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## Information Efficiency

Also known as Market Efficiency

# Efficient Prices

- A price is efficient if the market sets the correct price based on all available information

price = value  
*intrinsic*

$$P = V = \sum_{i=1}^{\infty} \frac{E[\widetilde{CF}_{t+i}]}{(1 + E[\tilde{r}])^i}$$

Information about future cash flows (dividends) and their growth and anything thing that may affect cash flows or their growth.

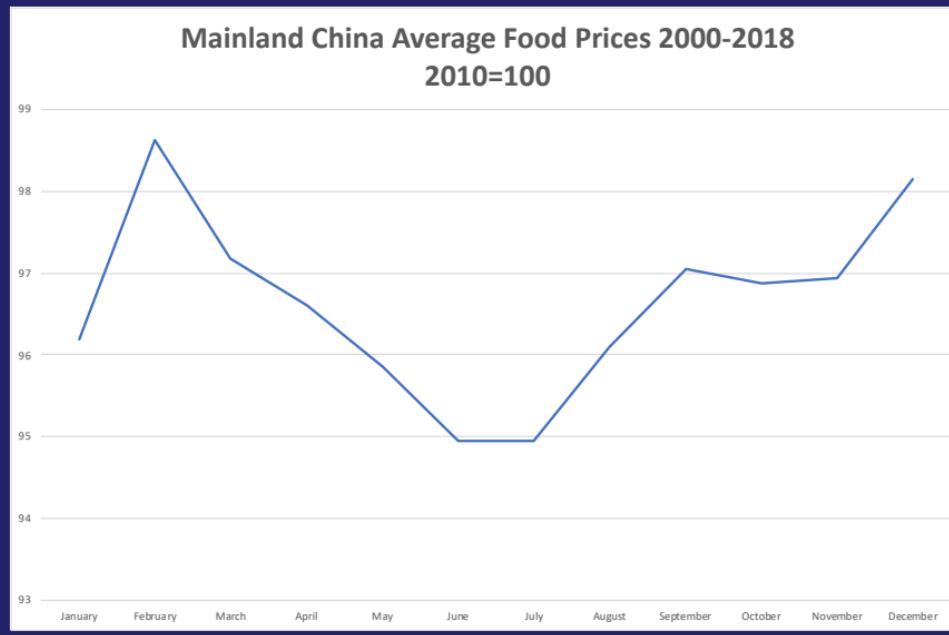
Information about changes in risk that affect the cost of capital,  $E[\tilde{r}]$  or  $k$ .

- It is very difficult to know if all information is impounded into stock prices, so
- We tend to think of efficiency dynamically: how prices change in response to new information

arrival of information is random  
price movement should be random

# What do efficient prices look like?

- In the 1950's a statistician from the London School of Economics, Maurice Kendall, set out to examine the trends (and deviations from trends) in stock prices.



# Maurice Kendall (1953)

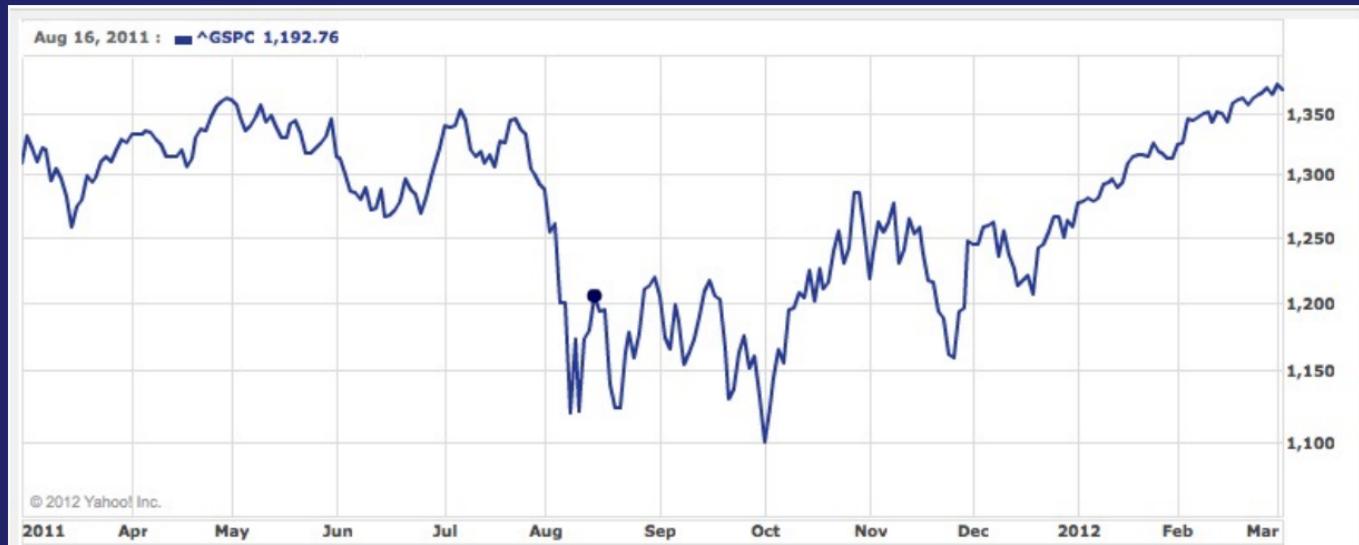
- He had assumed that stock prices, like the prices of tomatoes, wheat or other commodities would have cyclical patterns or trends like other prices.



- Much to Kendall's surprise the surprise of many economists there were no trends. Prices "behave almost like wandering series."

# Wandering Series:

- Does this indicate that prices are driven by psychology or “Animal Spirits”?



- Is there a more rational explanation?

## Efficient Prices and Competition (assuming rational investors)

- Suppose stock X is currently priced at \$10 per share
- But you've developed a model that allows you to predict with confidence that prices will rise to \$15 per share in a week.
- If you were alone in the knowledge that the price will go up, you'd slowly buy as much stock as you can so don't affect the price and can earn the biggest profit.

# The Limit Order Book

The dealer or other investors are offering \$26.12 to buy up to 24,595 shares

**MICROSOFT CP (RT-ECN: MSFT)**

Last Trade:	<b>26.12</b>
Trade Time:	<b>3:58pm ET</b>

The dealer or other investors are asking \$26.14 to sell up to 30,363 shares

Bid		Ask	
Price	Size	Price	Size
<b>26.12</b>	24,595	<b>26.14</b>	30,363
<b>26.11</b>	20,770	<b>26.15</b>	19,280
<b>26.10</b>	20,490	<b>26.16</b>	25,430
<b>26.09</b>	17,645	<b>26.17</b>	10,780
<b>26.08</b>	9,892	<b>26.18</b>	5,980

Source: <http://finance.yahoo.com/q/ecn?s=MSFT>

## Efficient Prices and Competition (2)

- Suppose other investors also had access to your brilliant model.
- You'd have to buy the stock quickly before they did and push up the price.
- Everyone else would realize the same thing and place a large number of orders and push the price up to (nearly) \$15.
- The more investors who know – the more orders and the faster the prices will change

# Competition and Efficient Prices

- Competition (arbitrage) assures prices reflect information
- Because prices quickly adjust to new information prices appear to “behave almost like wandering series.”
  - Key assumption: Information arrival is random.
- Random Walk - stock prices are random
  - Actually submartingale
    - Expected price is positive over time
    - Positive trend and random about the trend

## Security Prices

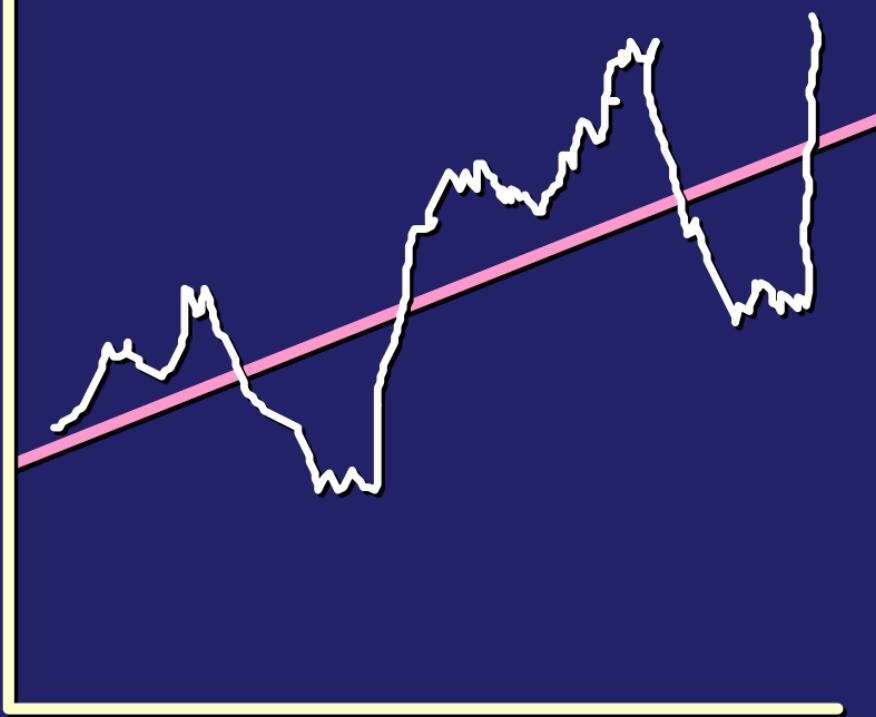
why upward trend?

Expected return



dividend & growth in value.

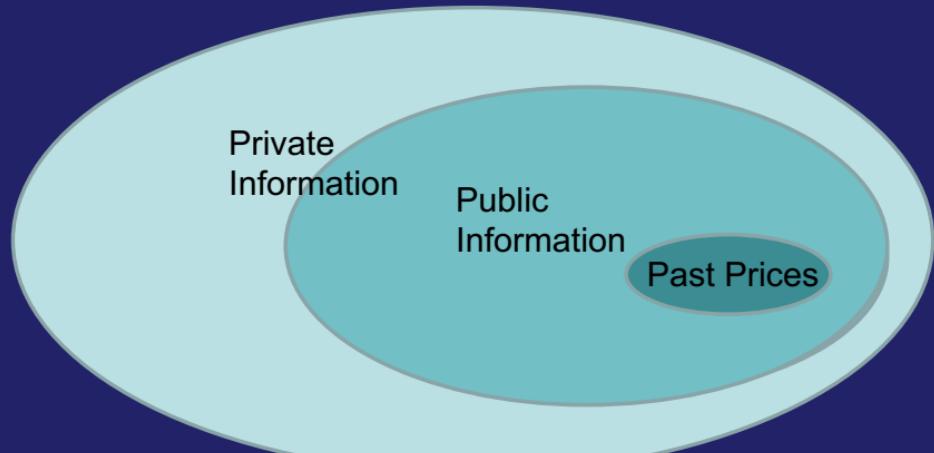
## Random Walk with Positive Trend



Time

# Efficient Market Hypothesis (EMH)

- The Efficient Markets Hypothesis: the prices of stocks reflect all available information



- Information Generated by
    - Exchanges → past price information
    - Investors, Analysts, Companies
      - Public
      - Private
- trade → report the price from the trade to the public*
- earning announcement*
- price may reflect those private information*

# Forms of the EMH

- Weak form: Prices reflect all information contained in past prices  
    ⇒ with knowledge of past prices, you can develop strategies to allow you earn in the future
- Semi-strong form: Prices reflect all publicly available information  
    ⇒ as soon as price become public, price adjusts immediately, (not possible to earn from that public information)
- Strong form: Prices reflect all relevant information, even if it is not in the public domain (private information)

# Why should we care about market efficiency?

- Implications for investment
  - If markets are efficient, what is the best investment strategy?
  - Can you earn riskless profit (i.e. arbitrage)?
    - Yes.
- Implications for business and corporate finance
  - If prices reflect all information then prices are a good signal of the quality of managerial decisions
    - Example: management announces its intent to buy another company and the price of its stock drops – it probably ain't such a bright idea....

*reduce risk by investing  
↓  
in a well-diversified portfolio*

# Are Markets Strong Form Efficient?

# Strong Form Efficient?

- If markets are strong form efficient can the CEO profit if she knows information that affects the value of the firm?
  - No.
- In real life, do they always profit?
  - No.
    - **Insiders** buy more stock before declines than increases (Driscoll, 1956)
    - But they do profit when they trade for mergers and acquisitions (Keown and Pinkerton, 1981 and Meulbroek, 1992)
    - But not before Seasoned Equity Offerings (Scholes, 1962)

shouldn't expect price be strong form efficient

# Are Markets Semi-Strong Form Efficient?

# Semi-Strong Form Efficiency & Fundamental Analysis

- Semi-Strong Form Efficiency
  - All PUBLIC information is quickly, correctly and completely incorporated into stock prices.
- Fundamental Analysis:
  - The analysis of balance sheets, earnings reports, dividend announcements, interest rates, etc. to arrive at proper stock price

in real life, public information gets incorporated into stock price  
within seconds.

# Event study intuition: Oct. 31, 2011



# Are markets semi-strong form efficient? Mostly



# Are Markets Weak Form Efficient?

# Evidence: Weak-form efficiency

↓ incorporate all past price information  
you should be able to profit merely by past information

- Pro

- Little to no evidence you can consistently profit from technical trading strategies (strategy based on past information)
- Appears to be some evidence that stocks with certain characteristics have higher returns than others-may be due to:
  - Limits to arbitrage
  - Data mining (Data snooping)
  - Risk or other economically significant rational market distortion(taxes)

- Cons

①

②

- Momentum and reversal strategies appear to be profitable.

↓ return may be compensation for risk

# Technical Analysis: (Luck and Survivorship Bias)

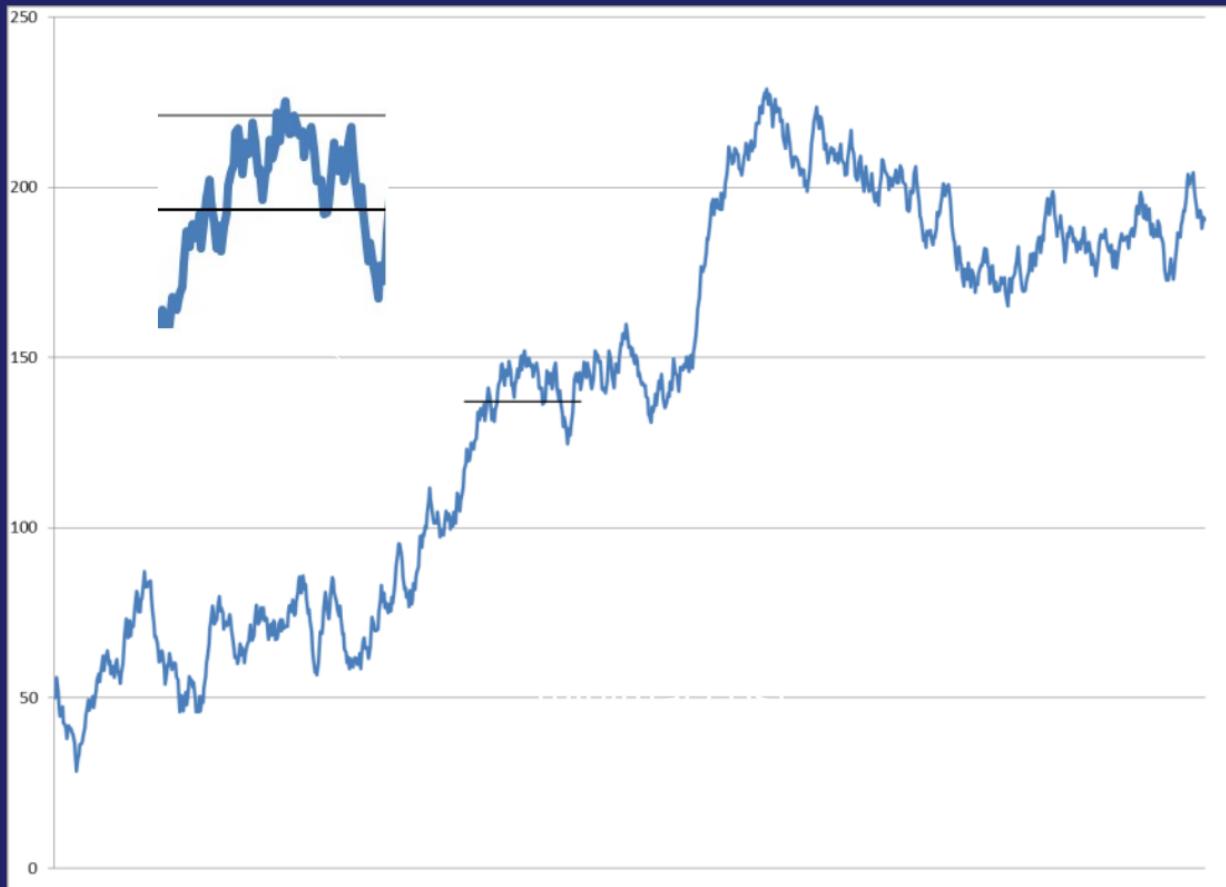
- Predict future stock price movements by looking at patterns in past prices: charting
  - Example: Head and Shoulders, from: <http://www.investopedia.com/terms/h/head-shoulders.asp>
  - 1. Rises to a peak and subsequently declines.  
2. Then, the price rises above the former peak and again declines.  
3. And finally, rises again, but not to the second peak, and declines once more.



→ price will continue decline  
sell or short sell assets

# Head and Shoulders in Actual Data

BUT IT IS  
completely  
random !



# Data mining

- Data mining is the act of sifting through a lot of data and only reporting the best results.
  - Suppose there are a universe of 100 possible strategies.
  - If none of these truly work to generate high (or low return), how many will show high or low return at the 5% significance level?  $n \approx 5\%$
- Data mining can be accidental!!
  - Consider: Research finds technical trading strategies that work
    - Perhaps because earlier researchers and analysts found those strategies were successful?
      - How many other strategies did earlier researchers look at?

## WSJ Strategy: Data mined?

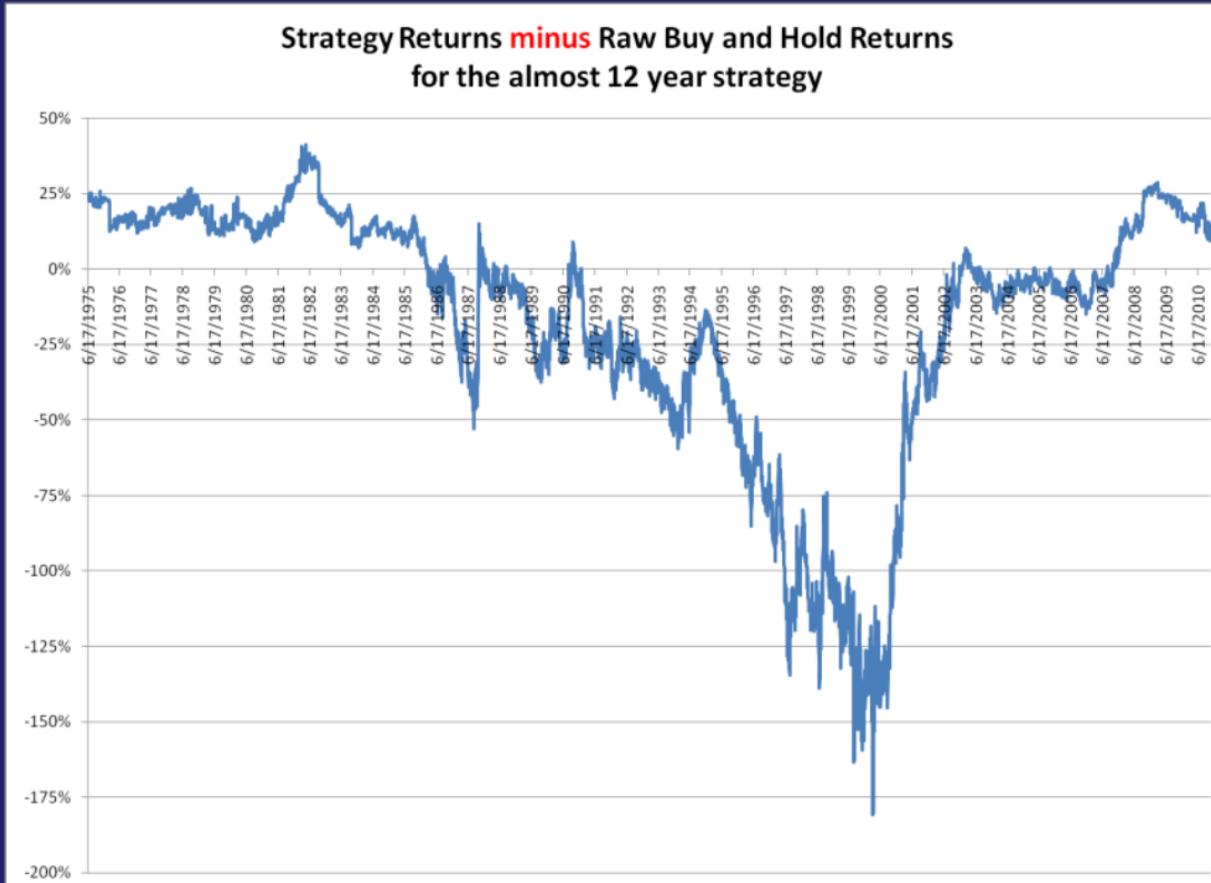
- Consider an investor with a \$1 million portfolio on Dec. 24, 1998, the first time the Standard & Poor's 500-stock index was at its current level. If the investor had merely held on, he would have seen essentially zero appreciation through Nov. 11 of this year. But if that same investor instead had sold one-tenth of his portfolio every time the stock market gained 20% and allocated one-fifth of his cash to the market when stocks fell more than 10%, he would have gained about \$140,000, according to a Wall Street Journal analysis.
  - I actually got \$86,892, assuming I invested the cash in 1 month T-Bills and completely ignoring transactions costs.

From: "How to Play a Market Rally" by Ben Levisohn and Jane J. Kim, WSJ Nov. 13, 2011.

# S&P 500

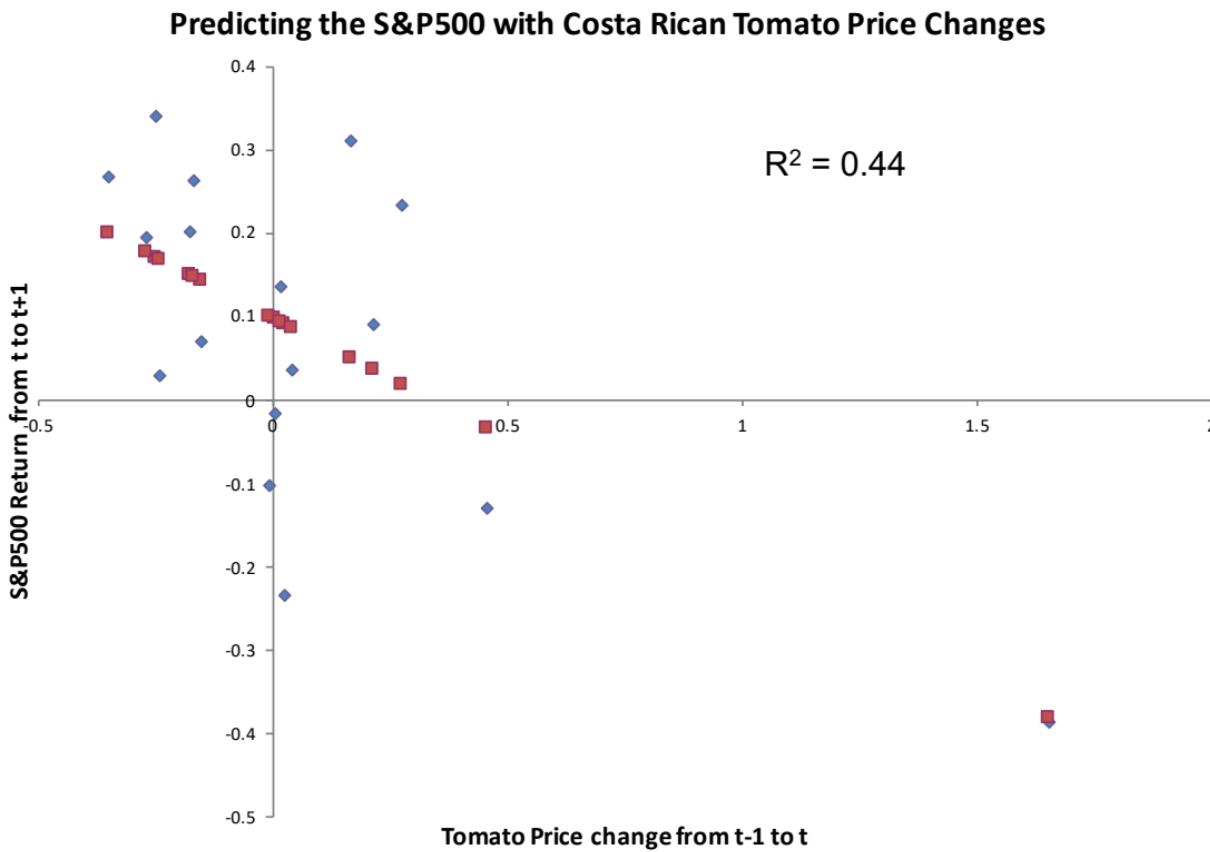


# WSJ Strategy Back Tested



- Markets are not very predictable.
  - They're efficient?

get predictability (rational part)  
since  $\Delta$  risk changes  $E(r)$  & future return
- Data mining can (accidentally) lead to false confidence
  - Best predictor of the S&P500 from 1993 through 2009 is last year's price change in Costa Rican Tomatoes ( $R^2 = 0.44$ )
    - The correlation is negative
    - Source <http://faostat.fao.org/>, finance.yahoo.com and own calculations
  -   
 $R^2 > 10\%$  and can predict  
future price
  - irrelevant but high  $R^2$   
risky



# “Small Firm in January” effect

- “Small Firm in January” effect → small firm earn unusually high returns
  - Return difference occurs almost entirely in January
- Anomaly or Rational Explanation?
  - Explained by tax-loss selling
    - Selling losers in December (or earlier) in order to offset profits
    - Buying back these losers in January to re-establish desired portfolio diversification
- Actually, it seems to have disappeared....

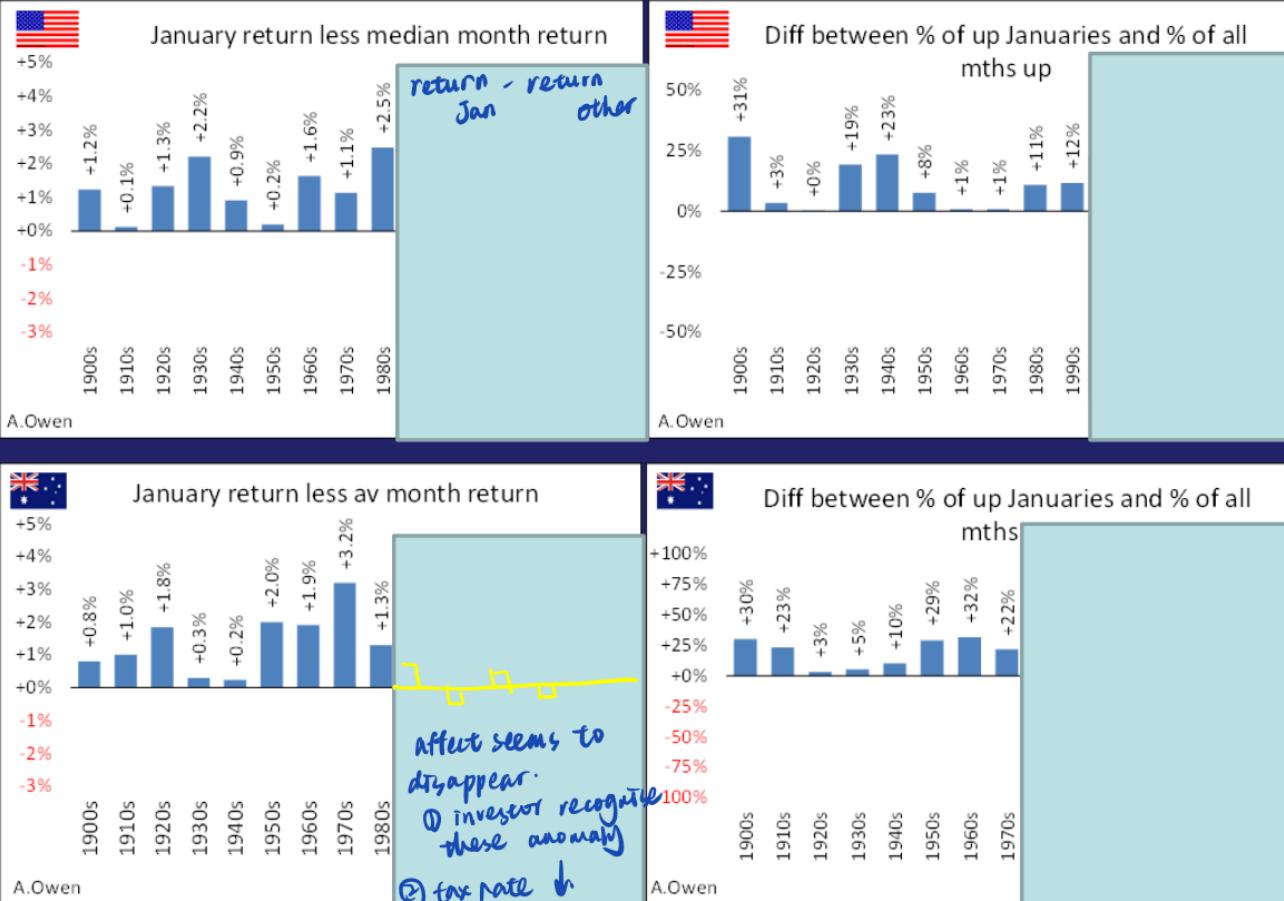
tax year December

Why affects AU stock market ?

(tax year in June)

trader in other part's of  
the planet has tax year in  
Dec, their trading activity  
affects AU market

# January Effect



# Small Firm Effect – Neglected Firms

- The “neglected firm” effect
  - Small firms are riskier, more uncertain investments
  - Information about these companies is less available
  - Small firms are neglected by large institutional traders
  - and therefore command higher returns

*compensation for risk ≠ inefficient*

## Limits to arbitrage

- Competition assures prices reflect information accurately
- Yes – but what if competition is limited?
- Trading costs
  - Bid-ask spread, broker fees, commissions
- illiquidity/price pressure
- Information collection (research costs)
- Taxes

# No transaction costs

- Consider our example of a stock currently priced at \$10 but you know will be worth \$15 next week.
  - What if it costs you \$1 per share per trade?

$$r = \frac{(15-1)-(10+1)}{(10+1)} = 27.3\%$$

- If trading costs are \$2.50 there is no profit to be had, i.e. your return is 0%.
  - So with trading costs of \$2.50 per share – **mispricing less than \$5 is not worth trading on.**
- Notice something else trading costs are affecting:
  - Trading costs affect the value of firms too.
    - Cash flows received from a high transaction cost stock are worth less than the same cash flows from a low transaction cost stock

*vixi diey* !

## Transaction Costs (*continued*)

- Transaction costs are more than just the cost of trading. They include anything that affects the cost of investing:
  - Broker fees
  - Costs of paper work
    - For example to fill out forms for getting a loan to execute a trading strategy involving a purchase on margin.
  - Time and money spent investigating a stock or stocks

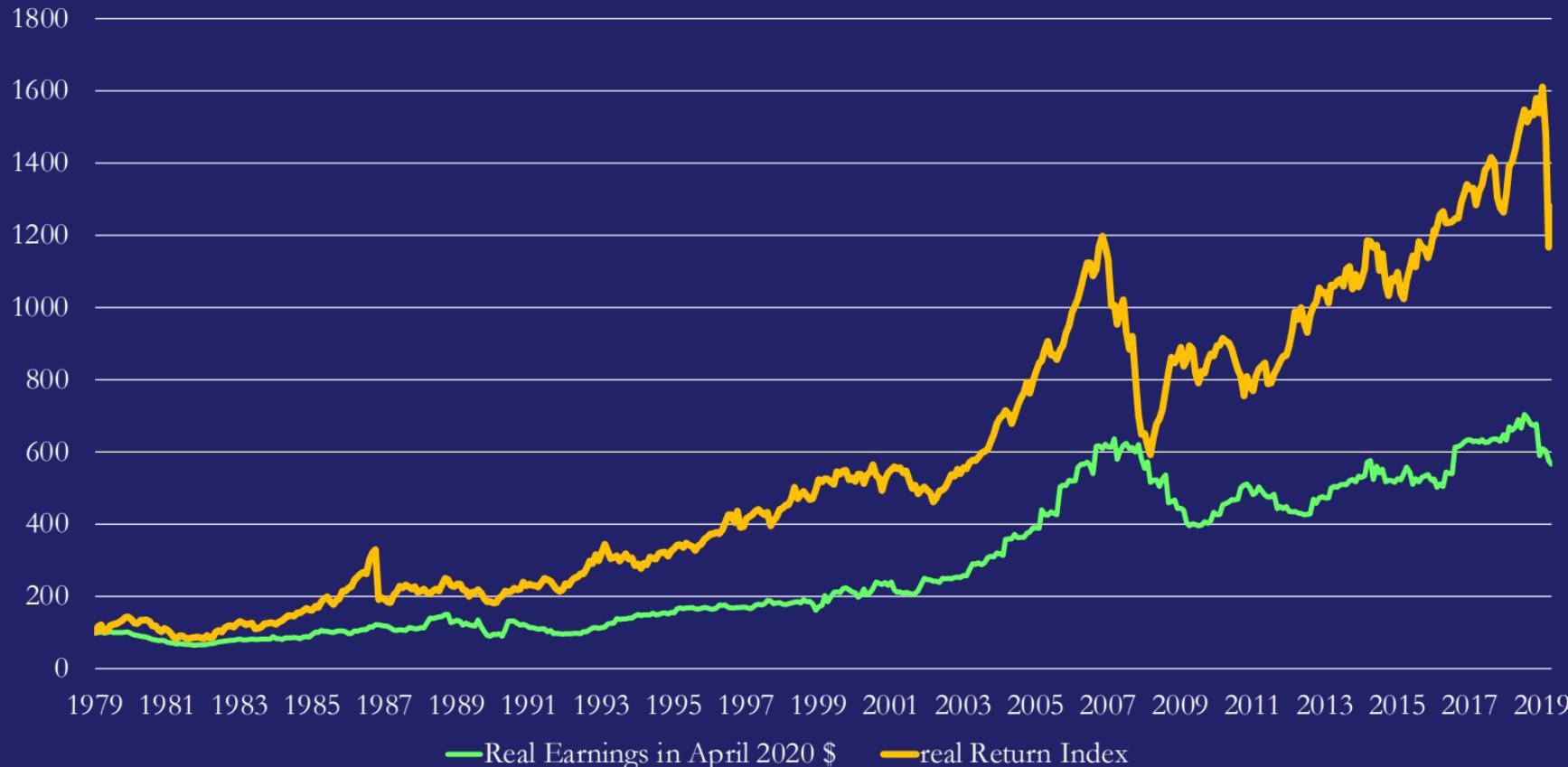
# Big challenge in real life: Illiquidity

- For large traders in real life, their trades can be so large that their buys and sales move prices.
  - Buys will tend to push the price up
  - Sales will tend to push the price down
- Profits are small, so this “**price pressure**” can kill your profit.
  - Traders are typically more worried about price pressure than the actual costs of trading, which are small for them

as small investor, focus on more illiquid stock  
since it will be “**price pressure**”  
for large institution  
be less sufficiently priced

# ASX All Ordinaries

## Real Stock Price Levels and Real Earnings



# Evidence Against Weak-Form Efficiency

- Weak form efficiency says:
  - Prices reflect all information contained in past prices
  - Simple trading strategies based on past returns shouldn't be profitable.  
Returns should not be predictable!
- Cons:
  - Short-Term Reversal Strategies
  - Medium-Term Momentum Strategies
  - Long Term Reversals Strategies
- All seem to generate consistently strong profit.
  - And we have no evidence that there is risk associated.
  - Some evidence reversals are within limits to arbitrage

# The Reversal Strategy

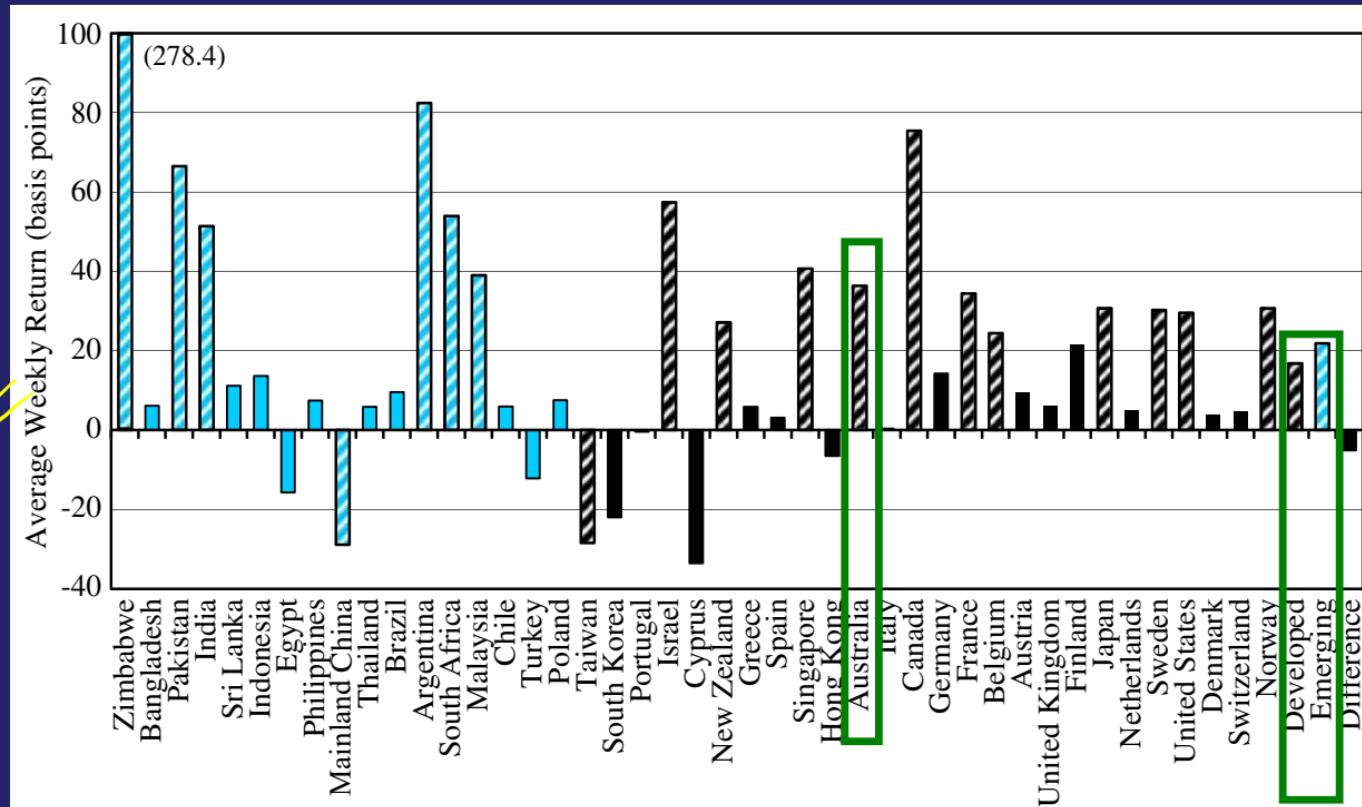
- Sort all stocks based on past one week returns.
- Buy the losers – the worst 20%
- Short-sell the winners – the best 20%
- Repeat.

## Example that looks like reversal



# One week contrarian profits

seems high  
return - high  
BUT  
don't take  
account of  
Trading cost



Griffin, Kelly, Nardari (2010)

# Contrarian Profits

- Are these profits meaningful?
- The long-short strategy in the U.S. earns only 30 basis points per week before accounting for the cost of buying and selling stock.
  - Is 30 basis points of return per week enough to cover the cost of a high turn over strategy that buys, sells, shorts and covers stocks each week?
  - With \$1,000,000 in assets, 30 basis points generates \$3000 in profit ignoring trading costs.
- Limits to arbitrage
  - If it is too costly to trade on an anomaly – a seemingly easy way to profit – the anomaly will continue to exist

*trading cost is high*

# Contrarian Profits

- In the past many have assumed that less developed markets are less efficient in the sense that investors tend to
  - overreact or are
  - slow to incorporate information
- We just saw that there are significant profits to be had from simple contrarian strategies even in developed markets
  - There are differences across markets
  - But over all emerging and developed markets are  similarly efficient

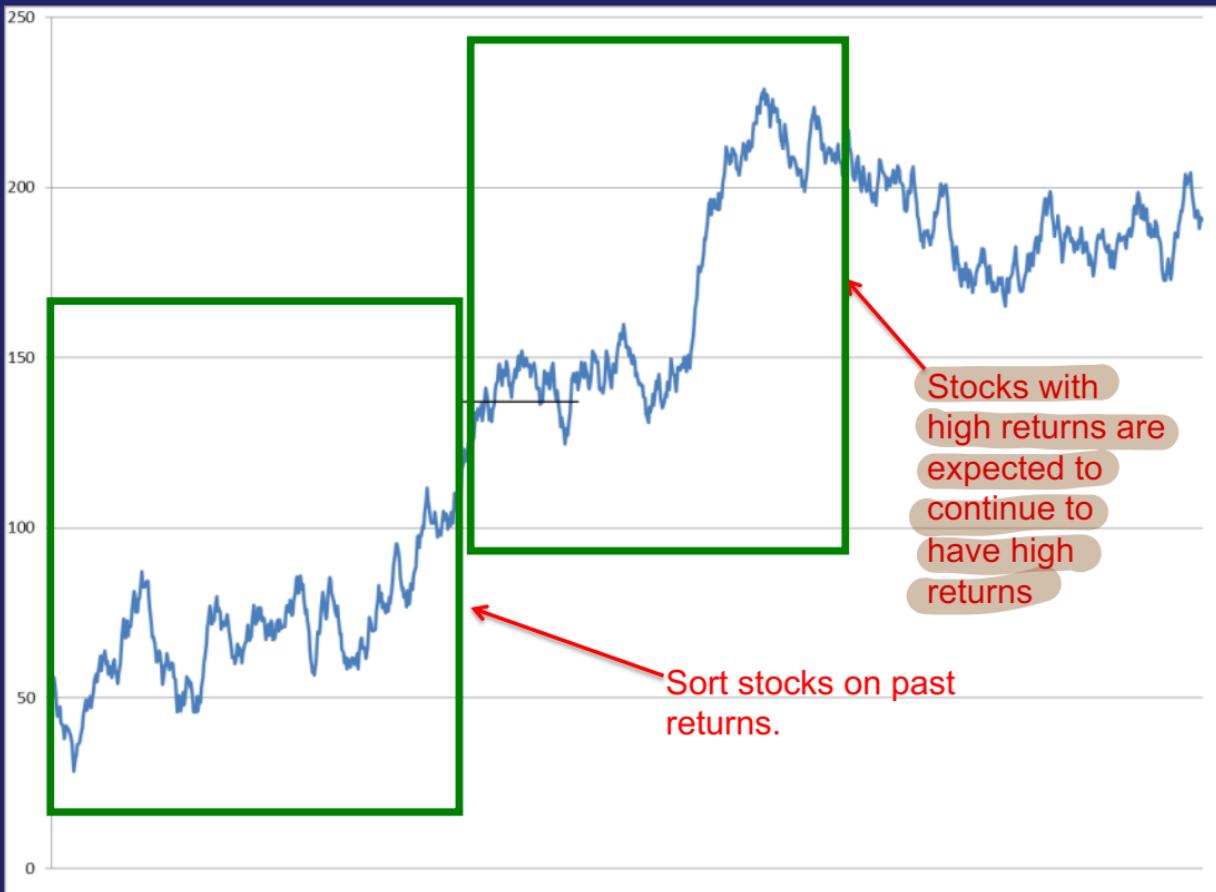
# Tests of Market Efficiency - Momentum

Momentum predicts return

- Portfolios Long on past six-month winners and short past six-month losers earn high returns.
  - Winners are the 10% of stocks with the highest returns
  - Losers are the worst 10% of stocks with the lowest returns

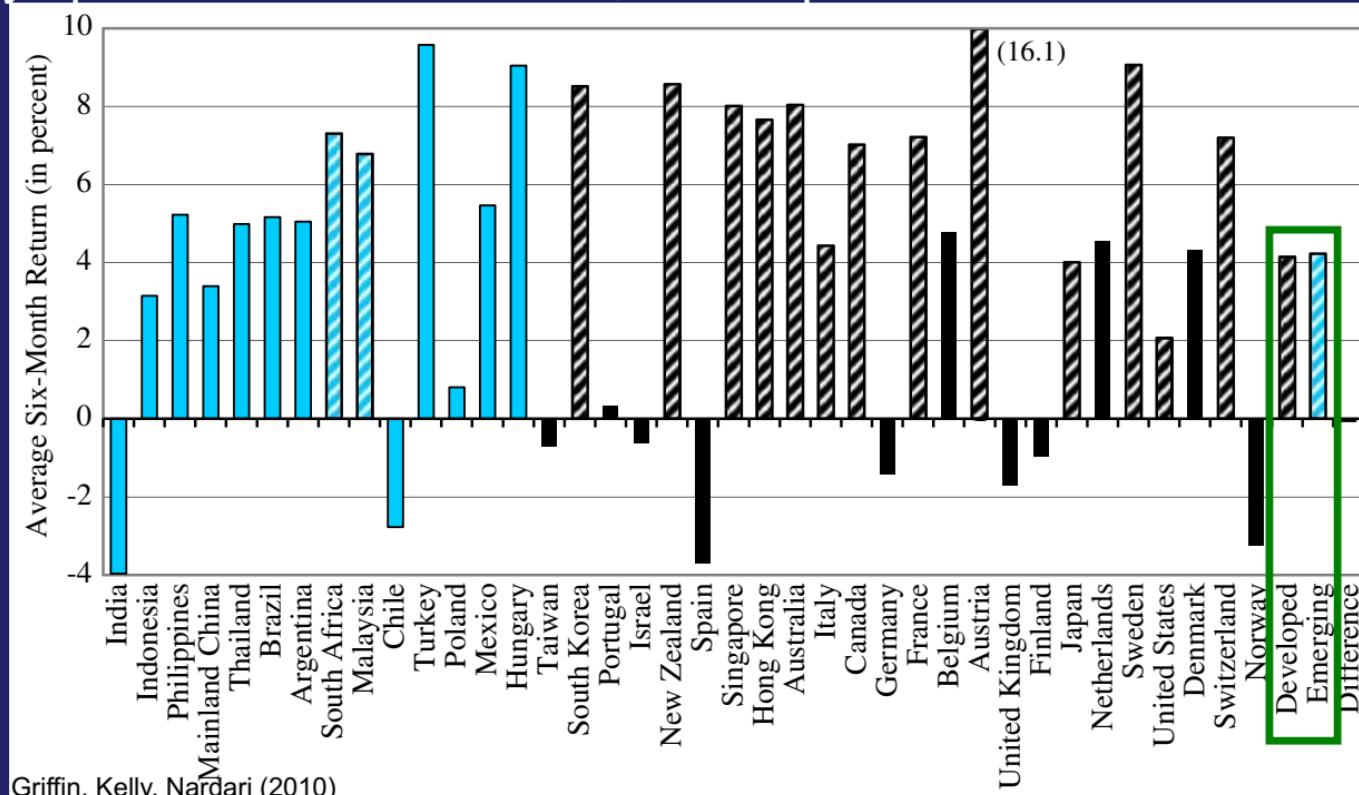
Portfolio:  
long those winners  
short those losers

# Example that looks like momentum



# Six-Month Momentum

- Buys past six-month winners, shorts past six-month losers



# More Modern Classification (EM)

Efficient Market

- True EM believer: Price is always PV of the firm's cash flow.
- Firm EM believer: Price deviates from PV, but this is not exploitable.  
*(limit to arbitrage)*  
*short period, high frequency, price might deviate from PV*  
*long period, price might deviate, but might not*
- Mild EM believer: Price deviates from PV, and exploiting it is possible, giving you as an investor a mild edge.  
*| be able to arbitrage*
- Non EM believer: Price deviates strongly from PV, so investors can easily get rich.

# Behavioral Finance

# Prelude: The perverse ability of individual investors

- The average individual investor underperforms the market – before and after costs.
  - Contrasts with managed funds
    - Outperform before costs, but, on average,
    - under perform after costs.
  - Some evidence that large institutions are able to
    - Outperform both before and after costs.
- Over long horizons stocks individuals purchase under perform by 2.76% the stocks they sell. (Odean, 1999)
  - Even considering trades for liquidity, rebalancing and taxes.
  - Mostly due to trading costs (Barber and Odean, 2000)
    - 20% most frequent traders earned 11.4%, before costs.
    - The 20% least frequent traders, (buy and hold) 18.5%.

# What is Behavioral Finance?

- Behavioral finance argues some phenomena are best explained if some agents are not rational
- (In my opinion) better studies of behavioral finance will look for evidence of non-rational decision making in the returns investors receive or the effects on wealth that occur as a result of their choices
- More controversial studies will look of evidence of non-rational decision making in prices in actively traded markets.

Investors will come in to earn from stupid investors .

⇒ BUT they will correct the price during this process .

Price will not have indication . (Get corrected through arbitrage)

# Allais (1953) Paradox

- Which do you prefer A or B?

*Experiment 1*

Gamble 1A		Gamble 1B	
Winnings	Chance	Winnings	Chance
100 million	100%	500 million	10%
		100 million	89%
		Nothing	1%

*Experiment 2*

Gamble 2A		Gamble 2B	
Winnings	Chance	Winnings	Chance
100 million	11%	500 million	10%
Nothing	89%	Nothing	90%

# Allais (1953) Paradox

Why is 1A > 1B then 2A > 2B consistent?

*Experiment 1*

Gamble 1A		Gamble 1B	
Winnings	Chance	Winnings	Chance
100 million	89%	100 million	89%
100 million	11%	Nothing	1%
		500 million	10%

*Experiment 2*

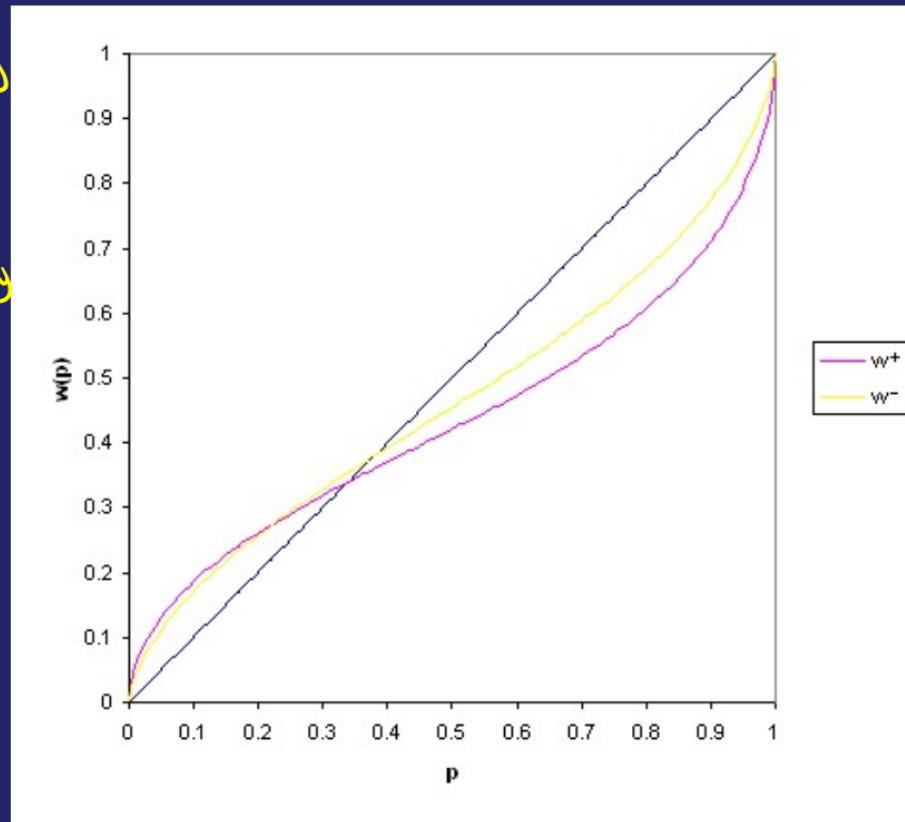
Gamble 2A		Gamble 2B	
Winnings	Chance	Winnings	Chance
Nothing	89%	Nothing	89%
100 million	11%	Nothing	1%
		500 million	10%

- People overweight outcomes that are merely probable compared to certain outcomes
- AND
- Low probability events are more important than high
  - A lottery like chance looms larger than an event with near certainty
  - This might explain how people can simultaneously buy insurance and lottery tickets  
*(risk loving)*  
*(risk averse)*

# Probability Weighting

we perceive low probability event as having high probability while for high probability event to have low probability.

perceive prob



true prob

Picture taken from <http://prospect-theory.behaviouralfinance.net/>

- Our choices are not consistent
- We don't always make the same decision when confronted with the same alternatives
- Framing is important

- Traditional “Neoclassical” Economics focuses on outcomes. Process is unimportant.
- For most primates, the process is important. Whether we experience a gain or a loss affects our perception of utility.
- For that reason, most people, if they follow their gut choose gambles that are inconsistent in a rational framework.

- Kahneman and Tversky, *Econometrica* 1979
  - Kahneman won the Nobel Prize in Economics for this descriptive model of decision making under risk.
  - Experimental evidence suggested that individuals are risk averse in gains and risk loving in losses
    - Next slide

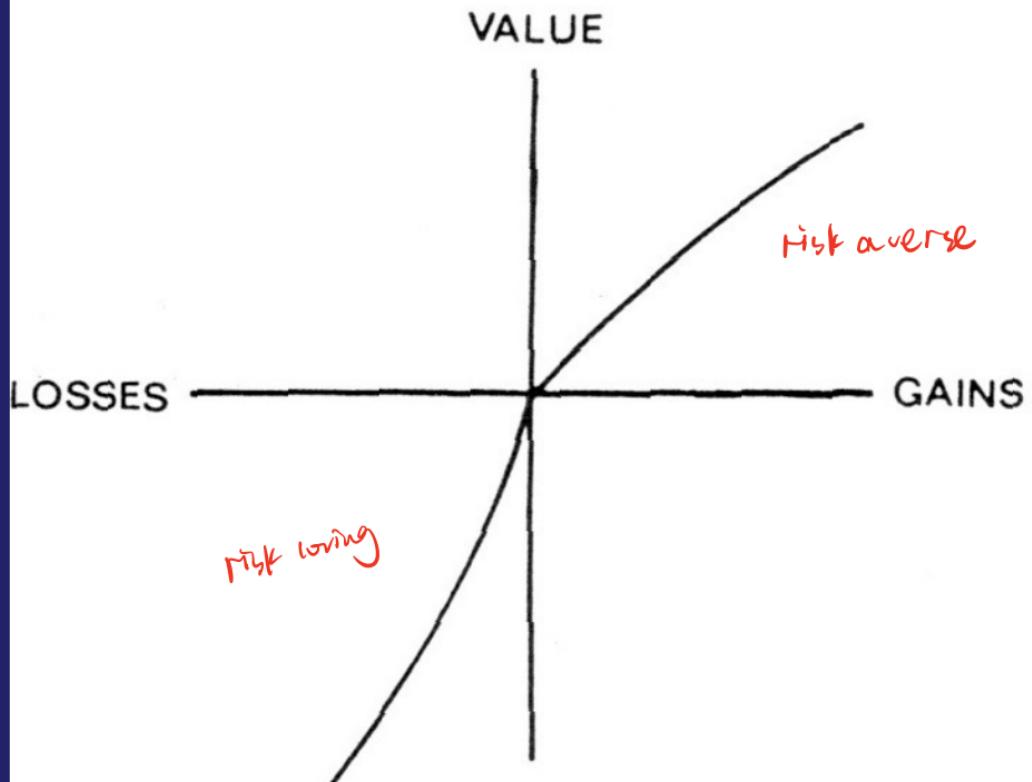
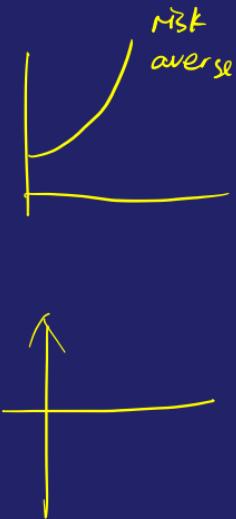


FIGURE 3.—A hypothetical value function.



# Loss Aversion

- What people value is not their terminal wealth as Markowitz (1952) suggests.  
*Rational investors should value terminal wealth*
- Rather what is important is whether they experience loss or gains.
- In particular, individuals find the same loss much more painful than the same gain is pleasurable.
- Individuals are risk loving in losses and risk averse in gains.
  - Losses encourage risk taking behavior

# Loss Aversion in Traders on the CBOT

- List (2002, 2003, 2004) finds that trading experience attenuates some biases
  - Suggesting that such biases may not be all that important in actual markets

BUT...

- Haigh and List (2005) conduct a study with 54 Chicago Board of Trade traders and find that Loss aversion is even greater among professional traders than students
  - Morning losses lead to extra risk taking in the afternoon

*Gain in the morning . more conservative in the afternoon (preserve gain)*

# Disposition Effect

- Analyzing the trades of individual investors Odean (1998) finds that investors are more willing to sell winners and hold on to losers.
  - Similar findings are found in Finland and China [Grinblatt and Keloharju (2001), and Feng and Seasholes (2005)]
  - U.S. mutual fund managers also suffer from the disposition effect [Frazzini (2006)]
    - But weaker than for individual investors
  - Similar effects are prevalent in the real estate market and in the exercise of executive stock options [Genesove and Mayer (2001) and Heath, Huddart, and Lang (1999)]

# Loss Aversion is probably hard-wired in our brains



# Loss Aversion is probably hard-wired in our brains

- Capuchin monkeys, taught to trade tokens for food, respond rationally price and wealth shocks
  - Increases in prices lead the monkeys to choose substitutes
- But when faced with gambles, they suffer from reference dependent preferences and loss aversion.
- See: TED talk delivered by Laurie Santos in 2010.
- [http://www.ted.com/talks/laurie\\_santos.html](http://www.ted.com/talks/laurie_santos.html)

# The problem

- If these irrational decisions are hard wired in our brains, it will be very hard for us to overcome them.
- Perhaps the best we can do is accept that we will make dumb decisions
- Learn about the dumb decisions we will make
- And try to design systems to avoid them
- Or profit from them

# Take away

- Behavioral biases certainly affect investors
  - Some of these biases are hard wired.
    - We even see effects in monkeys
- But for Behavioral Biases to affect prices, the behavior must be pervasive and it must manifest at the same time for all investors
  - And if you are going to profit, the manifestations must be predictable
- Biases do damage our wealth, even if they do not affect prices.
  - But if we are aware of our biases, we can avoid mistakes ourselves.

Market are likely efficient.  
Less likely to find behavioral biases  
In traded assets.

# In this subject we've learned

- Prices are mostly efficient *(through competition)*.  
*thus, less time to do research on all assets.*
- How to optimally invest **(diversification)**
  - Implications of diversification for asset pricing (finding  $E[r]$ )
- Asset pricing models (CAPM, APT, Fama-French, etc.)
- Applications of those models, particularly to performance measurement.
- How to value assets with risky payoffs
  - How the timing of those payoffs affects the sensitivity of prices to changes in risk-free rates and discount rates

# The End of a Beginning

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