Finance and the Unexpected

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What might one be uncertain about?

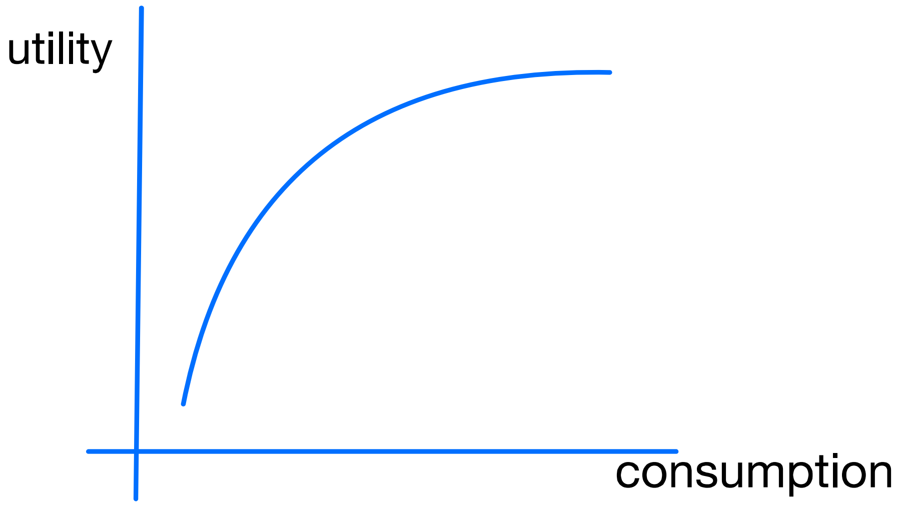
1. Outcome of a given FDA trial affecting valuation of a company
2. Whether an executive of a company might be defrauding investors
3. The return on S&P 500 on any given day? Over the next calendar year?
4. Whether there will be failure of a major U.S. stock exchange in the next calendar year
5. Whether your trading counterparty knows more than you
6. Whether your bank will be forced to close due to withdrawals or loss of funding source
7. What everybody else believes about these questions

What is “the unexpected”?

- Life is full of outcomes that we cannot predict with certainty
- We can represent the range of outcomes as $\tilde{x}$
- We can form an *expectation* $E[\tilde{x}]$
- Something is *unexpected* to the degree it is far from $E[\tilde{x}]$
- The larger is $\tilde{x} - E[\tilde{x}]$ the more unexpected the event

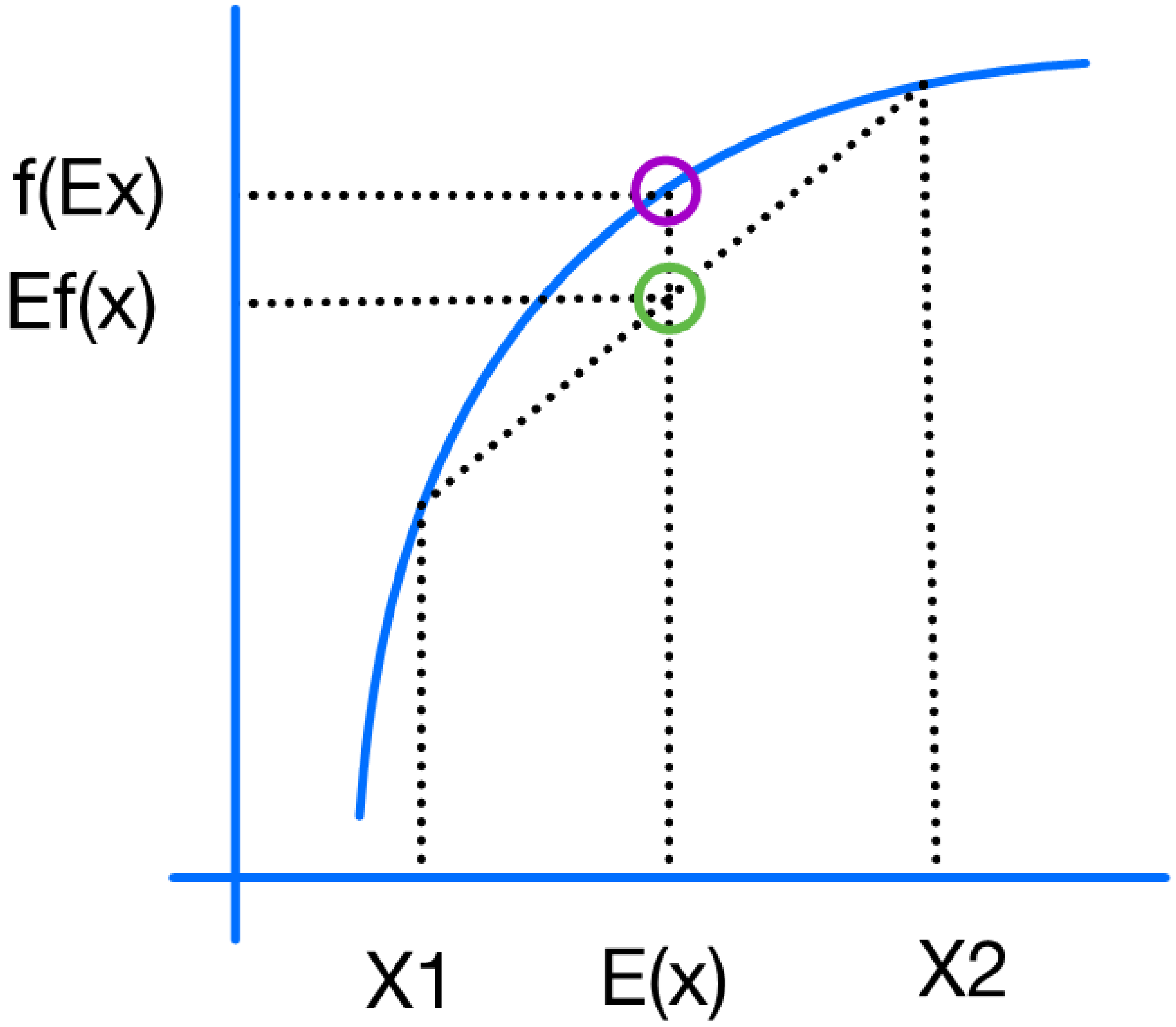
People are risk-averse

- Arises from decreasing marginal utility
- Individuals will not make a risky bet without compensation

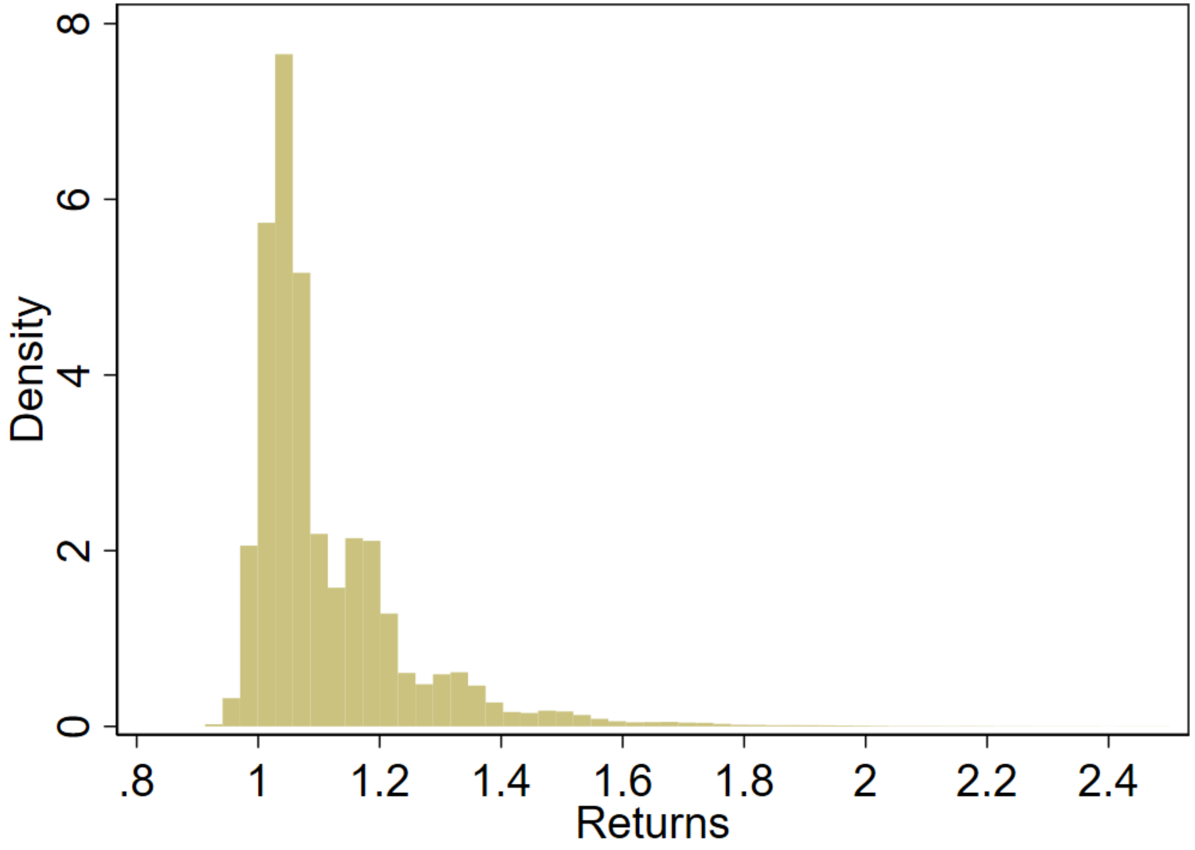


The risk averse investor requires a premium

- The amount you need to be compensated for risk depends on risk aversion and (to a first approximation) on the volatility of the gamble

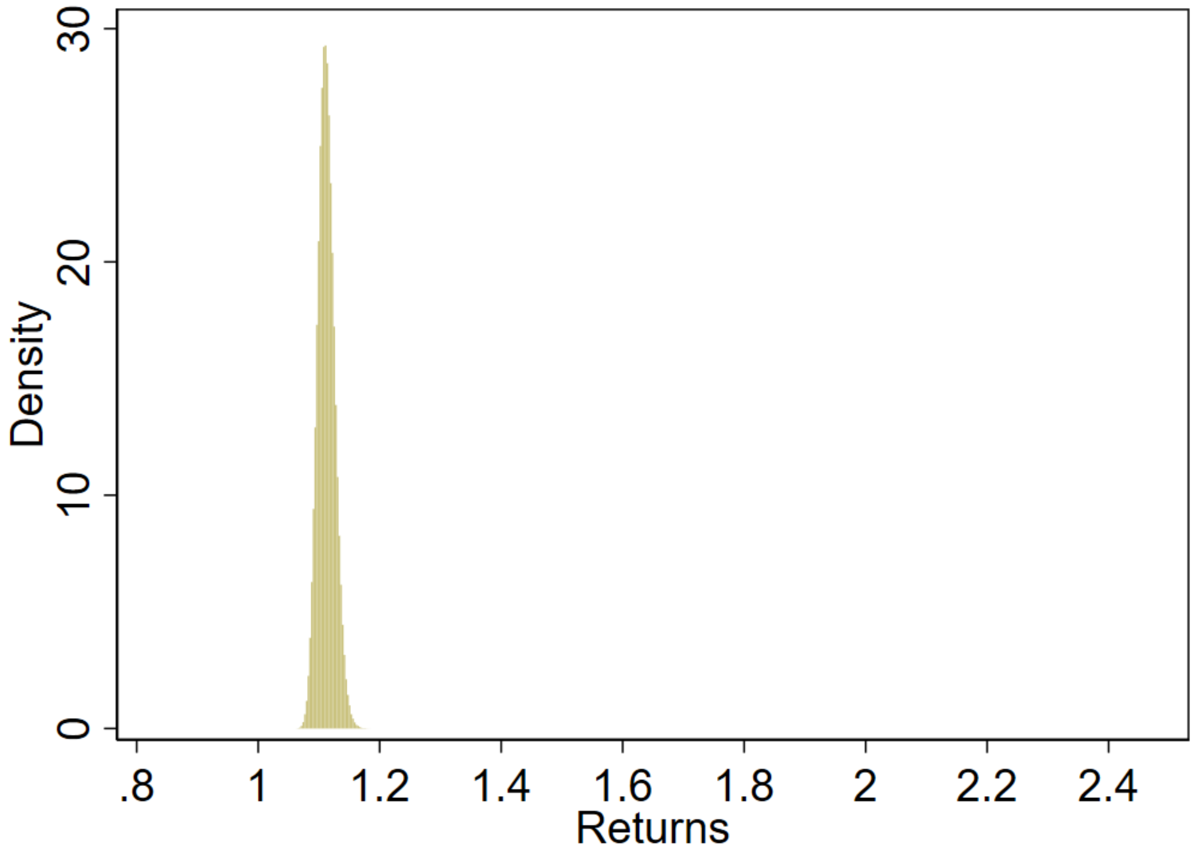


Return distribution for a single stock



Mean: 1.11%
Volatility: 13.77%
Skew: 2.96
Kurtosis 19.22

Return distribution for a portfolio

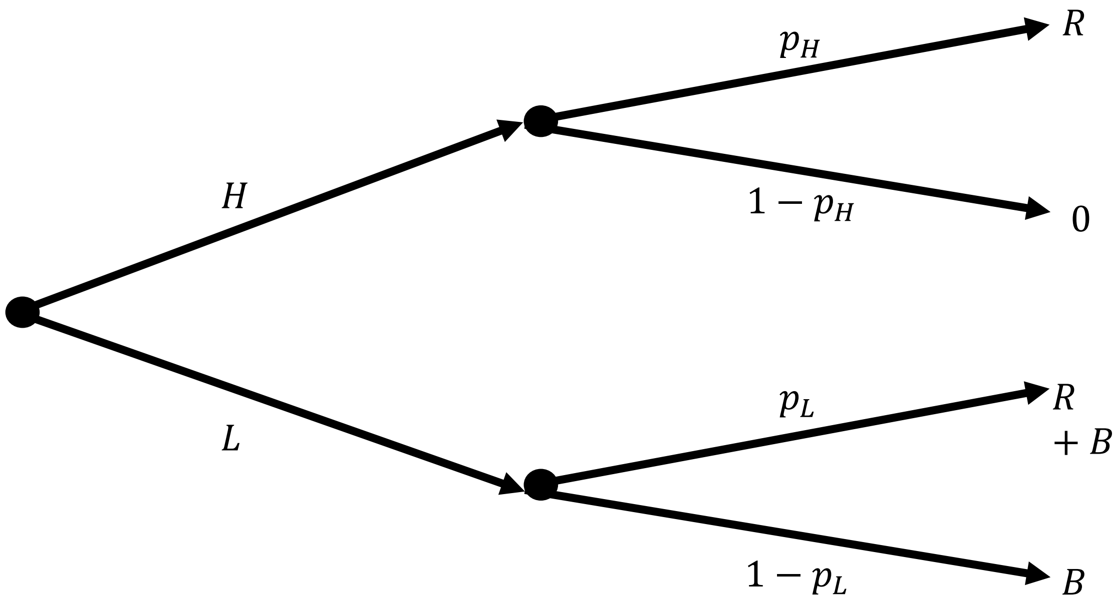


Mean: 1.11%
Variance: 1.37%
Skewness: 0.30
Kurtosis: 3.17

Some of the unexpected is diversifiable

- The positive skewness of specific returns averages out
- To become an (almost) normal distribution
- With a much smaller variance
- *This is the type of risk associated with the FDA trial*
- *What about moral hazard?*

A simple model of moral hazard



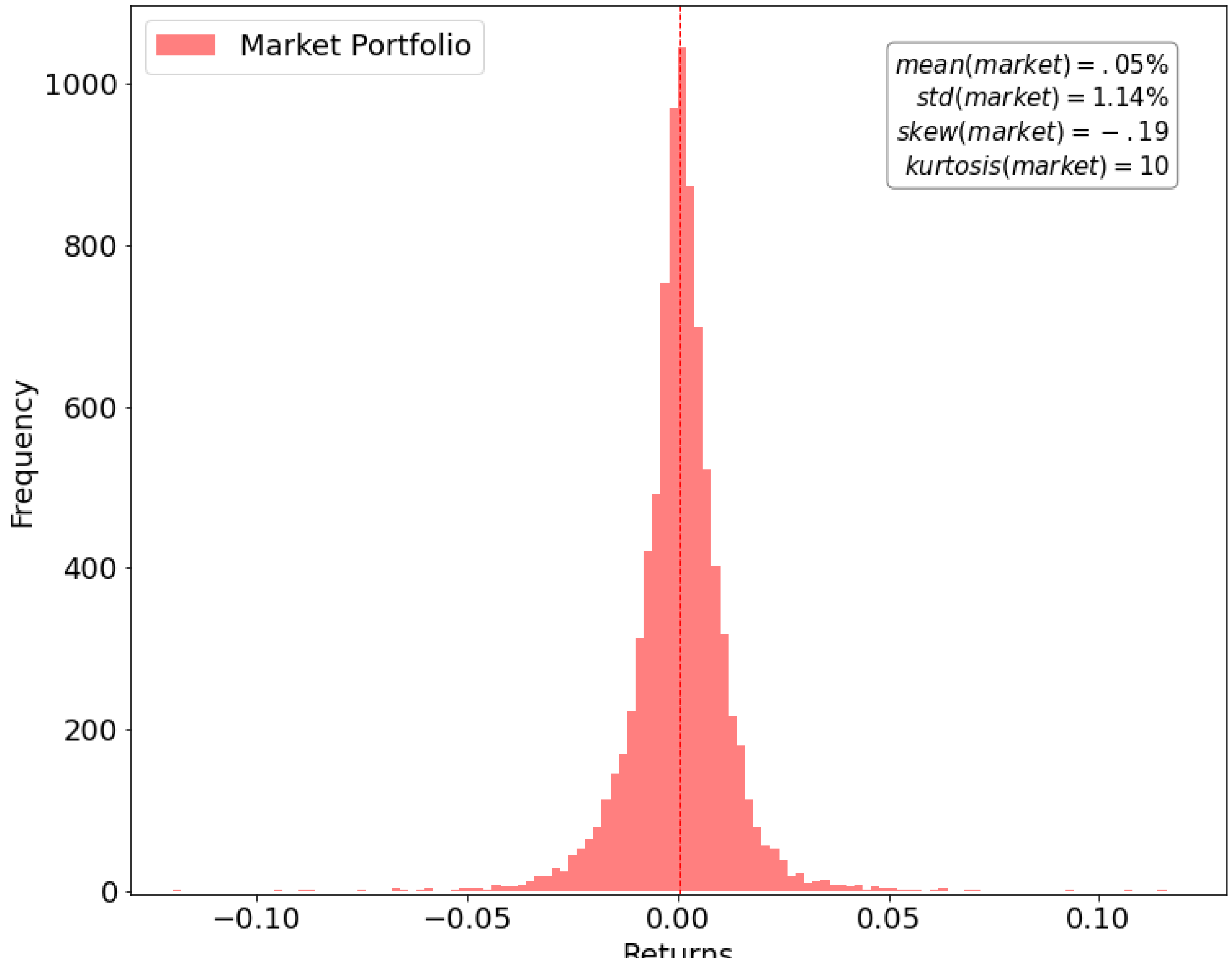
A simple model of moral hazard (cont.)

- Project costs I, paid by outside investors.
- Upper path profitable: $I < p_H R$
- Lower path not profitable: $I > p_L R$.
- Upper path better than lower in total: $B < \Delta p R$
- Entrepreneur only takes upper path if paid at least $B/\Delta p$ upon success
- Project cannot move forward if $p_H(R - B/\Delta p) < I$.

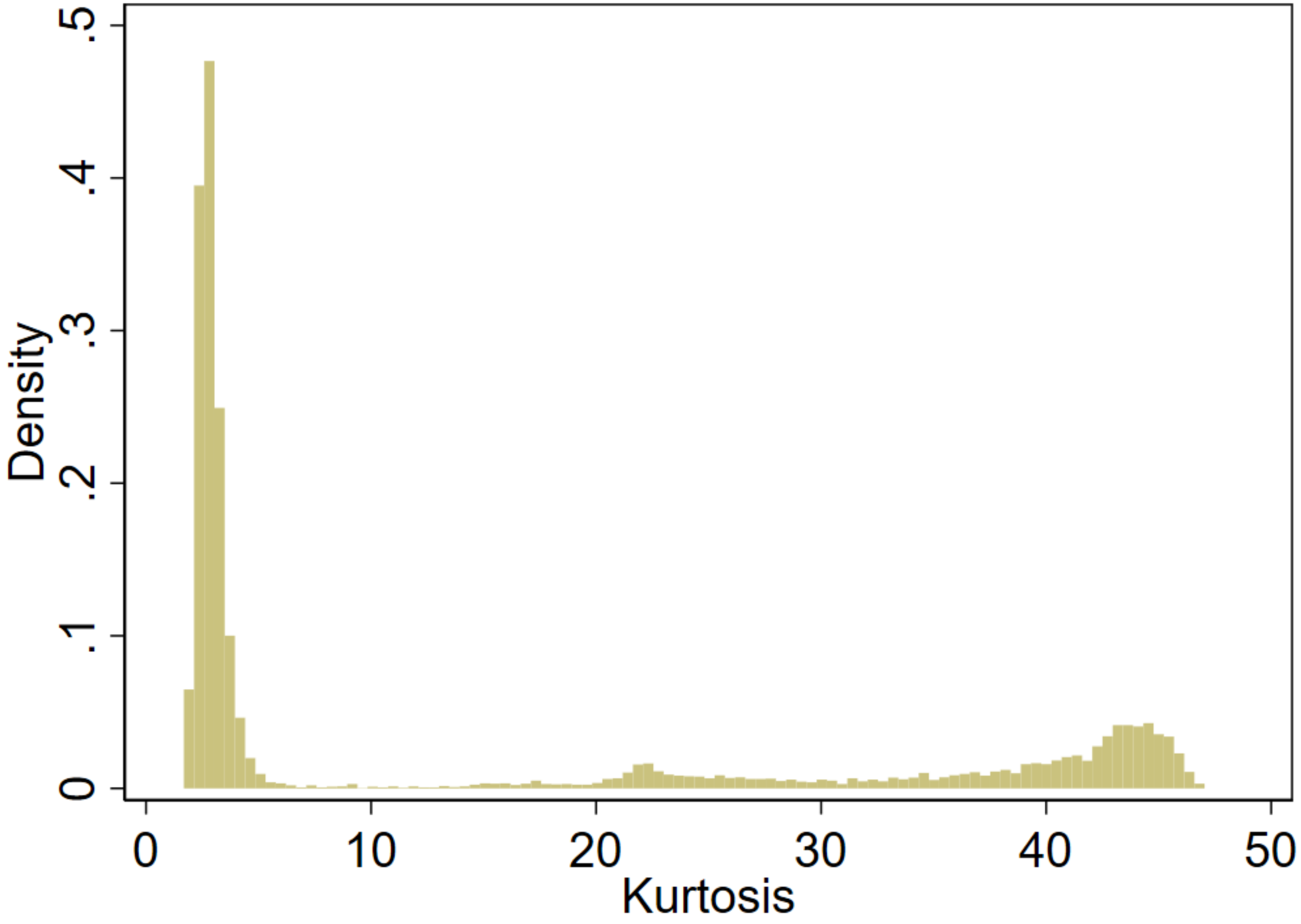
How market regulation can help

- It can reduce private benefits B
- It can increase the difference in probabilities Δp
- This is Pareto-improving: it helps both the entrepreneur and the outside investors.

Daily returns on the market portfolio



Sampling distribution for kurtosis



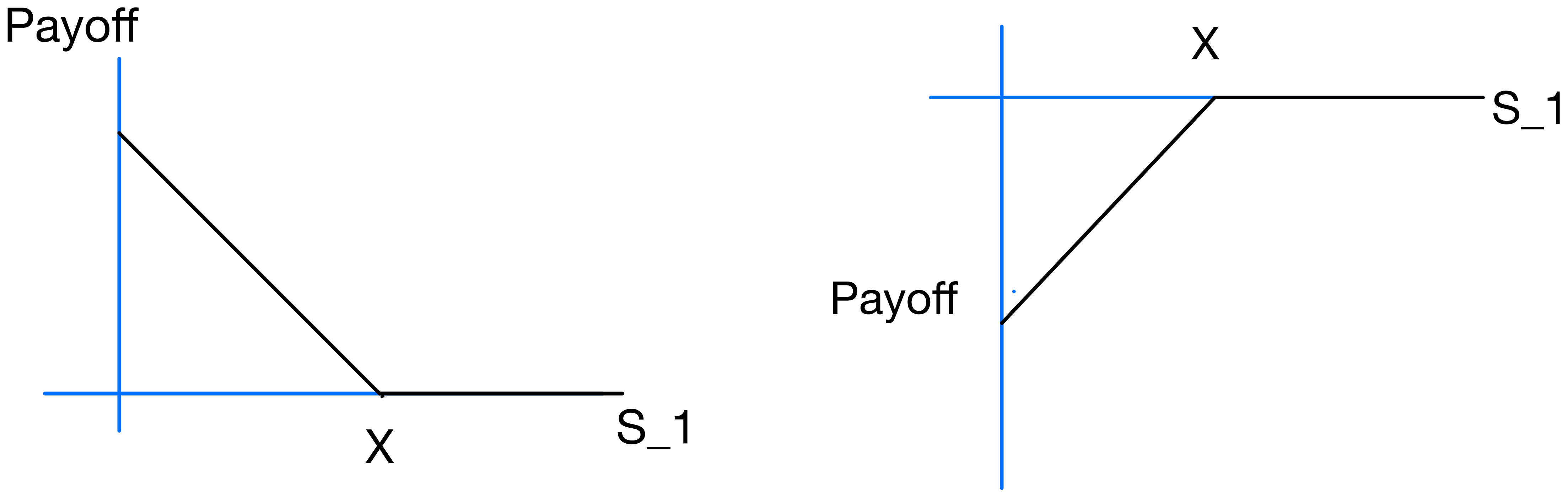
Mean kurtosis estimate: 15
Population kurtosis: 119

Hidden Kurtosis

- Sample kurtosis is supposed to measure the fat tails of a distribution
- However, true kurtosis may be much larger than any one sample indicates
- The fact that rare events can sometimes surprise is intuitive
- But we cannot take false comfort from a kurtosis statistic
- Kurtosis can reject the normal, not confirm the normal
- For one class of securities, correctly estimating kurtosis matters a great deal

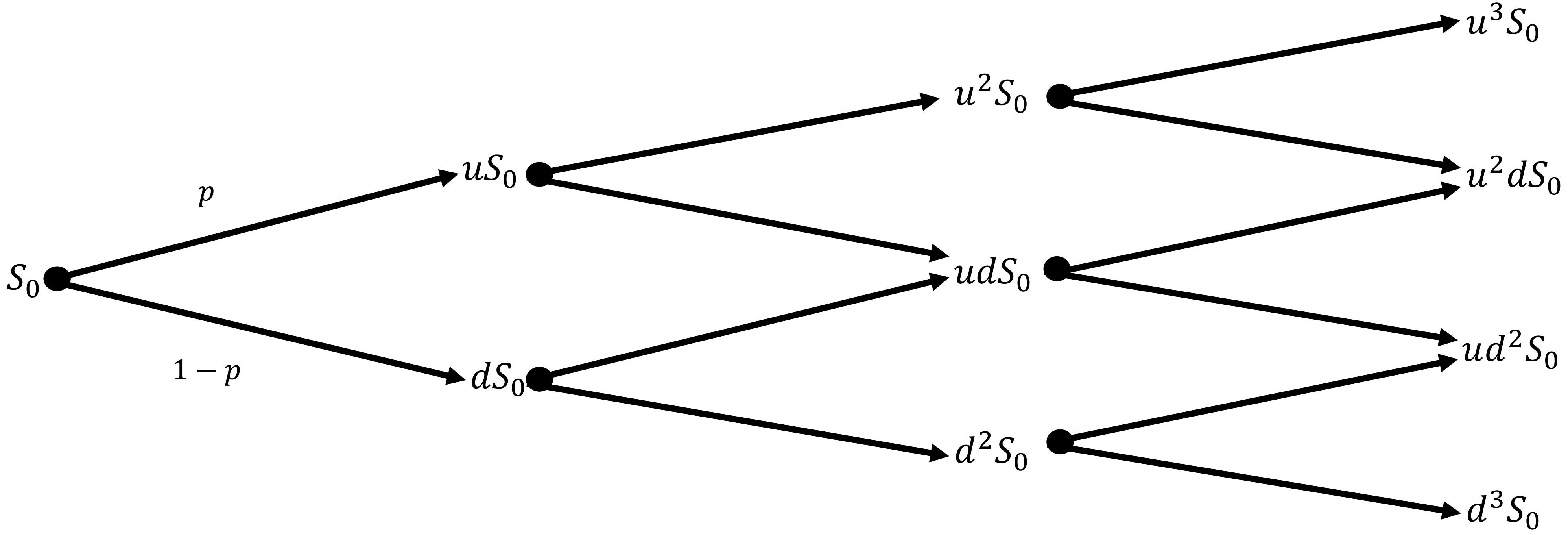
Case study: the options market

- Payoffs to a long and a short options position
- Exercise price X
- Price of underlying S_1

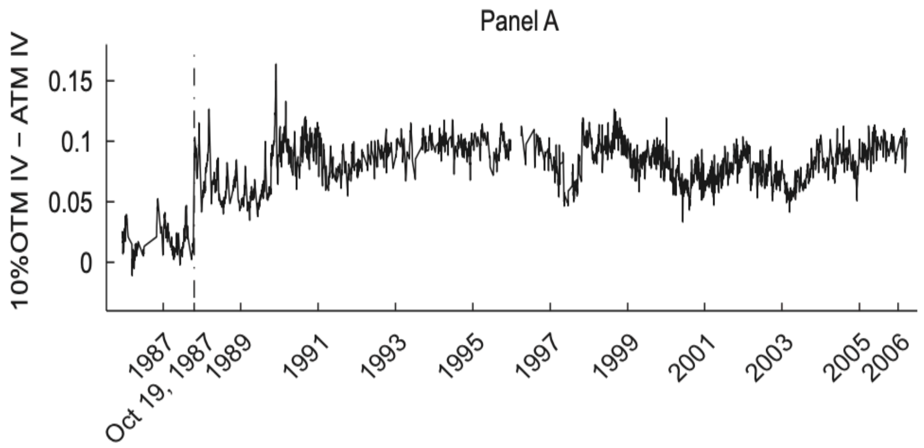


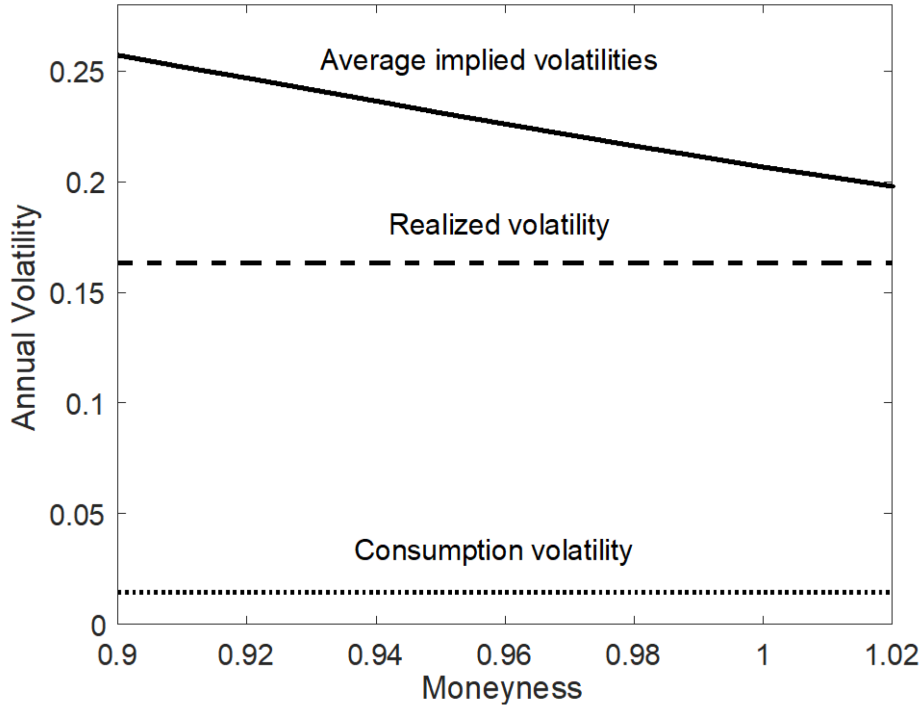
Black-Scholes-Merton model

- Their continuous-time model is a limiting case of a binomial tree



Implied volatilities





Case study: the options market (cont.)

- However, daily return on October 19, 1987 implied a 20 standard deviation event, essentially impossible
- That day proved that the model for returns used to price options was wrong.

Two types of uncertainty

The uncertainty *within* the model, e.g. the binomial tree

The uncertainty *outside* the model, e.g. an event outside the binomial tree

Two types of uncertainty

- Why did market participants fail to take into account non-normality in returns in pricing options?
- Even if events do lie outside models, why not use a model that better explains the data?
- Especially when the difference is important?

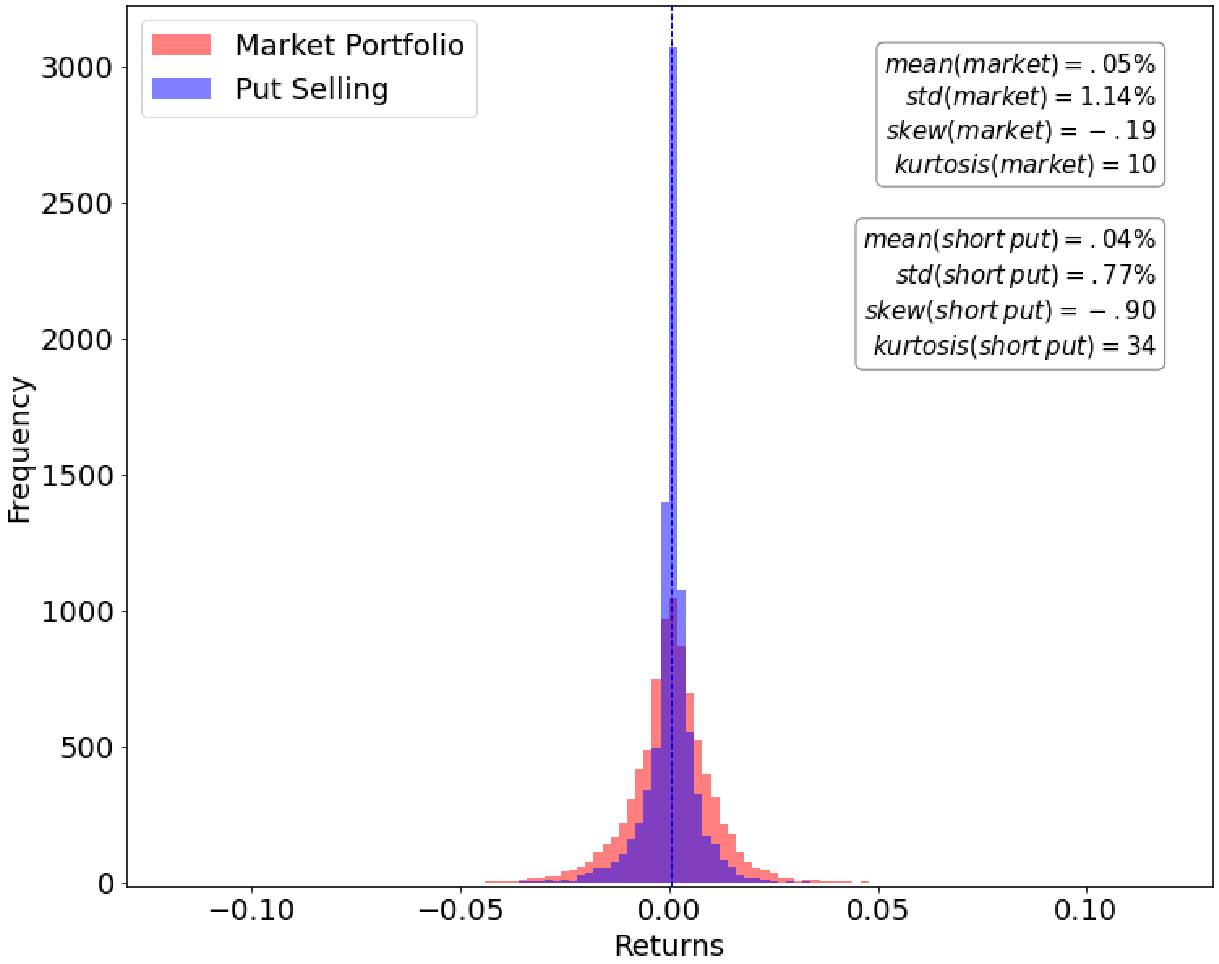
Perhaps 80s were the beginning of quantitative modeling in industry. Perhaps downward bias and small sample

Bertrand Russell’s chicken:

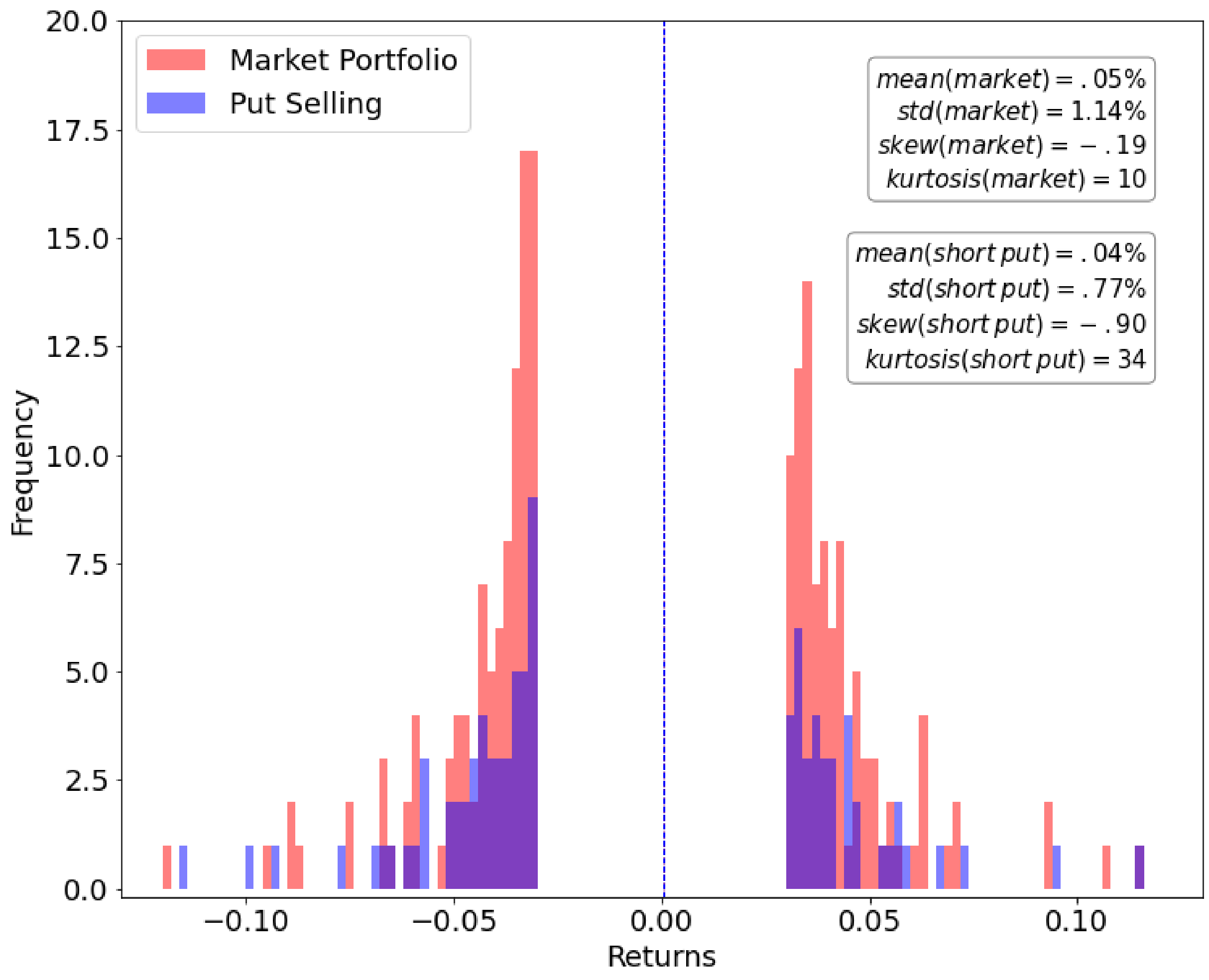
- “The man who has fed the chicken every day throughout its life at last wrings its neck instead, showing that more refined views as to the uniformity of nature would have been useful to the chicken.” – Bertrand Russell

- Some types of uncertainty seem destined to fool us, like the short put strategy
- Some distributions seem destined to fool us, like those with fat tails

Distribution of returns to putwrite index



Outliers



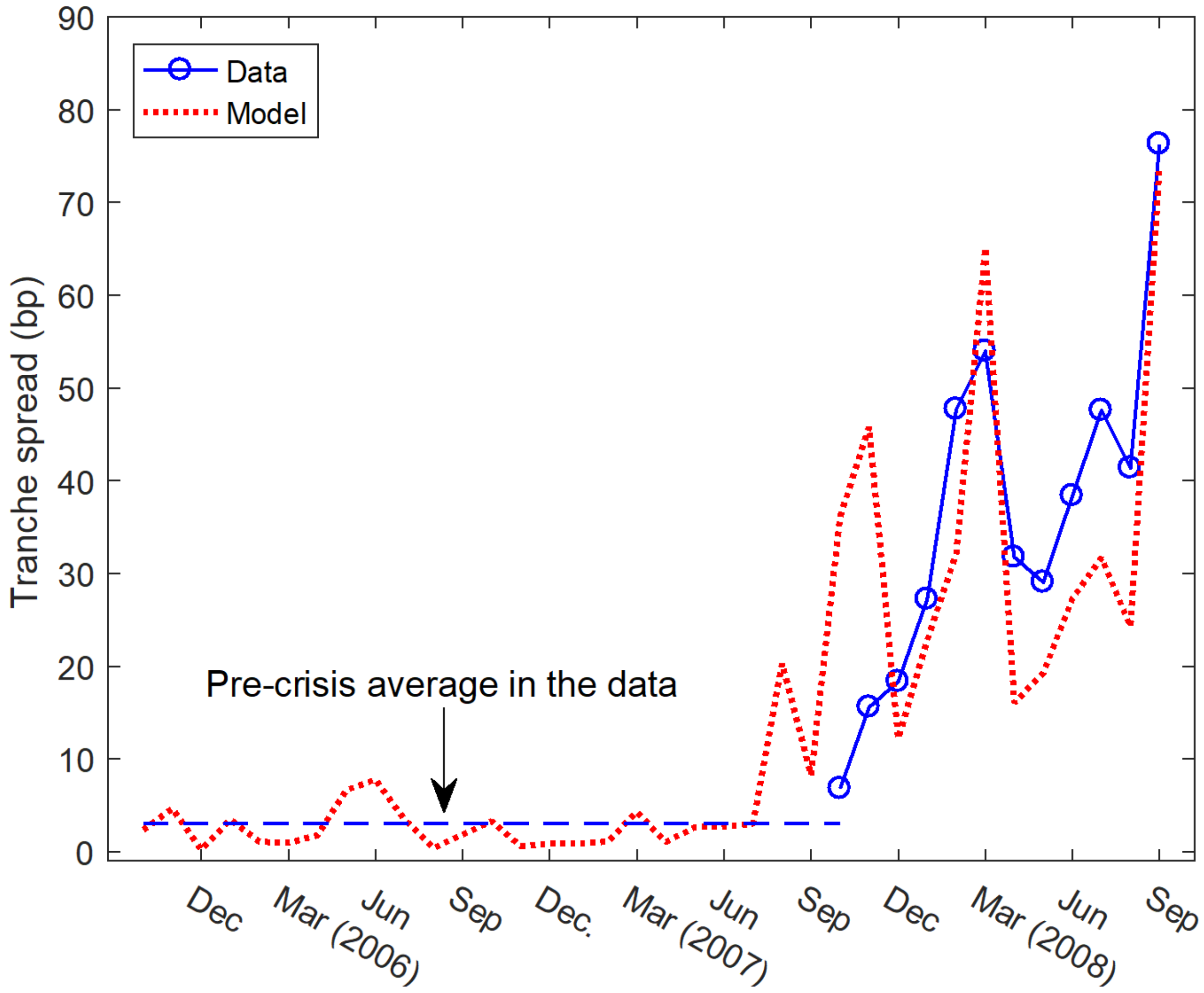
Market Portfolio
Put Selling
$mean(market) = .05\%$
$std(market) = 1.14\%$
$skew(market) = -.19$
$kurtosis(market) = 10$
$mean(short\,put) = .04\%$
$std(short\,put) = .77\%$
$skew(short\,put) = -.90$
$kurtosis(short\,put) = 34$
Frequency
Returns
20.0
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0.0
−0.10
−0.05
0.00
0.05
0.10

The chicken problem

Writing an option illustrates the chicken problem in two ways:

1. Their day-to-day payoffs represent the chicken before its neck is wrung
2. Option traders were like the thoughtful chicken: they had the wrong model

CDX spreads – super-senior tranche



Put options everywhere

- Short-put payoffs prone to the chicken problem
- The super-senior tranche on the CDX is an out-of-the-money put option on the overall economy
- Equity = call option written on the value of the firm
- Debt = Riskless bond + short put
- Run dynamics associated with short-term debt can make this problem worse

The chicken problem

Writing an option illustrates the chicken problem in two ways:

1. Their day-to-day payoffs represent the chicken before its neck is wrung
2. Option traders were like the thoughtful chicken: they had the wrong model

How do individuals think about the unexpected?

Do people make explicit probability calculations in decision-problems?

The evidence suggests not. Even colloquially, expected means “what comes to mind,” not a probabilistic statement

Recent research turns to evidence on memory to understand expectations

Core principles of memory

Our memories, and thus our thoughts and beliefs, are driven by:

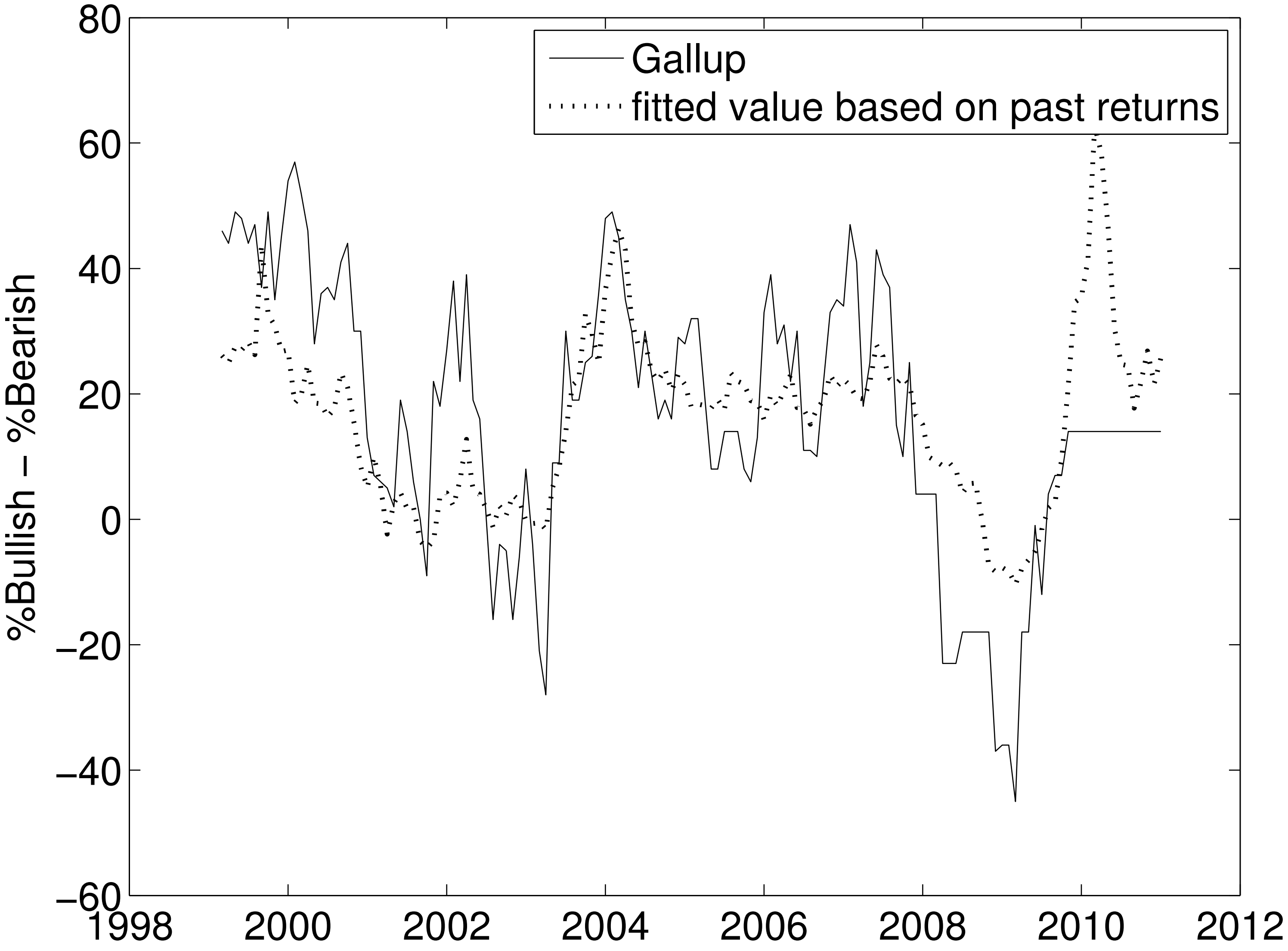
- Recency
- Similarity
- Temporal Contiguity

Recency effect exacerbates the chicken problem

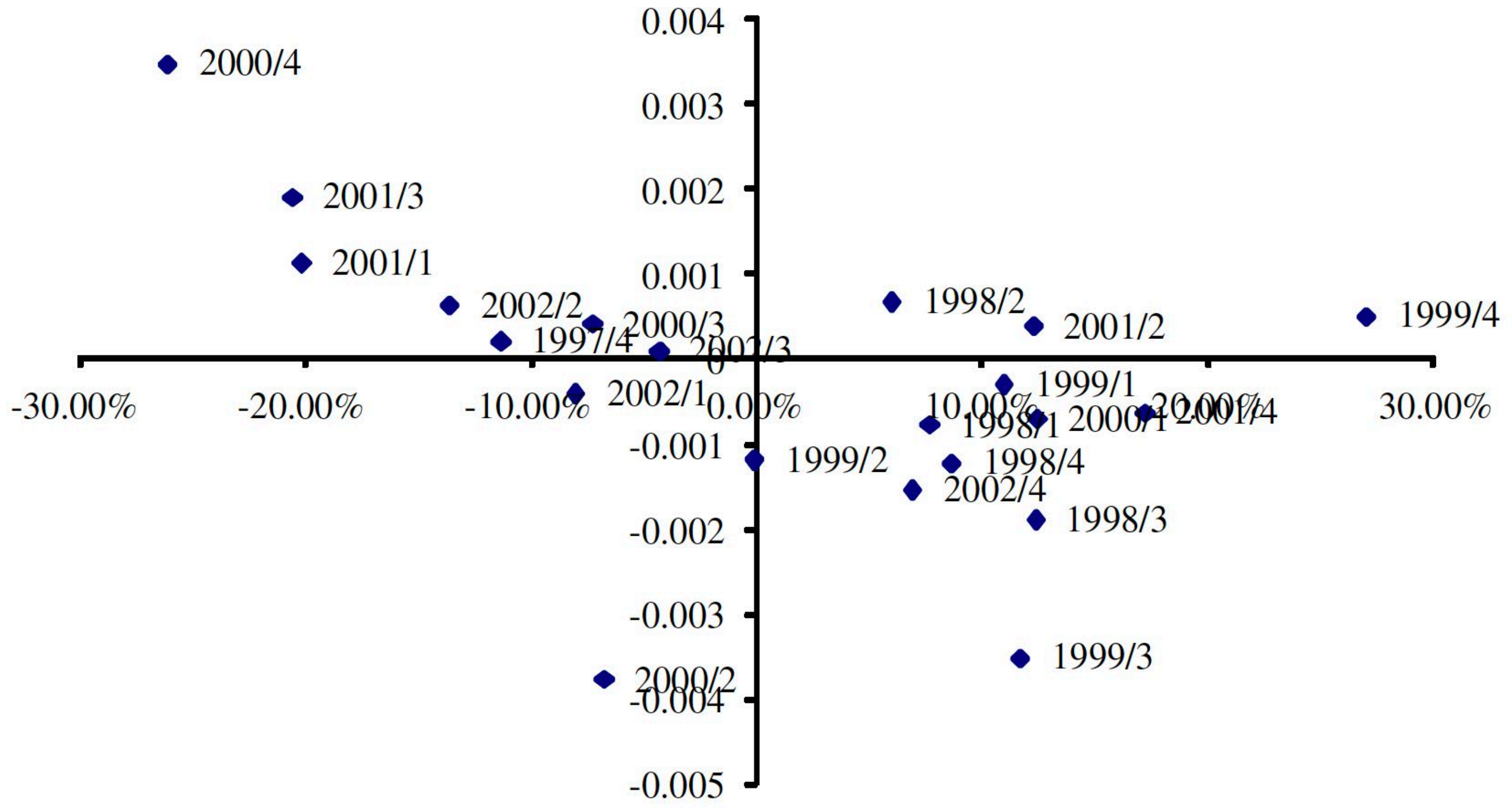
Evidence of recency in expectations of returns

- Gallup investor survey (700 respondents, 1996—2012)
- Graham-Harvey CFO survey (200 respondents 1998– present)
- Many others
- Survey expectations are well-explained (e.g., R^2= 61% for Gallup) by returns over the past 12 months

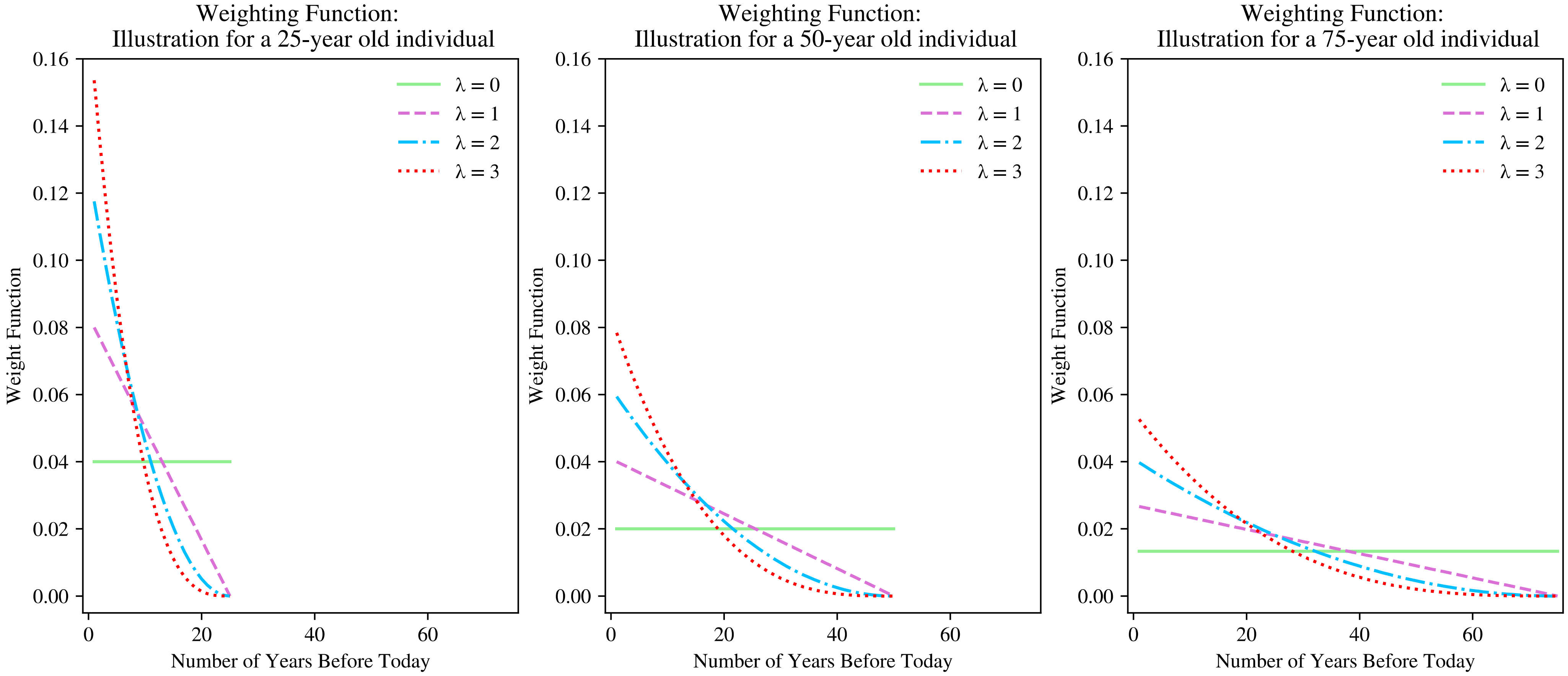
Recency in expectations of stock returns



Older cohorts of asset managers rely less on recent experience



Early-life stock returns are not forgotten



Context model

- Individuals’ thoughts and beliefs governed by an internal context
- Information from the environment *retrieves* a context
- *Retrieved context* depends on the features filtered through past memories: the individual retrieves past contexts in which similar features were experienced
- Retrieved context averages with past context to form current context
- Current context determines what pops to mind
- The current features – either real or imagined -- are encoded into memory

Explaining why some individuals invest

- How to invest and how much are some of the most important decisions an individual can make
- A 90^{th} to 10^{th} percentile difference in stock market performance over the lifetime implies an average difference in participation of 10 percentage points
- This effect is of comparable size to anything else known to influence household participation (for example, income and education)

Evidence from experiments and surveys

- Professional traders required a higher premium to take the same bet after the financial crisis as compared with before
- Professional traders who are presented with crash risk scenarios require a greater premium to take a bet
- Subjects who watch a scene from a horror movie require a greater premium to take a bet as compared with those that don’t

Summary

- Individual stocks exhibit positive skewness
- This skewness is diversifiable; requires equity issuance and hence amelioration of moral hazard through regulation
- Aggregate market exhibits excess kurtosis; measurement problems mean we don’t know how much
- Put option pricing subject to “the chicken problem”
- Recency bias makes the chicken problem worse
- Lifetime experience, associations, and context matter

Closing thoughts