Efficient Markets Hypothesis

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Efficient Markets Hypothesis (EMH)

- The 2013 Nobel Prize in Economics was given to Eugene Fama for the efficient markets hypothesis and to Robert Shiller for pioneering the field of behavioral finance.
- **Definition:** An **efficient market** is a market in which prices always "fully reflect" all available information.
- Different from a **Perfect Market**
- Historically, there has been much confusion. People sometimes mean **perfect markets** when they say **efficient markets**.

Assumptions we have made up until now: Perfect Markets

Perfect markets consist of 4 assumptions:

1. There are **no differences in information or opinions** among investors (everyone agrees on probabilities of events)
2. There are **no transaction costs** (costs incurred when buying and selling)
3. There are so **many buyers and sellers** (investors and firms) in the market that the presence or absence of one (or a few) individuals does not have an influence on the price
4. There are **no taxes**

What does perfect markets assumption buy us?

- Do we believe markets are perfect?
  - No
  - However, some markets are reasonable close to perfect to allow us to use this as a first working assumption
  - It is not "is this market perfect?" but "to what extent is this market perfect?"

How perfect is the market for PepsiCo shares?

1. Opinions: modestly different (unless someone trades on insider information, but this is illegal)
2. Many buyers and sellers: pretty close. On a typical day, around $250 million worth of PepsiCo shares change hands.
3. Transaction costs: low. Typical transaction costs for PepsiCo is about 5 cents on a $50 share price.
4. Taxes: depends on the seller's and your tax status.

- Unfortunately not every good is traded in a perfect market.

Perfect vs. Efficient Markets

- An efficient market is one that sets the price correctly.
- Historically, there has been much confusion here: most people mean perfect markets when they say efficient markets.

$$\text{Perfect Market} \Rightarrow \text{Efficient Market}$$

but

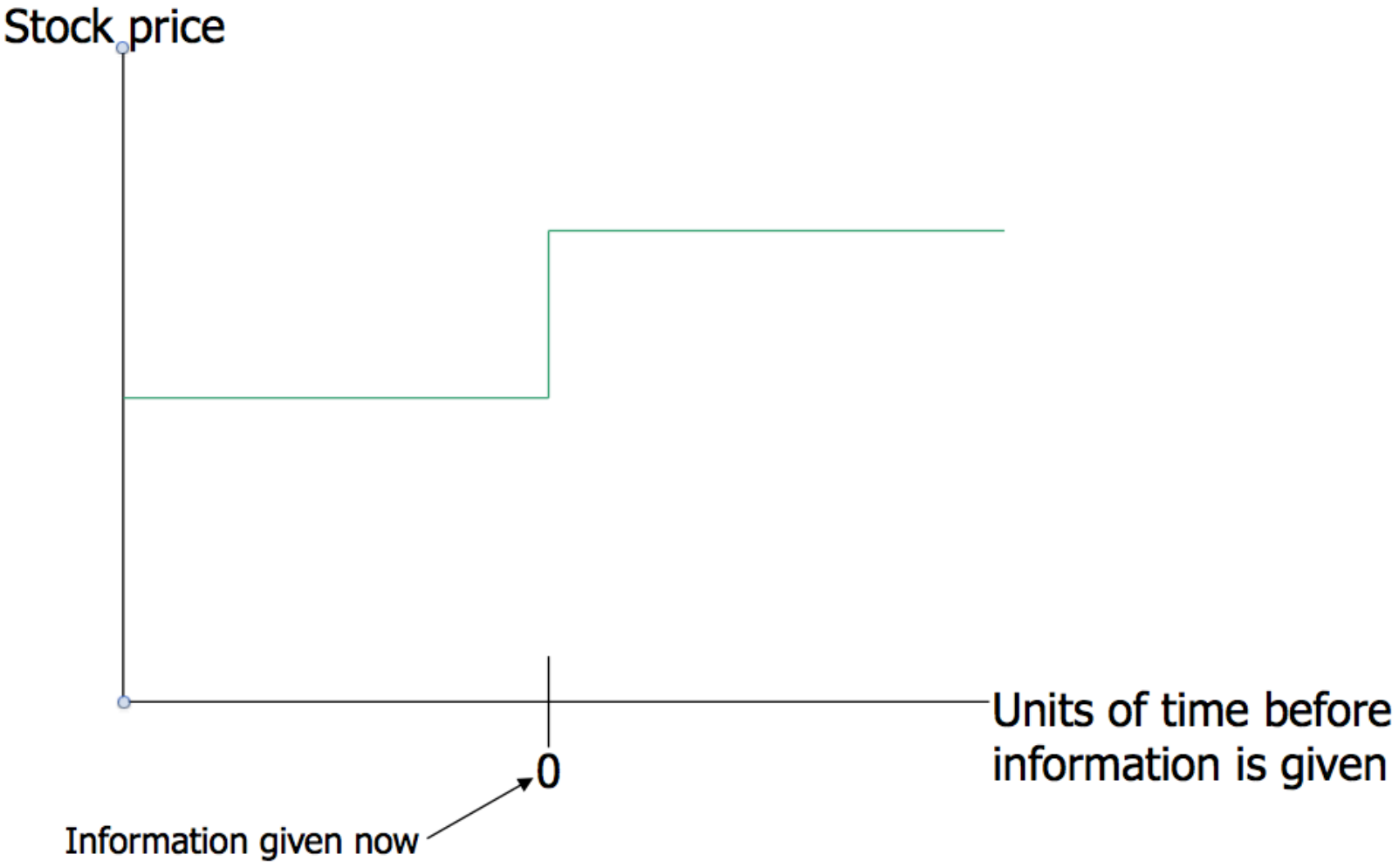
$$\text{Perfect Market} \not\Rightarrow \text{Efficient Market}$$

- One way to help dispell the confusion: when we talk about **"efficient markets"** think instead of **'reflective markets'**.
- In fact, people now refer to **'informationally efficient'** markets to distinguish it from other notions of efficiency, such as 'pareto efficiency'.
- Throughout this lecture when we say 'efficient', we mean 'informationally efficient'

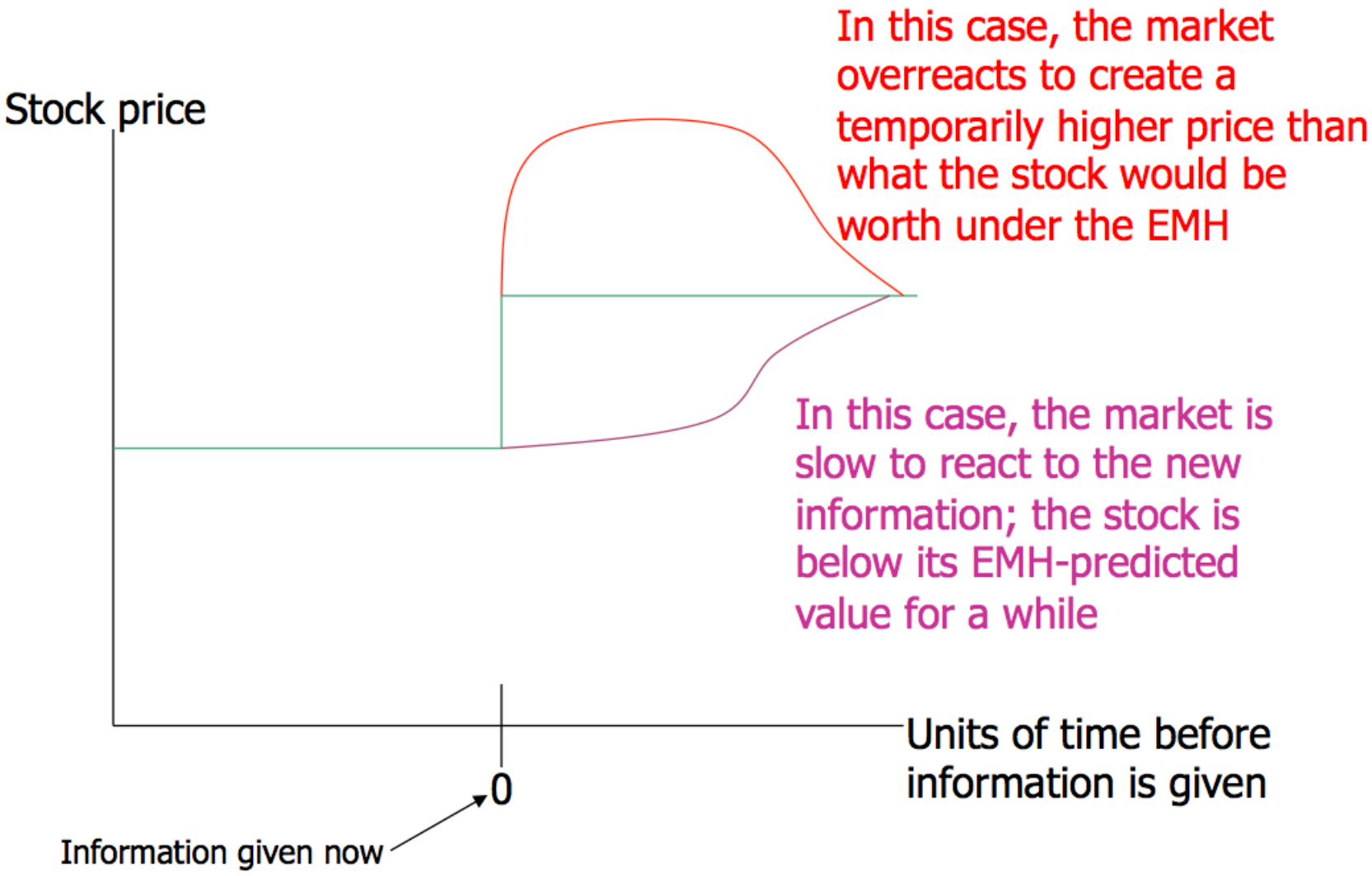
What is the link between perfect markets and efficient markets?

- If agents are not stupid (and there are infinitely many smart ones), then any perfect market will become efficient.
- However, even in an imperfect market (e.g., with transaction costs), the market could still be efficient, setting prices at whatever level is appropriate.

An example of an efficient markets response



What could happen if the EMH is NOT correct?



What could happen EMH is NOT correct?

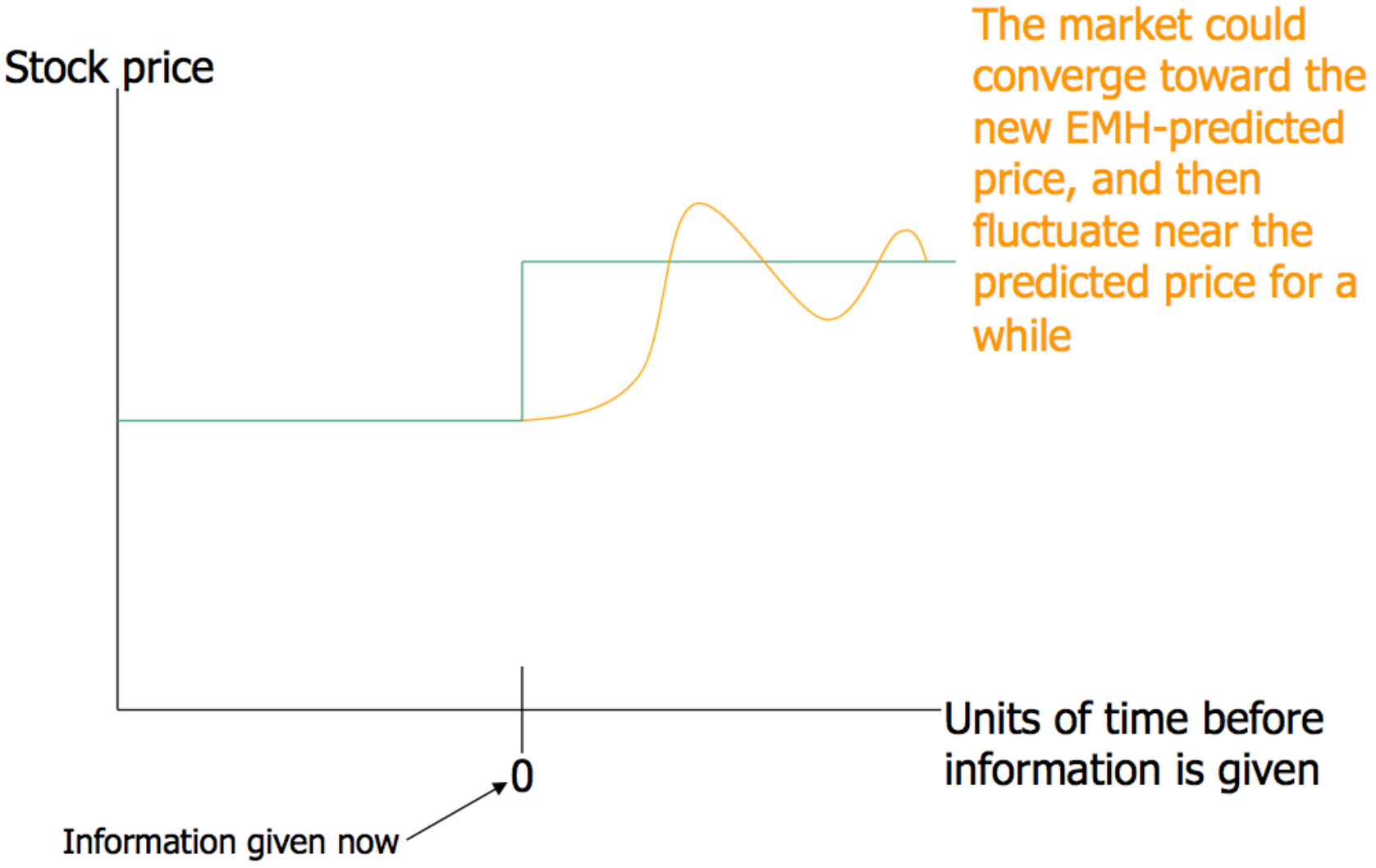


Illustration of EMH: The Challenger Crash

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The complexity of price discovery in an efficient market: the stock market reaction to the Challenger crash ☆

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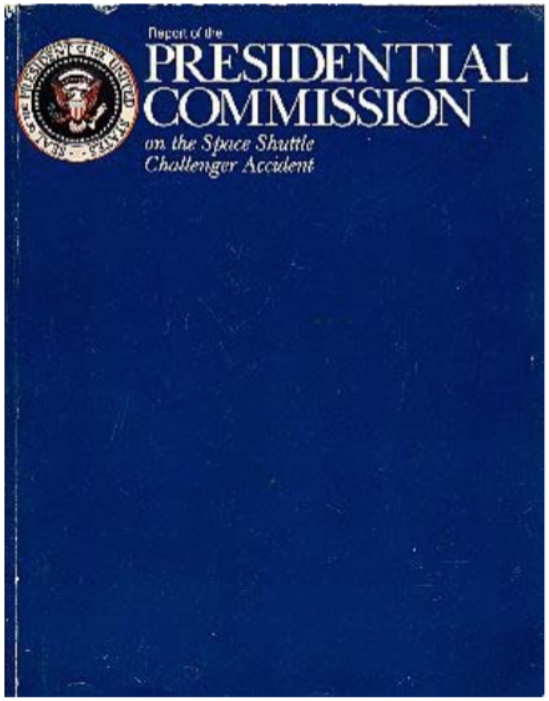
Illustration of EMH: The Challenger Crash

January 28, 1986, 11:39am

- 11:47am: "Space Shuttle Explodes"
- 12:17pm: "Lockheed Has No Immediate Comment"
- 12:52pm: "Rockwell Intl Has No Comment"

Illustration of EMH: The Challenger Crash

- Reagan Establishes Presidential Commission To Investigate



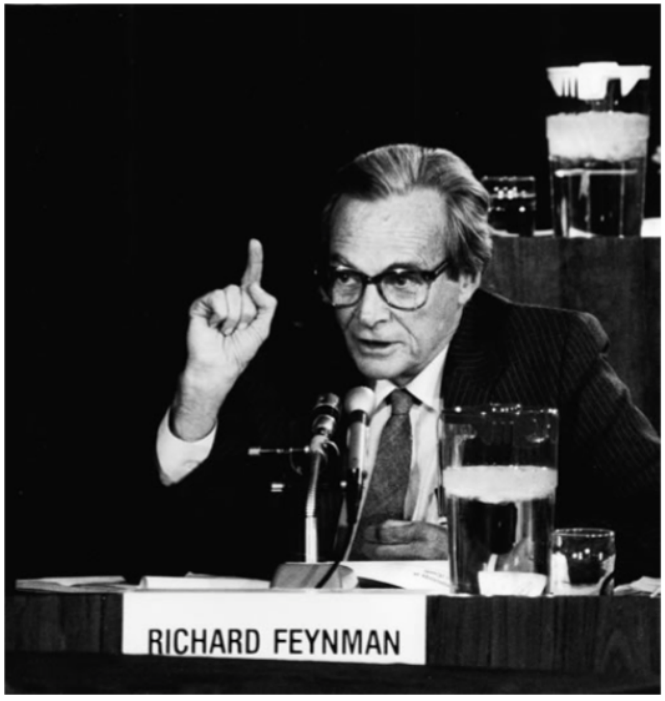


Illustration of EMH: The Challenger Crash

Rogers Commission Report Published June 9, 1986

- Concluded that Morton Thiokol was at fault

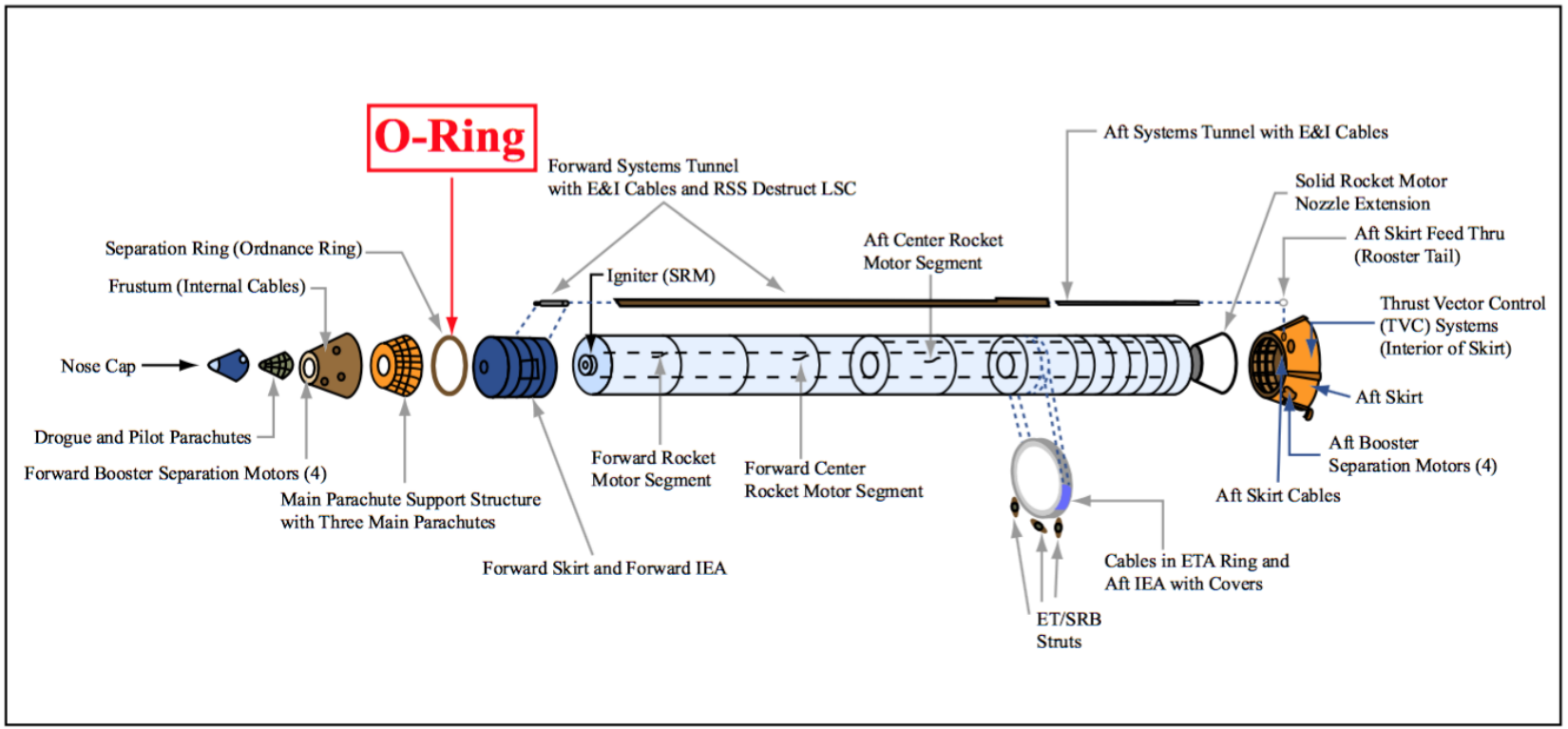


Illustration of EMH: The Challenger Crash

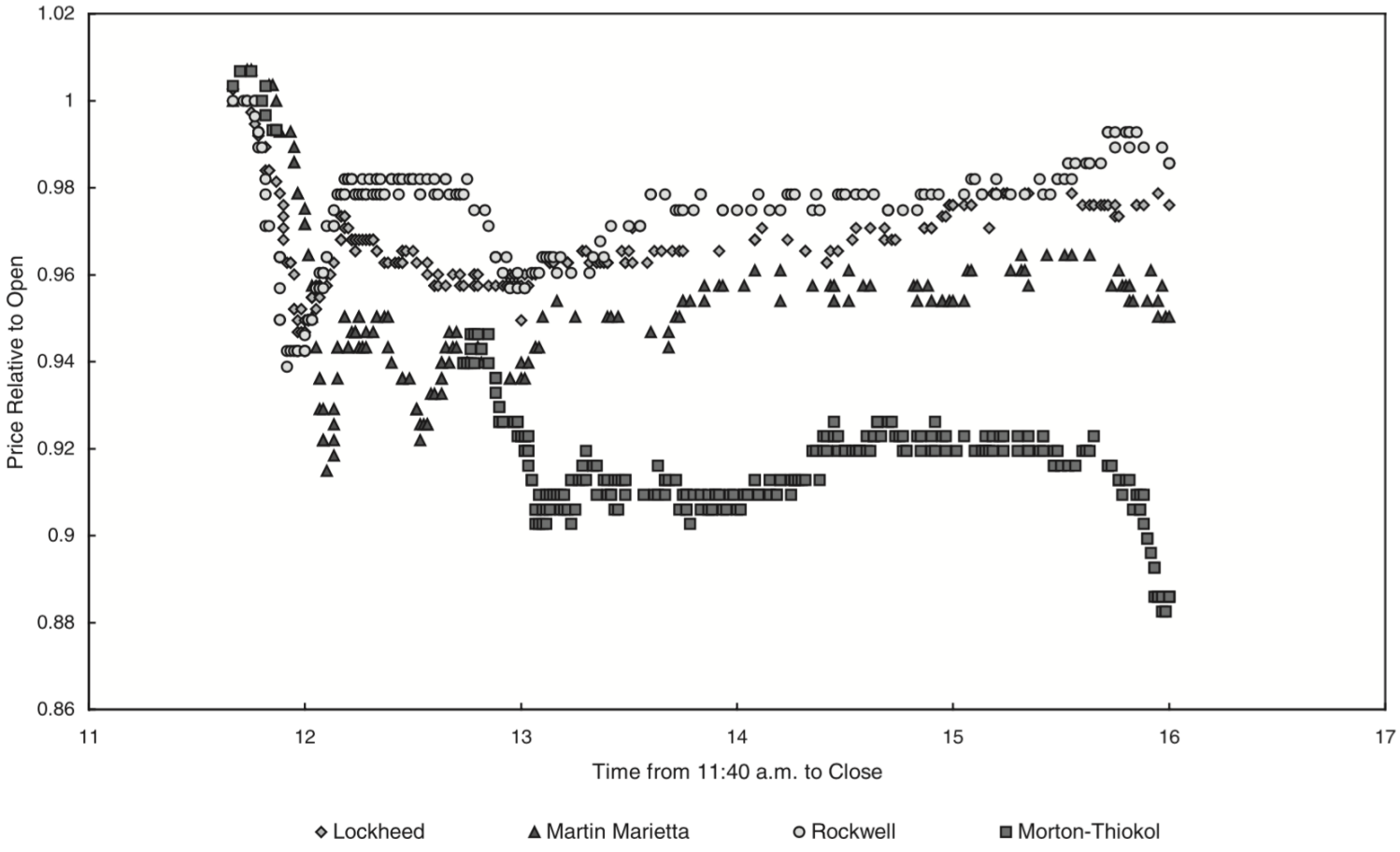


Fig. 1. Intraday stock price movements following the challenger disaster.

Implications of Efficient Markets Hypothesis

Theory of Market Efficiency:

- No Free Lunch, No Arbitrage
- Prices Fully Reflect All Available Information
- Prices Follow Random Walks
- Trade-Off Between Risk and Expected Return
- "Active" Management Does Not Add Value

Modern Classifications of Efficient Markets

Focuses on the relation between price reflecting underlying value, and closely linked to behavioral finance:

True believer: Price is always PV of the firm's cash flow.

Firm believer: Price deviates from PV, but this is not exploitable.

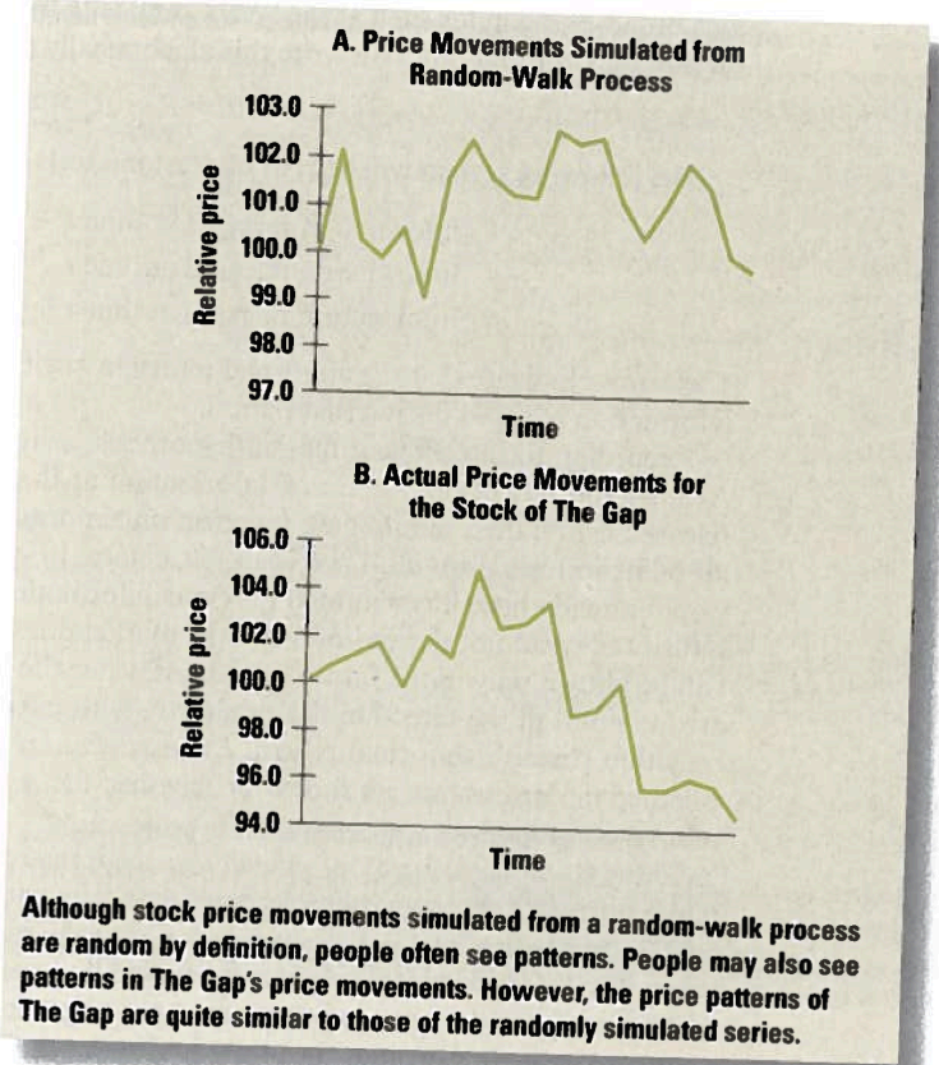
Mild believer: Price deviates from PV, and exploiting it is possible, giving you as an investor a mild edge.

Non believer: Price deviates strongly from PV, so investors can easily get rich, for example through **Technical Analysis**

What is Technical Analysis?

People who look at patterns of historical stock prices and try to predict the market with it.

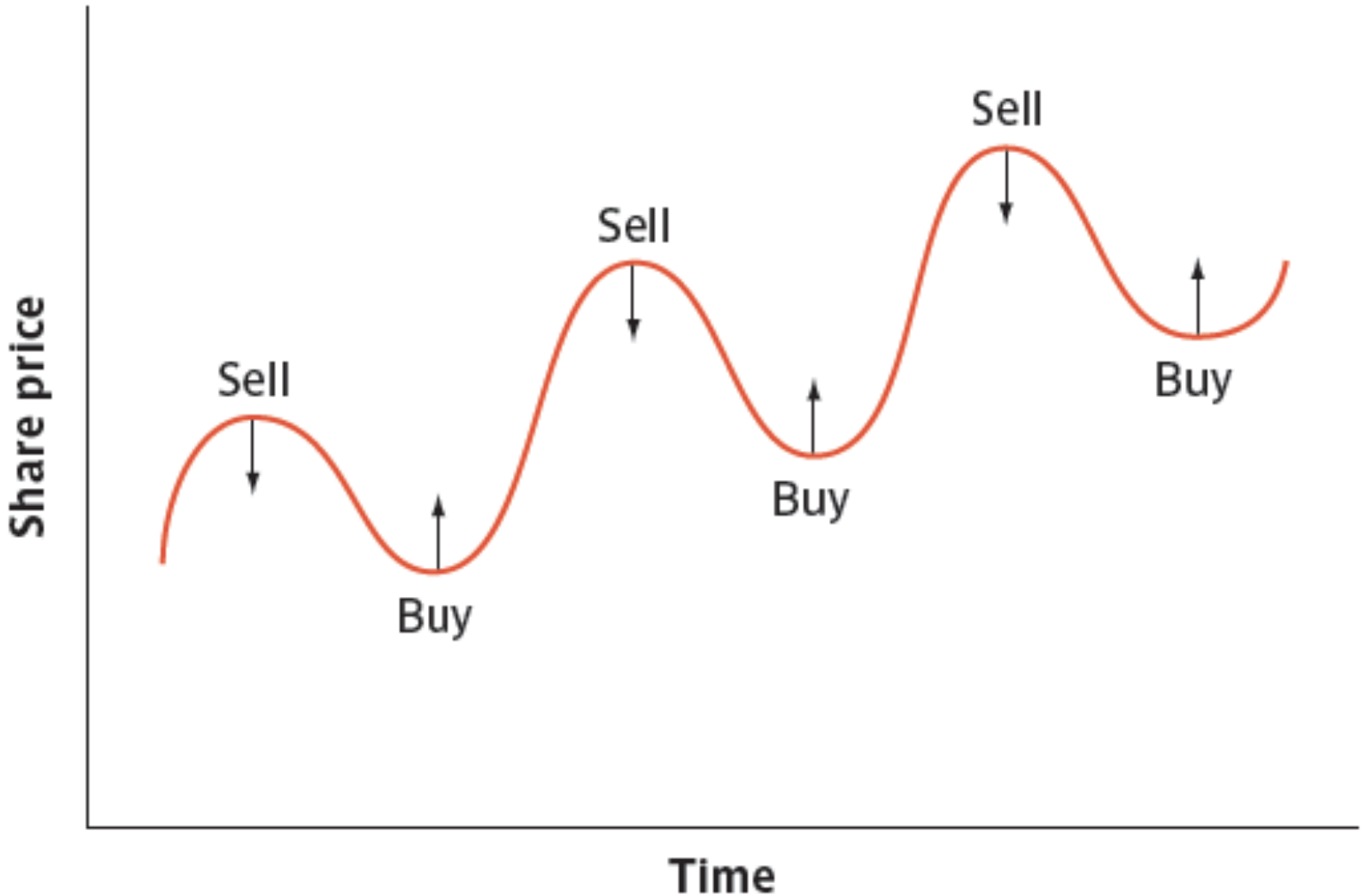
If price changes are truly random, why do so many believe that prices follow patterns? Probably because most people do now know what randomness looks like.



Although stock price movements simulated from a random-walk process are random by definition, people often see patterns. People may also see patterns in The Gap's price movements. However, the price patterns of The Gap are quite similar to those of the randomly simulated series.

Why is technical analysis pointless, according to EMH?

- If an equity's price follows a cyclical pattern, the pattern will be quickly eliminated.



Challenges to the Efficient Market Hypothesis

1. Empirical Anomalies: seemingly profitable investment strategies beyond of what can be explained by their CAPM risk
2. Behavioral Finance: challenges to the assumption of rational agents

Empirical Anomalies

What is the historical empirical evidence?

- First-order: the U.S. financial markets are reasonably efficient with respect to public information. It is very difficult to get rich easily. Few funds manage to outperform. It is close to random.

- Second-order: There may be some "anomalies" that seem to offer a tiny bit more than what seems reasonable.

Empirical Anomalies

- The three main equities-related anomalies are

  Value vs. growth: stocks with high book-to-market ratios (*value stocks*) tend to outperform stocks with low book-to-market ratios (*growth stocks*).

  Size: Returns on equities with small market capitalizations (market value of the firm) tend to be greater the the returns on equities with large market capitalizations.

  Momentum: tendency of rising asset prices to rise further, and falling prices to keep falling (over the next days).

- There are non-equities and other more specialized anomalies, too.

Fund Performance

Is Berkshire-Hathaway a good investment?

- Not good, not bad. For sure, its historical performance and behavior is not a secret.
- Even if Buffett is good at making money, this is certainly already known to investors, who have bid up the BH price to take this into acount.
- See *The Telegraph* article on Warren Buffet posted on ELE.

What is the empirical evidence for EMH?

- The empirical evidence is pretty consistent with EMH.
- Momentum and maybe value/growth strategies have outperformed by just a little bit—though there appears to be "fat-tail" risk.

Why is this debate so hard to settle?

EMH vs. Empirical Anomalies

Why is this debate so hard to settle?

1. Joint Hypothesis Problem
2. Low signal-to-noise ratio

Reason 1: Joint Hypothesis Problem

- EMH means roughly that "prices are set right."

  The problem is: what does right mean? We need to have a good model for the right target.

- Example: IBM just made an acquisition worth millions. Should the price of IBM stock double, triple, or something else?

- To be able to make any assertion about market efficiency, you need to make some assertion of how the market should reflect information.

- You need a model like CAPM to tell you what the price of IBM should be. Then you can test if it is reflecting all available information.

Reason 1: Joint Hypothesis Problem

- **Joint Hypothesis Problem:** You cannot say anything about market efficiency by itself. You can only say something about the coupling of market efficiency and some security price model.
- If prices do not follow CAPM predictions then it can either be that:
  1. CAPM is the wrong model and EMH is correct but reflecting other model
  2. CAPM is correct but EMH is wrong
  3. Both CAPM and EMH are wrong
- Mainstream finance has taken view 1. Behavioral finance takes view 2 or 3 (the market is trying to price securities according to some rational model like CAPM but falling short because of human frailty).

Reason 1: Joint Hypothesis Problem

- You see that the price of IBM is such that you expect it to earn 20% over the next year. Can you conclude that the market is inefficient?
  - No. Maybe 20% is the right number.
- What sort of claims would reject EMH?
  - An expected 10% in one day is contradicting EMH, because it is not plausible that any reasonable equilibrium model could tell you that you should earn 10% in one day.

Reason 2: Low signal-to-noise ratio

The signal-to-noise ratio is very low.

- According to the CAPM or similar models, what do you expect the expected rate of return on a trading day be?
  - Maybe $10\%/255 \approx 0.04\%$ per day (4bp per day). More realistically, 0.02% per day.
  - This is based on random walk: $E(P_1) = P_0 + m + \epsilon$, where m is small.
  - Transaction costs will further reduce this 0.04% in an imperfect world. A one-day roundtrip transaction will have you lose money.

Reason 2: Low signal-to-noise ratio

What is the typical daily move up or down of a stock? Of an Index?

- Around 1%-3% for stocks.
- Around 0.5% to 1% for portfolios, such as S&P500 or Dow-Jones.
- Signal = Mean. Noise = Standard Deviation.
- With this amount of noise, you need about 160 years of data to get statistical confidence.

Some Common MISPERCEPTIONS of Efficient Markets Hypothesis

- "What about Warren Buffet? He became rich betting on specific stocks"
  - By pure chance, some people will get rich on the stock market. Think about millions of people playing roullete.
- "According to EMH, investors are as well off throwing darts to select stocks"
  - The investor must still decide how much risk she wants in her portfolio and diversify.
- "Company's stock prices don't always rise with good news. In fact they fall with good news sometimes."
  - Prices will move up or down *relative* to expectations

Behavioral Finance

Behavioral Finance

- Market Participants Are Irrational
- Cognitive and Behavioral Biases
  - Loss Aversion, Anchoring, Framing
  - Overconfidence
  - Overreaction
  - Herding
  - Mental Accounting

EMH vs. Behavioral Finance

- **Behavioral Finance camp**: "Most people investing in the market do not incorporate all available information"
- **EMH camp**: "You only need a few smart people with deep pockets to engage in arbitrage and set prices 'right'. The few smart investors will take all the money from "naive" investors until they are driven out of the market."
- **Behavioral Finance camp**: "The market can stay irrational longer than you can stay solvent"
- **EMH camp**: "What seems like irrational market behavior can be seen as completely rational with a more complete/richer model."

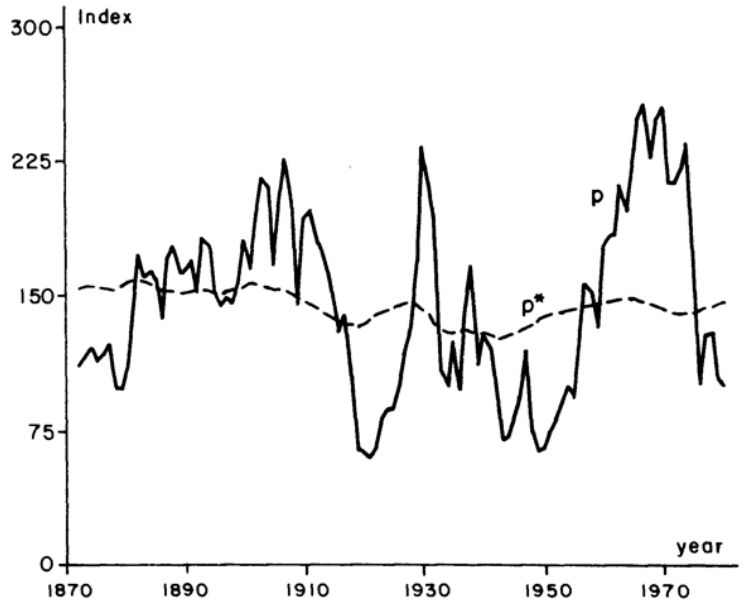
EMH vs. Behavioral Finance

Example: Price bubbles.

- Behavioral Finance camp: Price bubbles (deviation of prices from present value) are caused by herding behavior, overconfidence, ...
- EMH camp: Or by credit constraints, collateral constraints, expectations, not properly captured in our models.

Example: Shiller (1981)

Shiller has a famous article (1981) with this (now famous) graph:



- p is actual prices, p* is prices if we knew the future with certainty (discounted realized dividends)
- The title of the article is "Do Stock Prices Move Too Much to be Justified by Subsequent Changes in Dividends?" published in the American Economic Review
- Sidenote: Steven Leroy and Richard Porter made the same argument in a paper published the same year in another top journal, Econometrica, but Shiller's graph is what everyone remembers now.

Example: Shiller (1981)

- Shiller looked at this graph and concluded that prices move way to much compared to that predicted by subsequent dividends: it has to be psychological biases driving trades
  - People are overconfident
  - People dislike losing more than they like winning: loss aversion
  - Others
- Proponents of EMH say: it is not only dividends, there is also expectations and covariance with marginal utility.
- For example, preferences with habit formation seem to explain the volatility quite well.

Adaptive Markets

Adaptive Markets Hypothesis

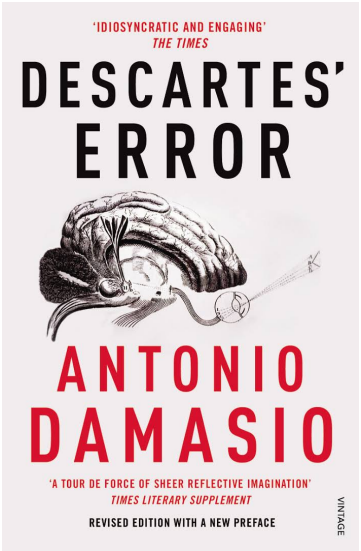
- Biggest problem of **behavioral finance** is that it is **not** a theory, it is a collection of observations. "It takes a model to beat a model."

- **Andrew Lo** (MIT, 2004): Adaptive Markets Hypothesis

  - The assumption of efficient markets holds reasonably well the majority of time: it is hard to get rich easily.

  - But in very good or very bad times, the majority of investors go with their gut feeling.

Logical vs. Rational



Patient Elliot Had Frontal Lobe Damage

- No Impact on IQ or Logical Functions
  - Perceptual Ability
  - Past Meory
  - Short-Term Memory
  - Learning
  - Language
  - Arithmetic
- But behavior was quite irrational!

Logical vs. Rational

Damasio (1994, p. 36):

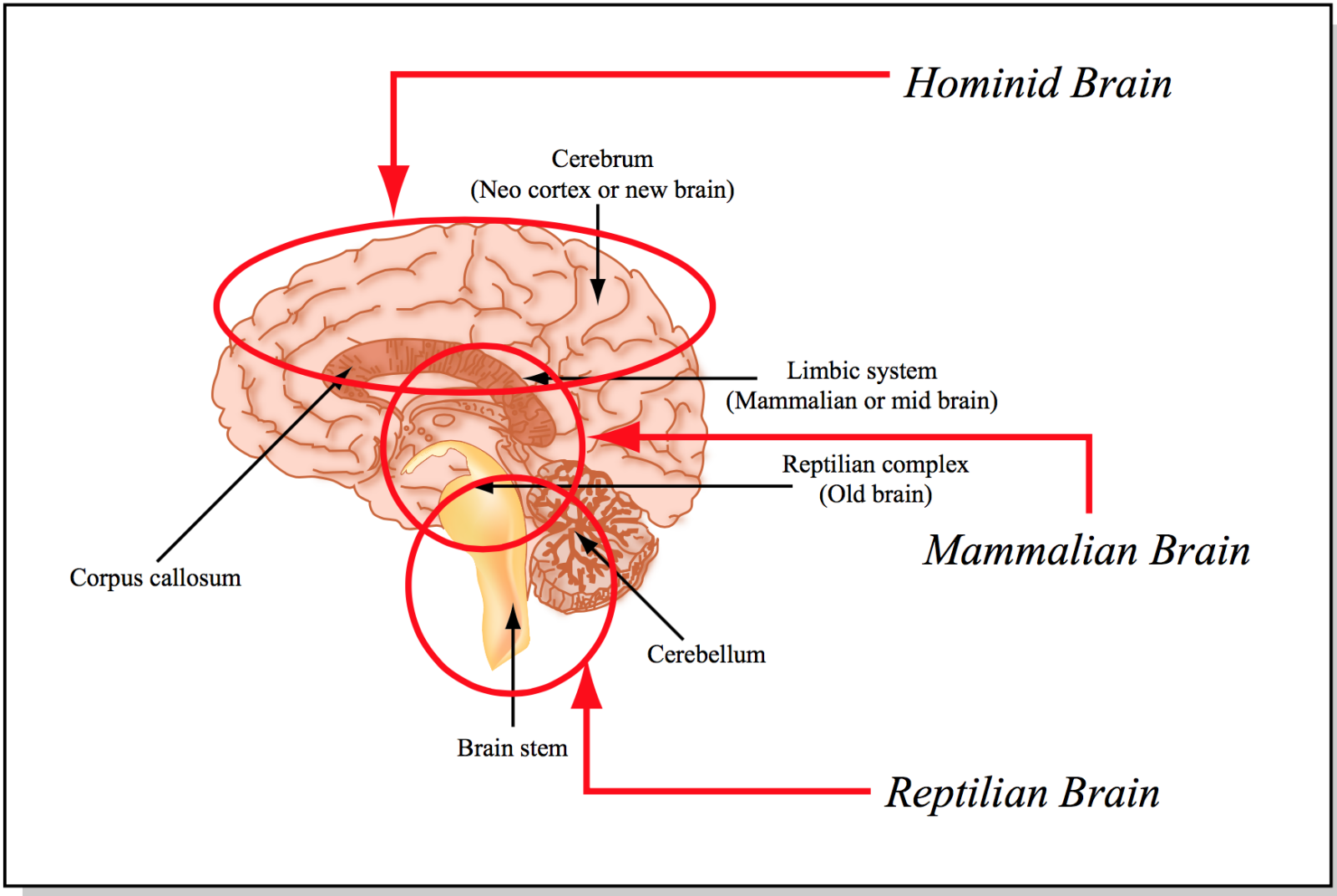
> When the job called for interrupting an activity and turning to another, he might persist nonetheless, seemingly losing sight of his main goal. Or he might interrupt the activity he had engaged, to turn to something he found more captivating at that particular moment The flow of work was stopped. One might say that the particular step of the task at which Elliot balked was actually being carried out too well, and at the expense of the overall purpose. One might say that Elliot had become irrational concerning the larger frame of behavior

Logical vs. Rational

No Reaction to Emotional Stimuli:

- "to know, but not to feel"
- Impaired Emotional Response $\rightarrow$ Irrationality
- Serious Implications For Decision-making
- What do we mean by rational?
- Left Brain/Right Brain Distinction is wrong

The Triune Model of the Brain



The Triune Model of the Brain

Examples of Applications:

- Forced Smile vs. Natural Smile
- Social Rejection vs. Physical Pain

Emotional Stimulus Can Short-Circuit Hominid Brain:

- "The Gift of Fear", G de Becker
- Too Flustered to Speak

The Triune Model of the Brain

Say the colours of the following words:

RED	GREEN	BLUE	YELLOW	ORANGE
BLUE	BROWN	RED	GREEN	PURPLE
PINK	BLACK	BLUE	YELLOW	GREEN

The Triune Model of the Brain

Say the colours of the following words:

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The Triune Model of the Brain

Preferences are produced by the three brains

- Logical Reasoning Produced by Hominid Brain
- Emotional Stimulus Overrides Hominid Brain
- Preferences May Not Be Stable Over Time
- Preferences May Not Be Stable Over Circumstances
- What Are Your Ultimate Objectives?
- Will Your Actions Help or Hinder You?

The Adaptive Markets Hypothesis

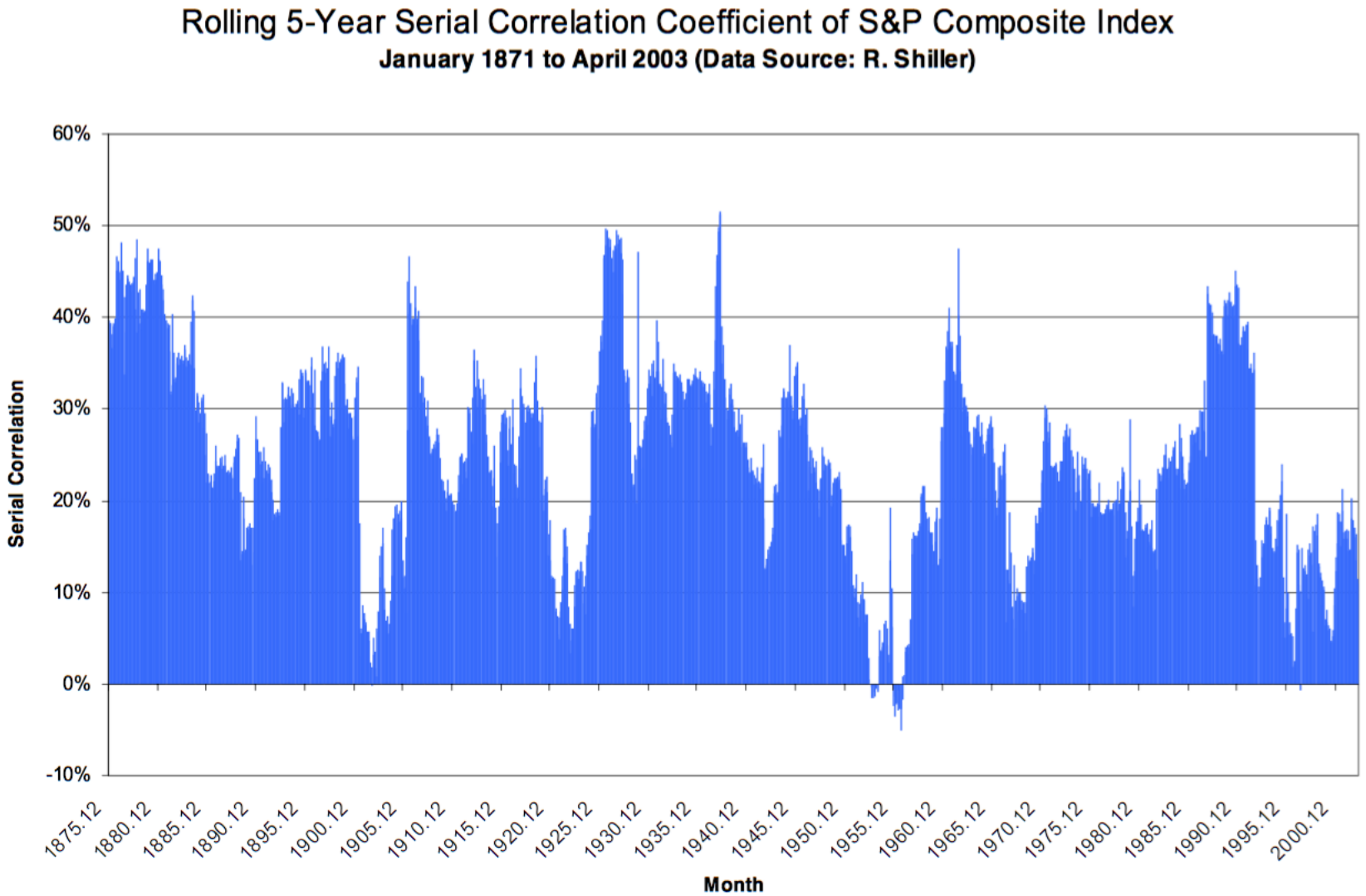
- **Behavioral Finance camp**: "Most people investing in the market do not incorporate all available information"
- **EMH camp**: "You only need a few smart people with deep pockets to engage in arbitrage and set prices 'right'. The few smart investors will take all the money from "naive" investors until they are driven out of the market."
- **Adaptive Markets Hypothesis**: EMH and Behavioral are both right and they are both wrong. Markets can be efficient or behavioral depending on the underlying population of naive vs. sophisticated investors. **Biology** theories of evolution and **survival of the fittest** help determine the composition of the underlying population of investors at any given point in time.

The Adaptive Markets Hypothesis

Practical Implications of Adaptive Markets Hypothesis:

- Risk/Reward Relation Not Stable (NonLinear)
- Risk Premia Are Time-Varying
- Limited Arbitrage Exists From Time to Time
- Strategies Wax and Wane
- Adaptation and Innovation Are Keys to Survival
- Survival is all the matters

The Adaptive Markets Hypothesis



Key Points

- $$\text{Perfect Market} \neq \text{Efficient Market}$$
- $$\text{Perfect Market} \Rightarrow \text{Efficient Market}$$

  but

  $$\text{Perfect Market} \not\Leftarrow \text{Efficient Market}$$

- Two main challenges to EMH come from Empirical Anomalies and Behavioral Finance.
- The debate is hard (impossible) to settle because of:
  1. Joint Hypothesis Problem
  2. Low signal-to-noise ratio

Key Points

What types of markets are more likely to be (in-)efficient?

- Think about the extent of market perfection. The closer a market is to being perfect, the more likely it is to being efficient, too.
- Of course, if the market is not perfect, there may not even be an efficient value.

Additional References

- Farmer, D. and A. Lo, 1999, "Frontiers of Finance: Evolution and Efficient Markets", *Proceedings of the National Academy of Sciences* 96, 9991–9992.
- Lo, A., 1999, "The Three P's of Total Risk Management", *Financial Analysts Journal* 55, 13–26.
- Lo, A., 2001, "Risk Management for Hedge Funds: Introduction and Overview", *Financial Analysts Journal* 57, 16–33.
- Lo, A., 2002, "Bubble, Rubble, Finance In Trouble?", *Journal of Psychology and Financial Markets* 3, 76–86.
- Lo, A., 2004, "The Adaptive Markets Hypothesis: Market Efficiency from an Evolutionary Perspective", *Journal of Portfolio Management* 30, 15–29.
- Lo, A. 2005, "Reconciling Efficient Markets with Behavioral Finance: The Adaptive Markets Hypothesis", *Journal of Investment Consulting* 7, 21–44.
- Lo, A. and C. MacKinlay, 1999, *A Non-Random Walk Down Wall Street*. Princeton, NJ: Princeton University Press.
- Lo, A. and D. Repin, 2002, "The Psychophysiology of Real-Time Financial Risk Processing", *Journal of Cognitive Neuroscience* 14, 323–339.
- Maloney, M. and H. Mulherin, 2003, "The Complexity of Price Discovery in an Efficient Market: The Stock Market Reaction to the Challenger Crash", *Journal of Corporate Finance* 9, 453–479.