# Risk and Time Horizon

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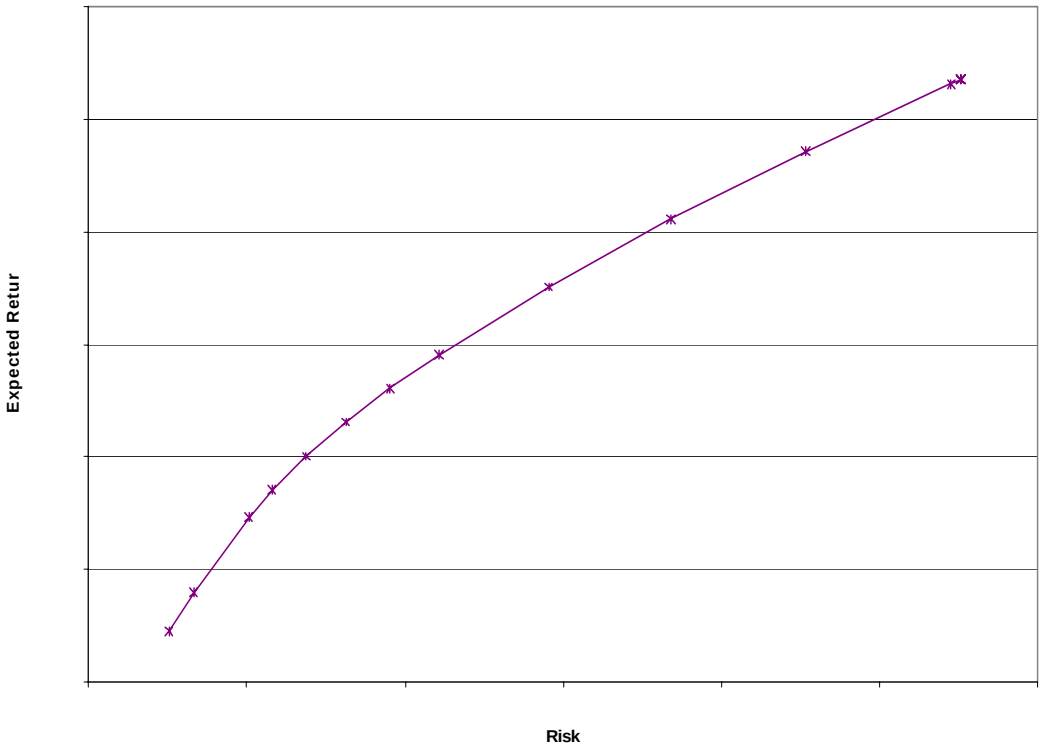
# Plan

- Motivation
  - Efficient frontiers: implicit assumptions
  - Case Study: PBGC
- Introduction
  - Risk, past and future
  - Variance often does not grow linearly with time
    - Varying expected returns
    - Momentum
- Housing Futures
  - Introduction to market
  - Simple risk metrics for various horizons
  - Behavior of housing futures
- Current Events
- Ambiguity (Uncertainty)
  - Is Ellsberg's Paradox really paradoxical?
  - Is there ambiguity in the "real world"?
- Summary and Open Questions

# Efficient Frontier

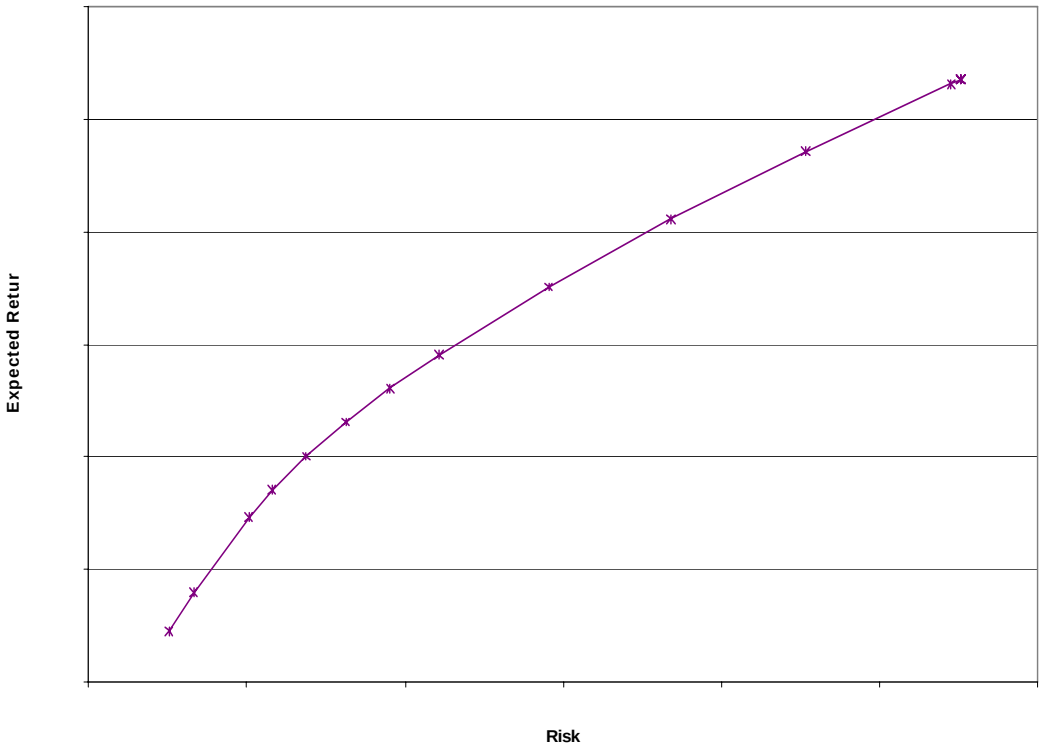



*The Pension Benefit Guaranty Corp., aided by a distinguished consultant, probably looked at something like this to decide on their asset allocation.*

*But something is missing.*

- What is missing?

# Efficient Frontier




*The Pension Benefit Guaranty Corp., aided by a distinguished consultant, probably looked at something like this to decide on their asset allocation.*

*But something is missing.*

- What is missing?
  - time horizon
  - real or nominal risk?
  - liabilities

# Pension Benefit Guaranty Corp.

- "we don't currently have the resources to keep all of our future commitments.

  This strategy gives the *Corporation* a 57 percent likelihood of full funding within ten years, compared to 19 percent under the previous policy."
  - PBGC Director Charles Millard

- "the diversified portfolio adopted by the Board *would have outperformed the current asset mix 98 percent of the time over rolling 20-year periods*. "
  - PBGC press release announcing the allocation decision

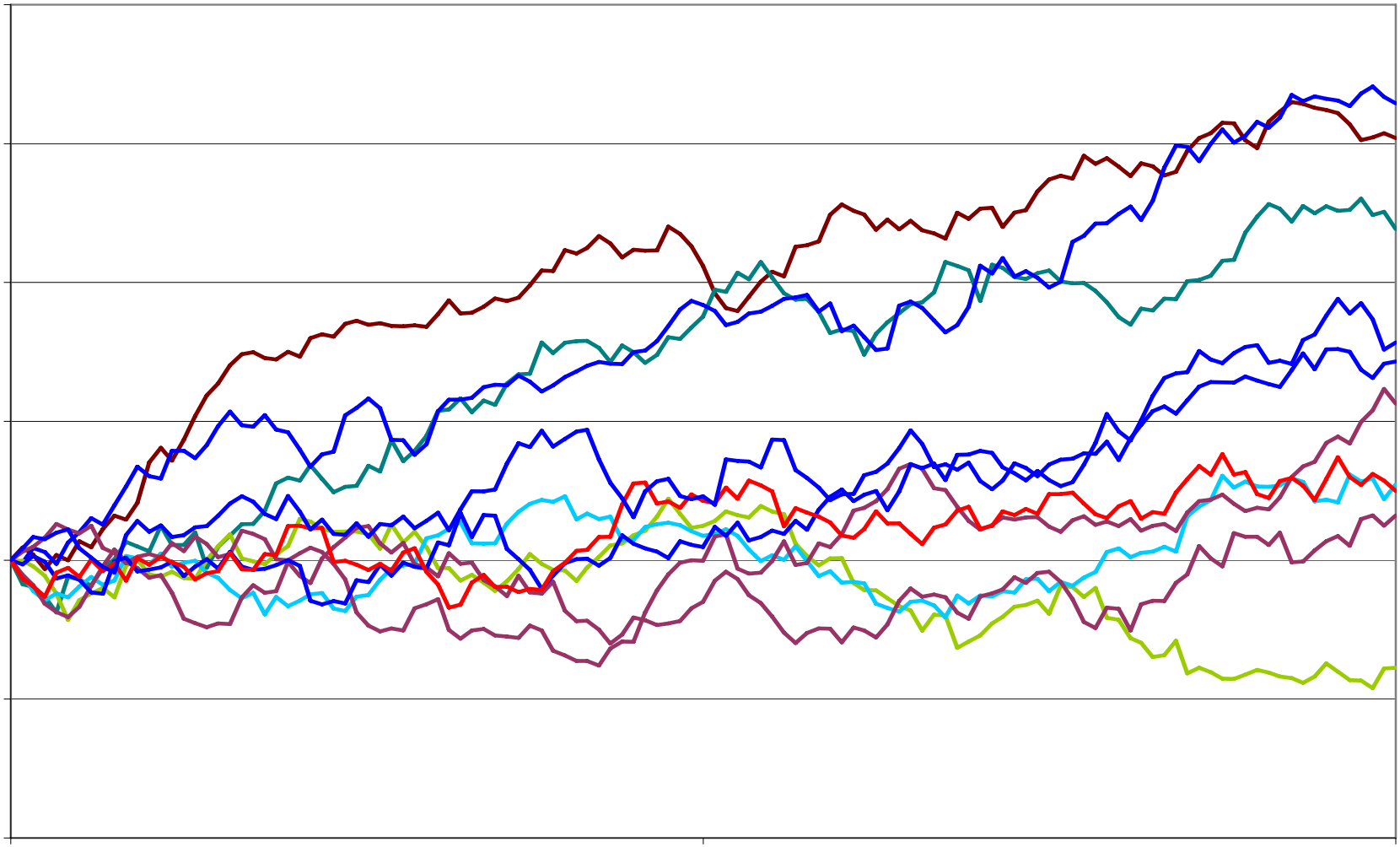
- "**Risk for the *agency* is the probability of failing to meet its obligation from available resources**.

  "The fact that the unfunded status is taken into account by the agency in formulating its investment policy is a source of confusion to many critics. Most economic entities are wealth-maximizers; the Pension Benefit Guaranty is not. It seeks to minimize the probability of an unfavorable outcome."
  - Leopoldo Guzman (PBGC advisory committee member)

# Pension Benefit Guaranty Corp.

- "the diversified portfolio adopted by the Board *would have outperformed the current asset mix 98 percent of the time over rolling 20-year periods*. "
  - 98% is 49/50. How long does it take to have 50 20-year periods?
- "Risk for the *agency* is the probability of failing to meet its obligation from available resources.
  "[The PBGC] seeks to minimize the probability of an unfavorable outcome."
  - The implication of this objective is to take more risk the more underfunded they get
  - If they get far enough below their obligations, maximizing volatility will minimize risk.
- What are their liabilities?
  - Existing obligations – Pension payouts: behave like long bonds
  - Contingent obligations – guarantee of leveraged stock portfolios:
    behave like short put options on stocks (perhaps quadratic puts)

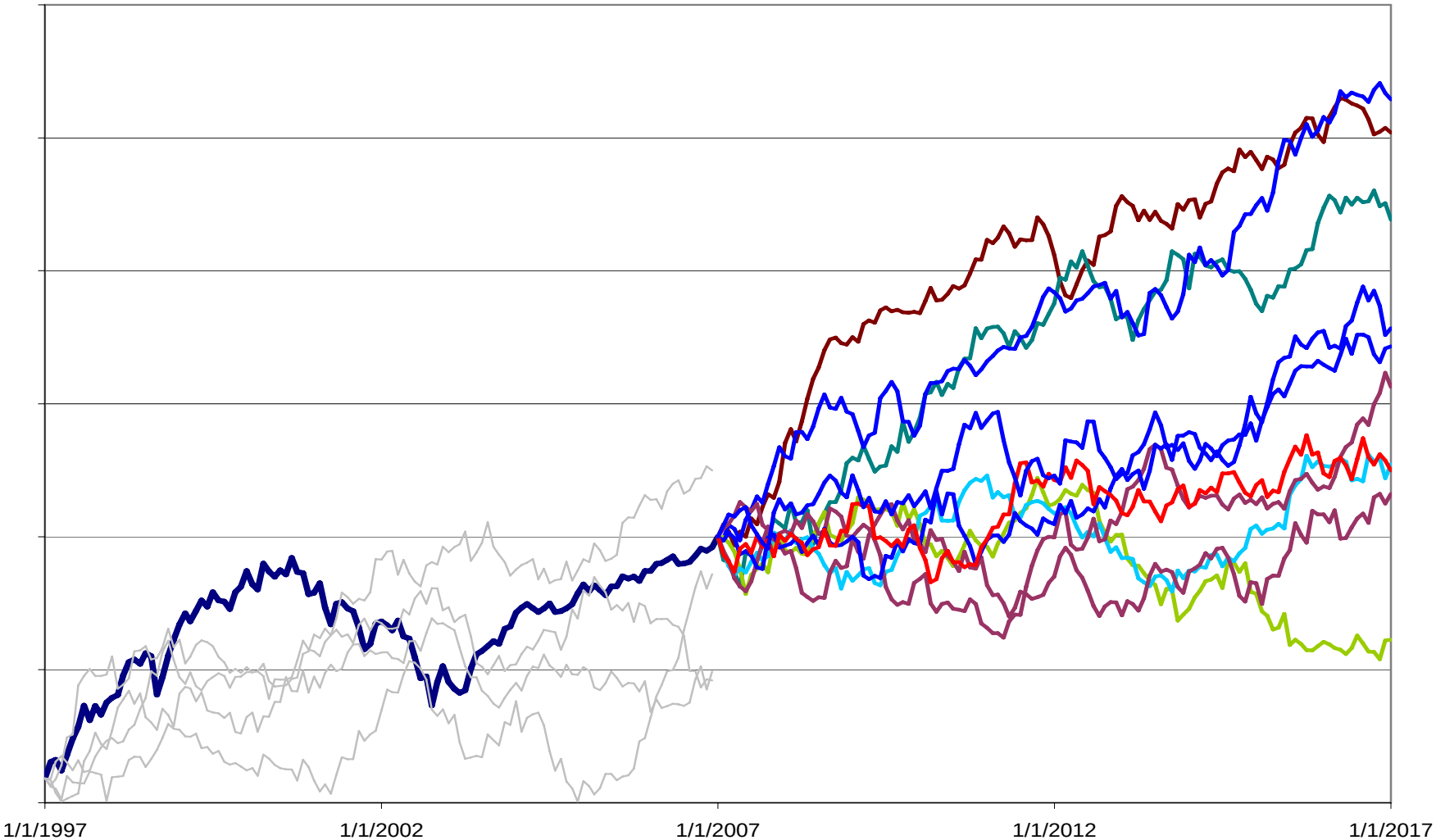
# Risk: Forward-Looking View



# Forward-looking risk

- How will my portfolio allocation affect my wealth in 10 years?
- Will I have enough to retire?
- What are the odds I will run out of money if I follow this strategy?
- Should I use a collar to hedge my concentrated low-basis stock position?
- What endowment payout is sustainable?

# Risk: Forward and Back View



# Wiggles and Cross-sectional risk

- *Sometimes*, the variability of the path tells you everything you need to know.
  - Independent and identically distributed
  - Other ‘ergodic’ processes
- For others, it doesn’t
  - A lot of focus on lack of identical distribution (e.g. GARCH)
  - For this purpose, lack of independence is much more important

***This talk is about why/when the implicit assumptions may not work.***

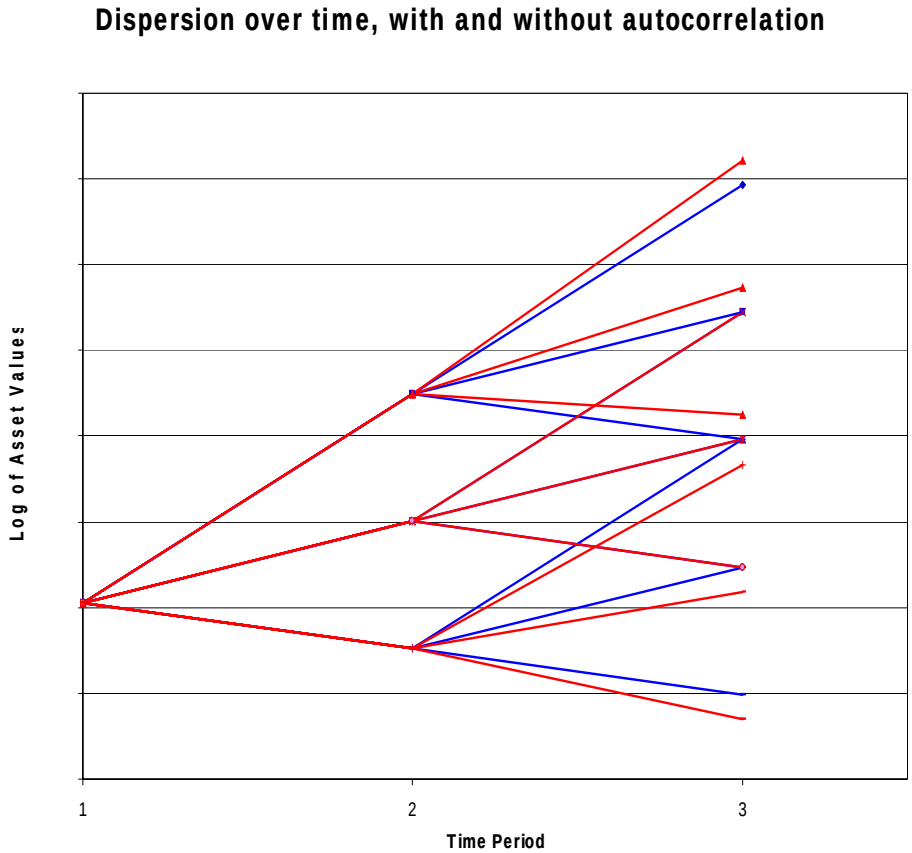
# Predictable returns?

- Lack of predictability is a tenet of efficient markets (even moderately efficient ones)
- How can returns not be independent:
  - Time-varying expected returns
    - This doesn't contradict efficiency
  - Momentum and mean-reversion
    - Fairly modest effects can matter
  - Uncertain expected returns
    - Errors in forecast are not independent

# Autocorrelation and Cross-Sectional Risk

- If the expected return varies over time, then the unconditional returns will be autocorrelated.
- Variance will grow more than linearly with time

- Note: in some circumstances, this greater dispersion will not be priced into options because the instantaneous volatility is not affected.



# Autocorrelation and Cross-Sectional Risk

- For 3-month Treasury-bills, essentially all of the variability is variation in the expected return.
- Inflation is similar

Standard Deviation of log returns, annualized

| Periodicity | Inflation | T-bills | Real T-bills |
|---|---|---|---|
| 3 months | 1.7% | 1.4% | 1.5% |
| 1 year | 2.8 | 2.7 | 2.4 |
| 2 years | 3.8 | 3.7 | 3.2 |
| 3 years | 4.5 | 4.3 | 3.8 |
| 5 years | 5.3 | 4.9 | 4.3 |
| | Autocorrelation (1 period) | | |
| 3 months | 0.60 | 0.93 | 0.52 |
| 1 year | 0.76 | 0.82 | 0.75 |

Data for 1970-2006.

# Improving the Housing Market

- The total value of houses in the US is about equal to that of US stocks
- Currently, it is very hard to separate the investment from the consumption good
- Suboptimal choices are often required:
  - You cannot own a fractional share of a house
  - You cannot invest in a diversified portfolio of housing
- A step in the direction of improving this situation is futures on house price indices. These began trading on the Chicago Mercantile Exchange in May 2006.
- Potential applications:
  - Hedging by housing developers
  - Housing ETFs as savings vehicles
  - Better terms on reverse mortgages

# Housing Futures and Options

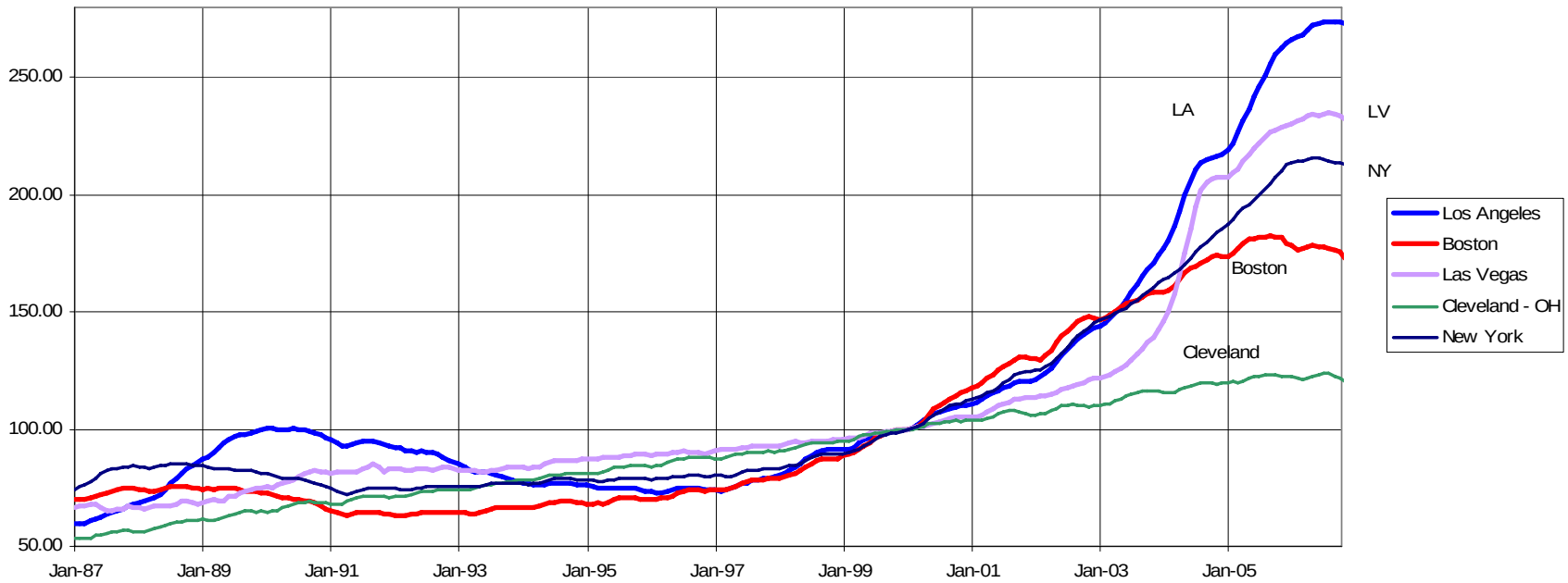
- Futures and options trade on house price indices for:

  Boston, Chicago, Denver, Las Vegas, Los Angeles, Miami, New York, San Diego, San Francisco, Washington, DC.

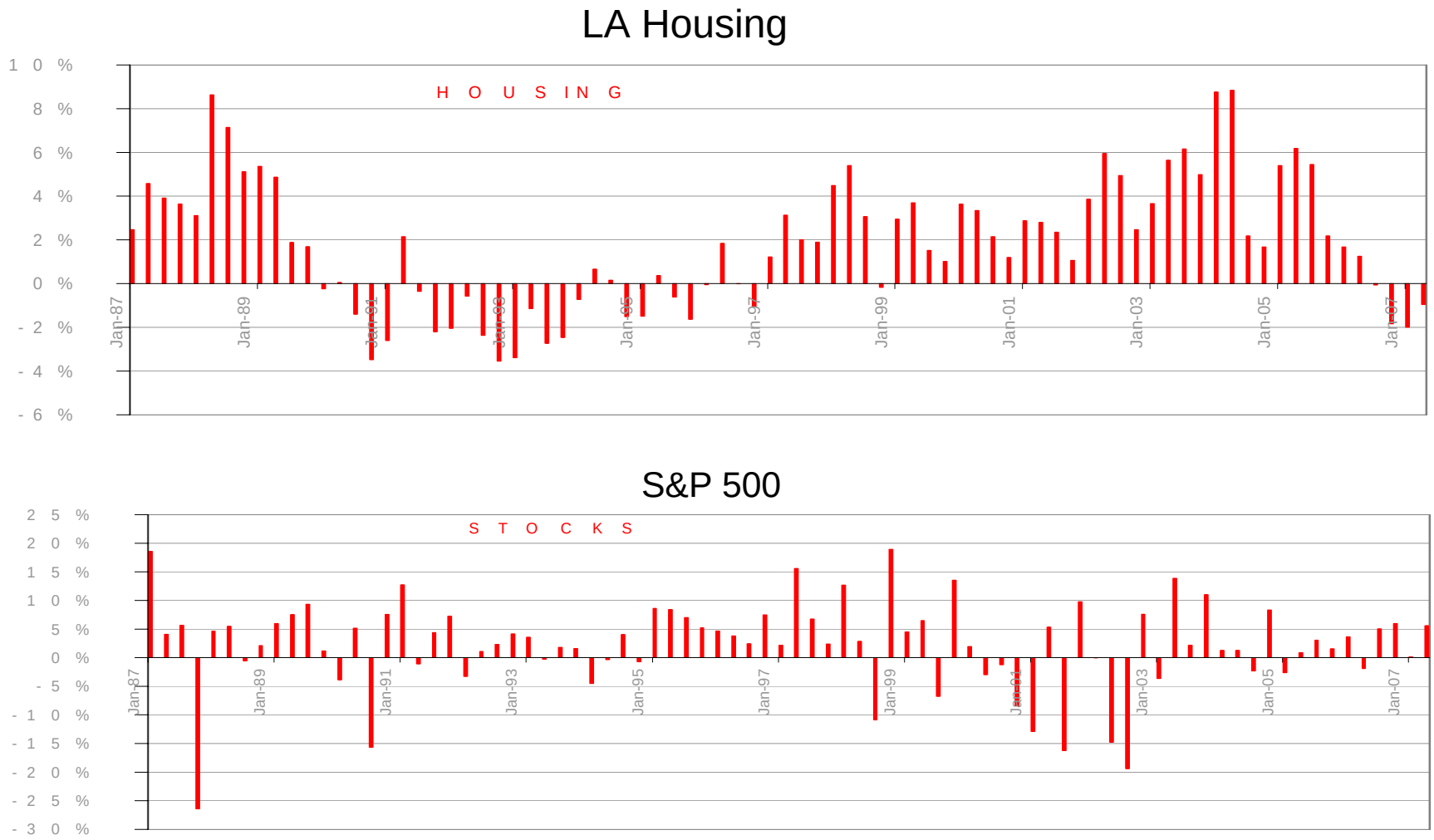
- Four quarterly contracts trade (efforts are being made to extend further)

- Open interest in futures is about $100 million and options are about twice that.

# House Price Indices



# Substantial Momentum in Housing Returns




Source: Standard and Poors

# Housing price indices: time-series behavior

- Autocorrelation of quarterly returns:

| | | |
|---|---|---|
| Lag | 1 | 0.70 |
| | 2 | 0.42 |
| | 3 | 0.56 |
| | 4 | 0.72 |

- Risk for different horizons:

| Periodicity | Unconditional | Conditional |
|---|---|---|
| 3 months | 3.8% | 1.9% |
| 1 year | 6.4 | 4.2 |
| 2 years | 8.6 | 6.9 |
| 3 years | 10.0 | 9.2 |

Data for 10-city composite, 1987-2006.

# Housing Price Indices and Futures: Time-Series Behavior

- Autocorrelation Miami Index & Futures:

| | |
|---|---|
| Index | 0.56 |
| 1st Futures contract | -0.03 |
| 2nd Futures contract | -0.01 |
| 4th Futures contract | 0.03 |

- Risk for different horizons:

Index

| Frequency | Annual. S.D. |
|---|---|
| 3-months | 4.4% |
| 6-months | 5.4% |
| 1-year | 7.1% |

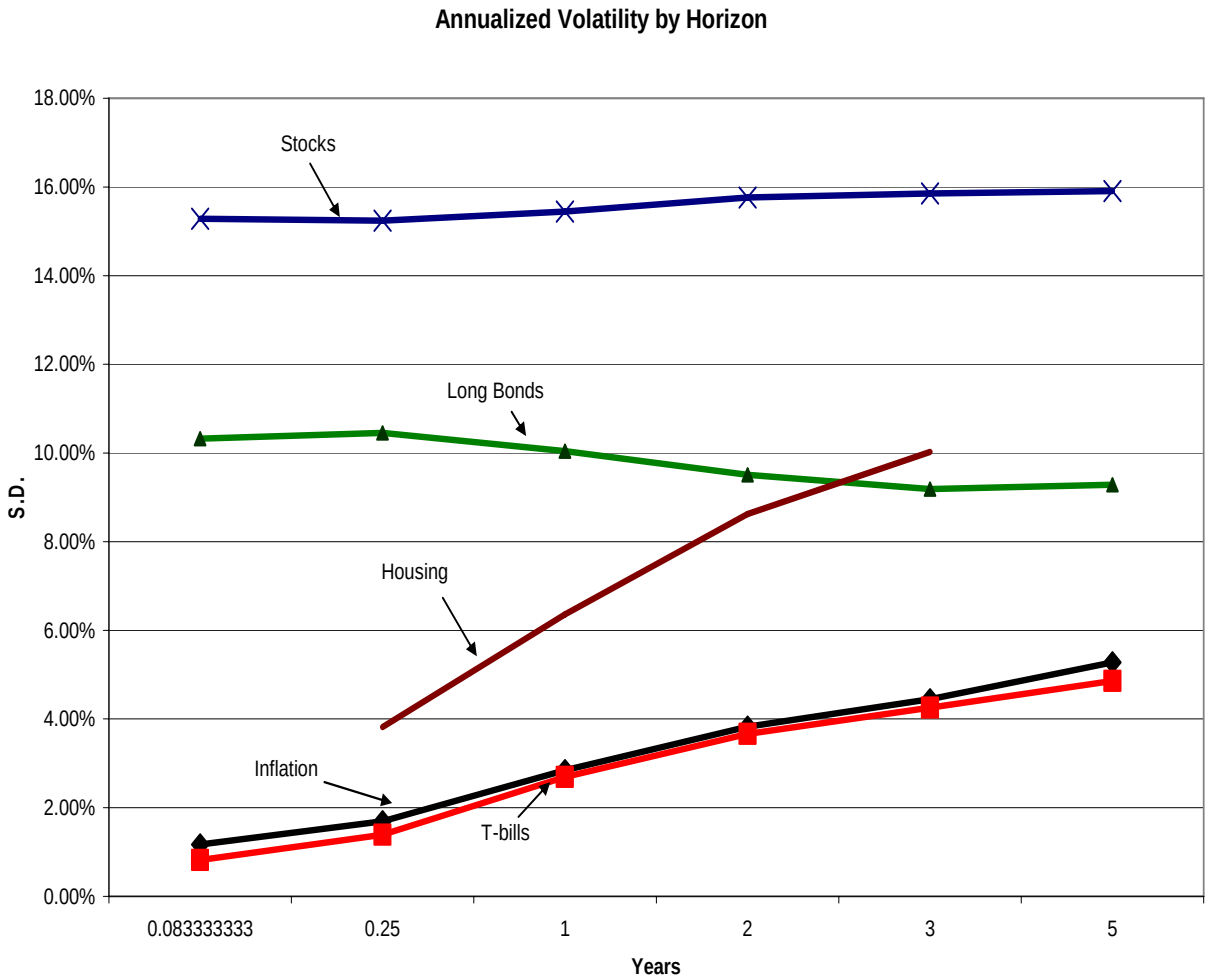
Futures

| Contract | Weekly vol. Annualized |
|---|---|
| Nearest | 3.4% |
| 2nd | 6.3% |
| 4th | 8.2% |

Futures measured weekly, index autocorrelation quarterly.

Source: S&P, Chicago Mercantile Exchange and Analytical Synthesis.

# Risk varies by horizon



# Autocorrelation and long-term risk

Annualized S.D. of returns

Nominal returns: 1970 – 2006 (Housing begins in 1987)

| Periodicity | Inflation | T-bills | Bonds | Stocks | Housing |
|---|---|---|---|---|---|
| 1 month | 1.2% | 0.8% | 10.3% | 15.3% | n/a |
| 3 months | 1.7 | 1.4 | 10.5 | 15.2 | 3.8% |
| 1 year | 2.8 | 2.7 | 10.1 | 15.5 | 6.4 |
| 2 years | 3.8 | 3.7 | 9.5 | 15.8 | 8.6 |
| 3 years | 4.5 | 4.3 | 9.2 | 15.9 | 10.0 |
| 5 years | 5.3 | 4.9 | 9.3 | 15.9 | n/a |
| | | | Autocorrelation (1 period) | | |
| 3 months | 0.60 | 0.93 | -0.10 | 0.01 | 0.70 |
| 1 year | 0.76 | 0.82 | -0.13 | 0.00 | 0.80 |

# Autocorrelation and long-term risk

Annualized S.D. of returns

Real returns: 1970 – 2006 (Housing begins in 1987)

| Periodicity | T-bills | Bonds | Stocks | Housing |
|---|---|---|---|---|
| 1 month | 1.1% | 10.6% | 15.5% | n/a |
| 3 months | 1.5 | 11.0 | 15.6 | 3.9% |
| 1 year | 2.4 | 11.5 | 16.2 | 6.7 |
| 2 years | 3.2 | 12.0 | 16.7 | 9.1 |
| 3 years | 3.8 | 12.4 | 17.1 | 10.7 |
| 5 years | 4.3% | 13.2 | 17.5 | n/a |
| | | | | |
| | Autocorrelation (1-period) | | | |
| 3 months | 0.52 | -0.03 | 0.03 | 0.71 |
| 1 year | 0.75 | 0.06 | 0.03 | 0.80 |

# Urns and Uncertainty

- Consider two urns:
  - Urn 1 contains 20 red balls and 20 blue balls
  - Urn 2 contains X red and (40 – x) blue balls,

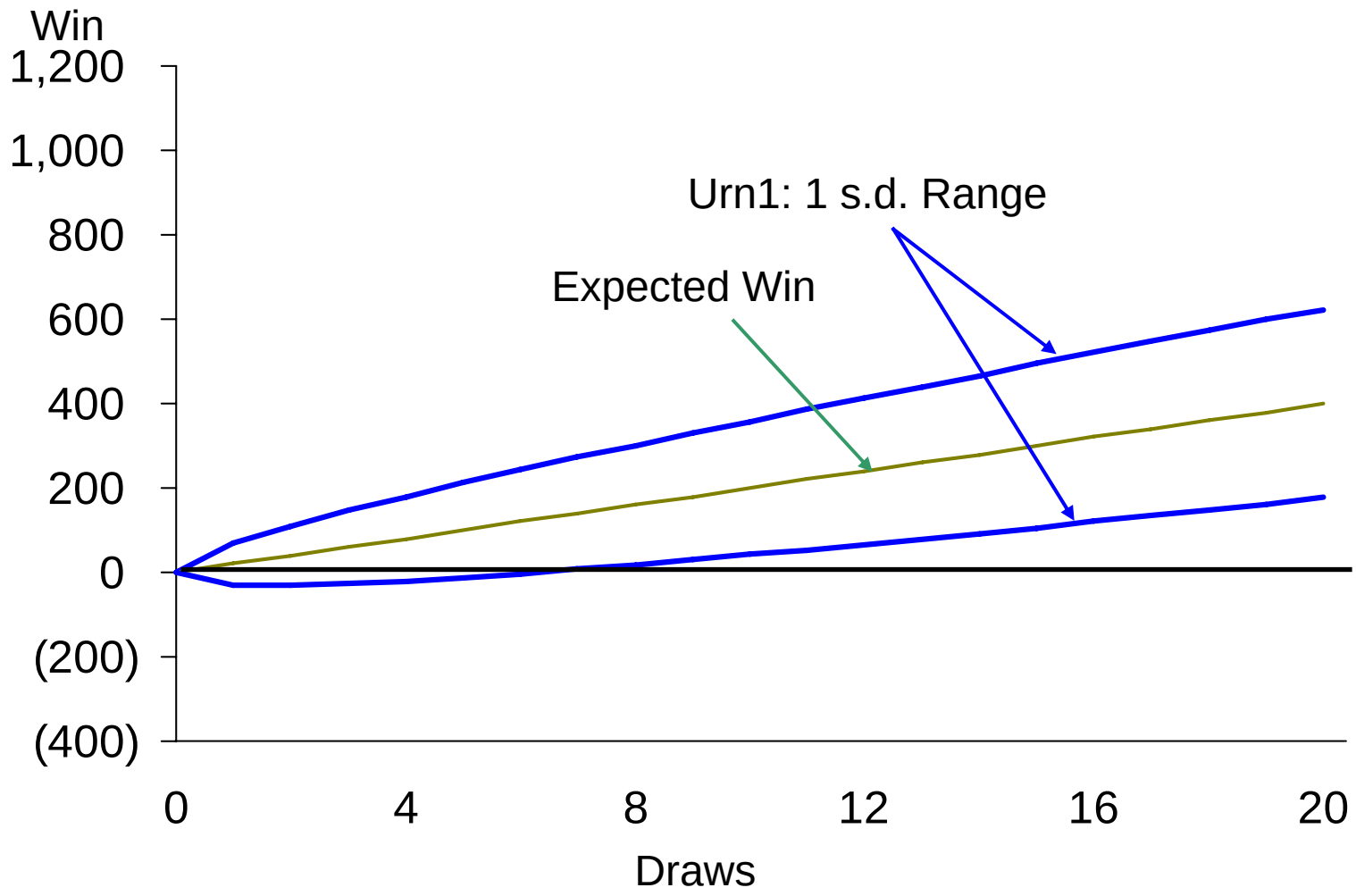
    X was randomly selected from the integers 0 – 40 (inclusive)
- You can pick a color to bet on
- The payoffs are: + $70 if we draw a ball of your color

  – $30 if we draw the other color

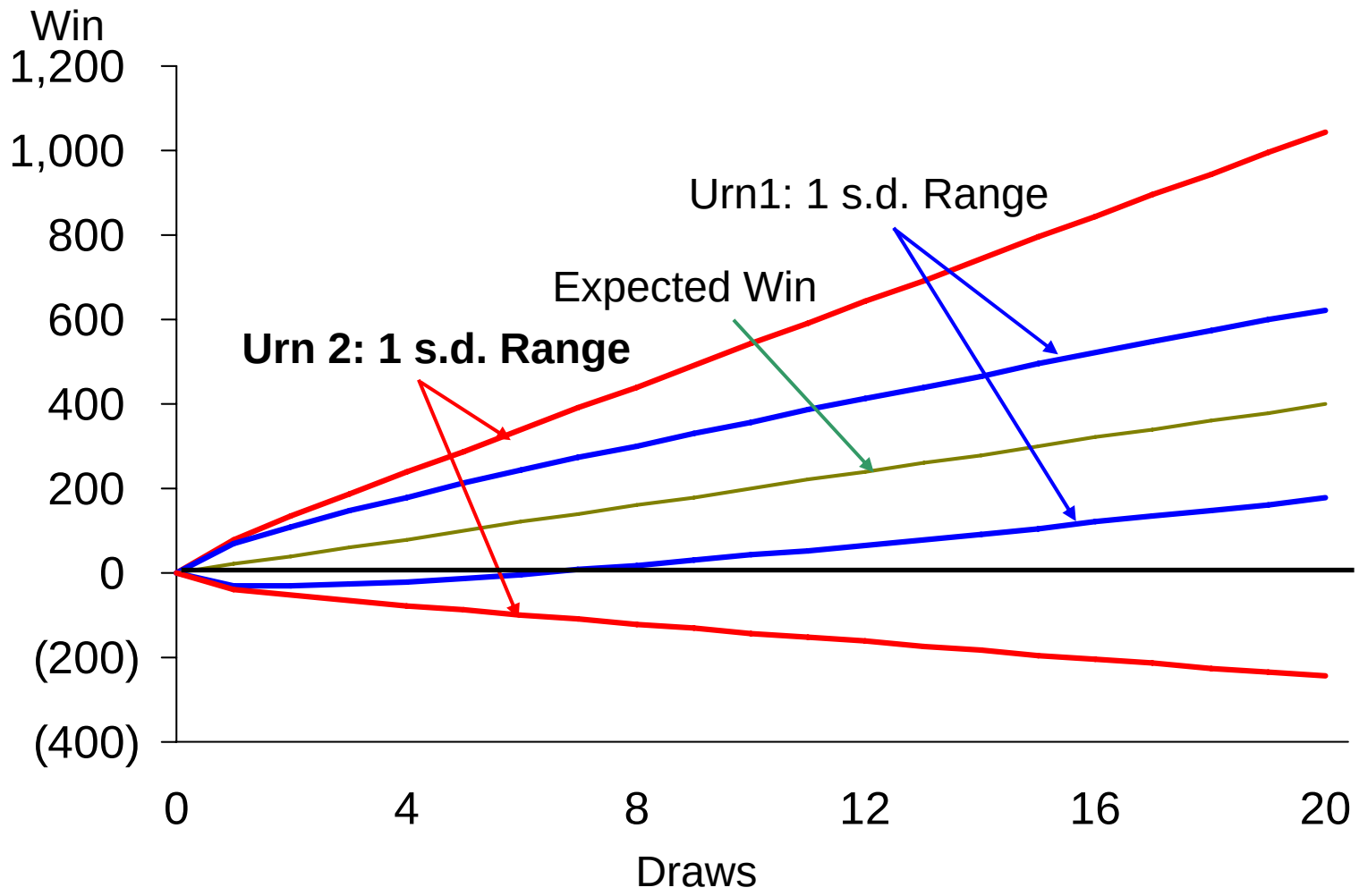
***Which urn would you rather draw from?***

*See: Chipman (1961), Ellsberg (1961), Knight (1921)*

# Dispersion of Outcomes: Urn1



# Dispersion of Outcomes: Urn1 versus Urn 2



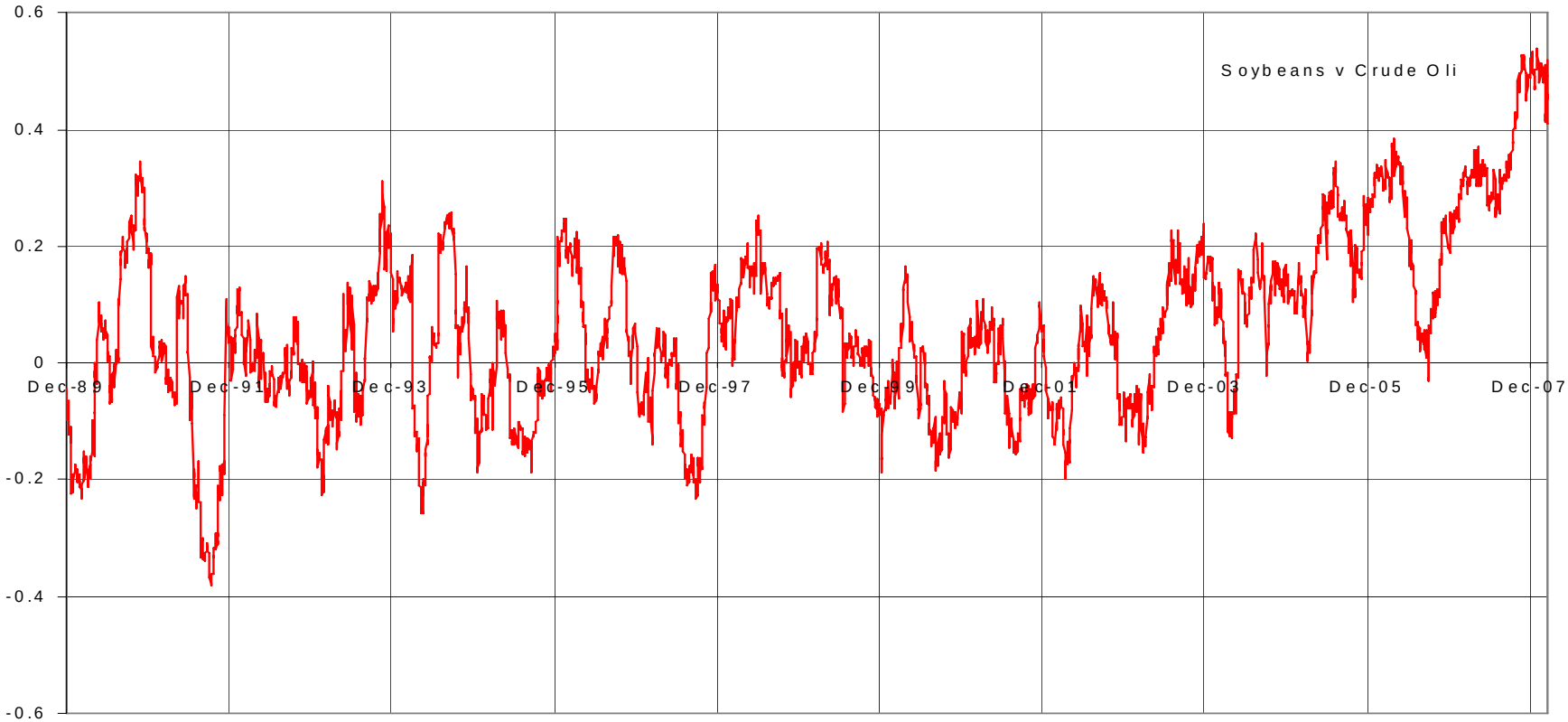

Urn1: If we play long enough, you almost surely win

Urn 2: NOT

# Ambiguity and Optimal Allocations

- One-period optimization bets too heavily on Urn 2
- Optimal bet declines with the total number of trials you are going to play
- Learning helps but does not overcome the problem because we don't learn fast enough.
- How does this relate to the "real world"
- What is the uncertainty of:
  - Stocks
  - Hedge Funds
- These questions affect "optimal" allocations
  - like Black-Scholes, optimizers are not correct but are useful
  - Optimal allocations are different for different horizons

# Market Participants Affect Market Behavior




- Correlation between soybeans and crude oil was close to zero …
- Until investors began to view commodities as an asset class

# Current Events

- The financial system became very convinced that:
  - Volatility would remain low
  - Risk management was improved
- Securitization creates incentive problems.
  - Wall Street was aware of them but believed they were insulated from the outcome.
- In fact
  - Volatility was at a cyclical low
  - Risk management systems create feedback loops that engender volatility
  - Wall Street was more exposed than expected
  - Housing downturn is likely to be protracted
- We are seeing this unwind.

# Current Events

- Currency carry trades
- Quantitative blow-ups
- Marking-to-market
- Equity risk premium
- Housing market and other economic outlook
- Real estate derivatives markets

# Summary

- Risk evolves over time in complex ways
- We can improve our understanding of the time-series dynamics of asset prices?
- Slow-moving processes such as inflation create significant long-term risks.
- The house *equity* market would benefit greatly from financial innovation
  - Housing finance could benefit from some simplification

- **Comments, questions, collaboration are very welcome**

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# Open Questions

- Far-sighted portfolio construction
  - What does our understanding of the time-series dynamics of asset prices tell us about optimal long-term portfolios
  - Can ambiguity help construct better portfolios?
  - Does global diversification work best over the long run?
  - How well does currency hedge (country-specific) inflation?
  - How do correlations change over time?
- Long-term dispersion and options pricing?
- Housing market improvements
  - What can be done?
  - Why hasn't it happened already?

- **Comments, questions, collaboration are very welcome**

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