Extrapolation of the Past:
The Most Important Investment Mistake?

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Overview

• behavioral finance tries to make sense of financial phenomena using models that are psychologically realistic
  – e.g. that allow for less than fully rational thinking
• aim for psychological realism on two dimensions
  – investor beliefs
  – investor preferences
• key ideas
  – (beliefs) extrapolation, overconfidence
  – (preferences) loss aversion, probability weighting, ambiguity aversion
Overview

• today, focus on *extrapolation*
  – the idea that, when forming beliefs about the future, people put too much weight on the recent past
• as of 2015, this may be the most widely-applied idea in behavioral finance
Outline

• definition of extrapolation and initial evidence

• applications
  – excess volatility and predictability in the aggregate stock market
  – momentum and reversal in individual securities
  – bubbles

• roots of extrapolation

• (very) recent developments
Extrapolation

• the extrapolation framework posits that many investors form beliefs about the future by extrapolating the past
  – e.g. form beliefs about future returns by extrapolating past returns

• surveys of both individual and institutional investors provide clear evidence of extrapolation
  – their forecasts of future returns are highly correlated with past returns
  – but such forecasts are incorrect
Extrapolation

• a common specification of extrapolative beliefs is:

\[
E_t^e(P_{t+1} - P_t) = (1 - \theta)((P_{t-1} - P_{t-2}) + \theta(P_{t-2} - P_{t-3}) + \theta^2(P_{t-3} - P_{t-4}) + \theta^3(P_{t-4} - P_{t-5}) + \ldots)
\]

where \( \theta \in (0, 1) \)

• consider an economy with two assets
  – a risk-free asset with a constant return
  – a risky asset that will pay a single, liquidating cash flow at some distant date \( T \)

• and two types of investors
  – extrapolators
  – fundamental traders

• how does the price of the risky asset evolve?
Extrapolation

- graph below plots the price of the risky asset and its “fundamental value” for a particular sequence of cash-flow news over $T = 50$ periods
  - 10 periods of no news
  - 4 periods of positive news
  - 36 periods of no news
Extrapolation

• in an economy with extrapolators, a sequence of good news generates an overvaluation followed by a correction

• the beliefs of extrapolators are roughly right in the short run
  – but very wrong near the peak of the overvaluation
Application: Excess volatility

• the P/E of the aggregate stock market has historically been very volatile

![Graph showing the P/10-year MA(E)]

• economists view this volatility as puzzlingly high
  – there is no consensus about its source
Application: Excess volatility

- to justify the volatility on rational grounds, we would need to appeal to one of
  - rationally-changing forecasts of future cash flows
  - rationally-changing forecasts of future interest rates
  - rationally-changing forecasts of future risk
  - rationally-changing risk aversion

- remarkably, the first three of these channels are largely unable to explain the volatility
  - high P/E ratios are not followed by higher cash flows, lower interest rates, or lower risk
  - Shiller (1981) famously first made the point, for the cash-flow channel

- the most prominent rational model of stock market volatility appeals to changing risk aversion
  - the “habit” model (Campbell and Cochrane, 1999)
Application: Excess volatility

• over-extrapolation provides a simple behavioral finance alternative
  – after good cash-flow news that pushes prices up, extrapolators expect high future price rises
    ⇒ they buy heavily, causing a sharp upward move in the short run ("excess volatility")
  – Barberis, Greenwood, Jin, Shleifer (2015a)

• there is an active debate about which model, habit or over-extrapolation, is closer to the truth
  – note: the over-extrapolation model is consistent with the survey evidence, but the habit model is not
Application: Stock market predictability

- the central fact about the stock market is that valuation ratios (P/E, P/D) negatively predict long-term subsequent returns
Application: Stock market predictability

• it is hard to explain this predictability by appealing to rationally-changing forecasts of future cash flows, interest rates, or risk

• the best-known rational approach to understanding this evidence is, again, the habit model

• but over-extrapolation offers a simple behavioral finance alternative
  – a sequence of good cash-flow news causes an overvaluation followed by a correction
  – high P/E’s near the peak are followed by low returns
    – Barberis, Greenwood, Jin, Shleifer (2015a)

• the over-extrapolation mechanism is consistent with the survey evidence, but the habit mechanism is not
Application: Momentum and reversal

- extrapolation, applied at the stock-level can generate both momentum and reversal
Application: Bubbles

- after a sequence of very good fundamental news about an asset, the overvaluation caused by extrapolation can become so large and persistent as to qualify for the label “bubble”

- this fits with Kindleberger’s (1978) observation that most bubbles occur on the back of good fundamental news
Application: Bubbles

- big challenge: how can extrapolation explain the high \textit{volume} we observe during bubbles?

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure1}
\caption{Prices and Turnover for Internet and Non-Internet Stocks, 1997–2002}
\end{figure}
Application: Bubbles

One answer (Barberis, Greenwood, Jin, Shleifer, 2015b):

- extrapolators also put some weight on how prices compare to fundamental value, so that their demand for shares becomes:

\[ w \left( \frac{E(D_T) - P_t}{\gamma \sigma^2} \right) + (1 - w) \left( \frac{X_t}{\gamma \sigma^2} \right) \]

where

\[ X_t = (1 - \theta)(P_{t-1} - P_{t-2} + \theta(P_{t-2} - P_{t-3}) + \theta^2(P_{t-3} - P_{t-4}) + \ldots) \]

and \( w \approx 0.1 \)

- think of the two components of demand as two (competing) signals
- a “value” signal and a “growth” signal

- in addition, the relative weight each extrapolator puts on the two signals varies slightly over time, independently across extrapolators and over time
  - “wavering”
  - reflects the difficulty extrapolators face in balancing the conflicting signals
  - may stem from shifts in mood or attention, or from cognitive errors
Application: Bubbles

- in the presence of such investors, a large overvaluation will be accompanied by heavy trading volume
  - extrapolators increase or lower their exposure to the risky asset as they waver between excitement and fear
Roots of extrapolation

A range of possible sources:

• people believe that the mean return of an asset varies slowly over time
  – a belief in a slowly-varying world may have been a good one in many contexts during human evolutionary history

• an (incorrect) belief in the “law of small numbers”

• memory
Recent developments

• Casella and Gulen (2015) show that the relative weight people put on recent vs. distant past price changes when forming beliefs about the future varies over time – and that this provides a way of forecasting when an overvaluation will be corrected

• find that when the P/E of the stock market is high \textit{and} investor beliefs load even on distant past price changes, there is no subsequent correction

– but when the P/E is high \textit{and} investor beliefs load mainly on recent past returns, there is a much higher risk of a correction
Summary

• extrapolation is the idea that people form beliefs about future returns by extrapolating past returns

• as of 2015, it may be the most widely-applied idea in behavioral finance
  – excess volatility and predictability in aggregate asset classes
  – momentum and reversal in individual securities
  – bubbles

• in the short run, extrapolative beliefs can be roughly correct
  – but near market peaks, they are very wrong

• the deeper roots of extrapolation are still not well-understood
References
