\right)\right]\\
&= \mathbb{E}_t\left[\frac{CF_{t+1}}{1+\mathbb{E}_t\left[r_{t+1}\right]}+\frac{CF_{t+2}}{\left(1+\mathbb{E}_t\left[r_{t+1}\right]\right)\cdot\left(1+\mathbb{E}_{t+1}\left[r_{t+2}\right]\right)}+\frac{P_{t+2}}{\left(1+\mathbb{E}_t\left[r_{t+1}\right]\right)\cdot\left(1+\mathbb{E}_{t+1}\left[r_{t+2}\right]\right)}\right]\\
&\vdots\\
&= \mathbb{E}_t\left[\frac{CF_{t+1}}{1+\mathbb{E}_t\left[r_{t+1}\right]}+\frac{CF_{t+2}}{\left(1+\mathbb{E}_t\left[r_{t+1}\right]\right)\cdot\left(1+\mathbb{E}_{t+1}\left[r_{t+2}\right]\right)}+\ldots\right]+\mathbb{E}_t\left[\frac{P_{t+\infty}}{\prod_{k=t}^{\infty}\left(1+\mathbb{E}_k\left[r_{k+1}\right]\right)}\right]\\
&= \mathbb{E}_t\left[\frac{CF_{t+1}}{1+\mathbb{E}_t\left[r_{t+1}\right]}+\frac{CF_{t+2}}{\left(1+\mathbb{E}_t\left[r_{t+1}\right]\right)\cdot\left(1+\mathbb{E}_{t+1}\left[r_{t+2}\right]\right)}+\ldots\right]
\end{aligned}$$

$$P_t=\sum_{h=1}^{\infty}\mathbb{E}_t\left[\frac{CF_{t+h}}{\prod_{k=t}^{t+h-1}\left(1+\mathbb{E}_k\left[r_{k+1}\right]\right)}\right]$$

Appendix: Proof of Valuation Identity (Not Required)

$$P_t = \sum_{h=1}^{\infty} \mathbb{E}_t \left[\frac{CF_{t+h}}{\prod_{k=t}^{t+h-1} \left(1 + \mathbb{E}_k \left[r_{k+1}\right]\right)} \right]$$

- If we assume that (i) $\mathbb{E}_t[r_{t+1}] = \mathbb{E}_t[r_{t+2}] \equiv \mathbb{E}_t[r]$ and (ii) shocks to cash flows are independent of shocks to expected returns, then we have:

$$P_t = \sum_{h=1}^{\infty} \frac{\mathbb{E}_t[CF_{t+h}]}{(1 + \mathbb{E}_t[r])^h}$$

Appendix: Proof of Valuation Identity (Not Required)

$$P_t = \sum_{h=1}^{\infty} \mathbb{E}_t \left[\frac{CF_{t+h}}{\prod_{k=t}^{t+h-1} \left(1 + \mathbb{E}_k \left[r_{k+1}\right]\right)} \right]$$

- If we assume that (i) $\mathbb{E}_t \left[r_{t+1}\right] = \mathbb{E}_t \left[r_{t+2}\right] \equiv \mathbb{E}_t \left[r\right]$ and (ii) shocks to cash flows are independent of shocks to expected returns, then we have:

$$P_t = \sum_{h=1}^{\infty} \frac{\mathbb{E}_t \left[CF_{t+h}\right]}{\left(1 + \mathbb{E}_t \left[r\right]\right)^h}$$

Appendix: Proof of Valuation Identity (Not Required)

$$P_t = \sum_{h=1}^{\infty} \mathbb{E}_t \left[\frac{CF_{t+h}}{\prod_{k=t}^{t+h-1} \left(1 + \mathbb{E}_k \left[r_{k+1}\right]\right)} \right]$$

- If we assume that (i) $\mathbb{E}_t \left[r_{t+1}\right] = \mathbb{E}_t \left[r_{t+2}\right] \equiv \mathbb{E}_t \left[r\right]$ and (ii) shocks to cash flows are independent of shocks to expected returns, then we have:

$$P_t = \sum_{h=1}^{\infty} \frac{\mathbb{E}_t \left[CF_{t+h}\right]}{\left(1 + \mathbb{E}_t \left[r\right]\right)^h}$$