Contemporary Economic Challenges
Autumn 2019

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Economists' ideas shape debates

> *The most important decisions a scholar makes are what problems to work on (Tobin, 2009)*

> *The ideas of economists and political philosophers, both when they are right and when they are wrong, are more powerful than is commonly understood (Keynes, 1936)*

Examples accepted as common since I became an economist:

1. carbon permits
2. auctions to allocate spectrum, etc.
3. 'behavioural' economics

What makes a good question?

any hypothesis, however absurd, may be useful in science, if it enables a discoverer to conceive things in a new way (Russell, 1945)

1. practical/policy relevance: would the newspapers care?
   - most highly cited papers often policy related or empirical
2. "Glaeser's rule" at the QJE: does it involve more than 2% of GDP?
3. does it help us think about a problem in a new way?
4. can you explain it to your parents/room-mates?
5. do you care?

How do we find good questions?

The economist has no right to expect of the universe he explores that its laws are discoverable by the indolent and the unlearned (Stigler, 1950)

The best economists have taken their subjects from the world around them (Tobin, 2009)

In the last five hundred years we have had five major concept-driven revolutions ...[and] about twenty tool-driven revolutions ...The effect of a concept-driven revolution is to explain old things in new ways. The effect of a tool-driven revolution is to discover new things that have to be explained. ...We have been more successful in discovering new things than in explaining old ones. (Dyson, 2005)

How do we find out about the world around us?

look at the world around you or take courses in other disciplines. Some of the papers in my own dissertation ...were thought of while daydreaming in some law courses I took. (Rubinstein, 2013)

1. follow the news, whether 'macro' or 'micro' (e.g. Nokia fora)
2. learn about something (e.g. the Marseilles fish market, Kirman and Vriend (2000))
3. speak to people who know things we don't
   - 'I know how to integrate $x \log x$; if I need to solve another problem, I find a co-author' (Dutta)
   - Shapley's value is used in ...?
4. play

   I was in the cafeteria and some guy ... throws a plate in the air ... the whole business that I got the Nobel prize for came from that piddling around with the wobbling plate (Feynman, 1985)

OK, but practically ...

1. sign up to receive free copies of the NBER Digest and Reporter
2. create a free non-member account with the American Economic Association and receive notifications of new issues of the JEL and JEP
3. read biographies of economists, e.g. Breit and Hirsch (2009), Szenberg (1992)

Secondary considerations?

I am not a donkey and do not have a field (Weber?)

1. is it economics?

Outline

Lambert (2019)

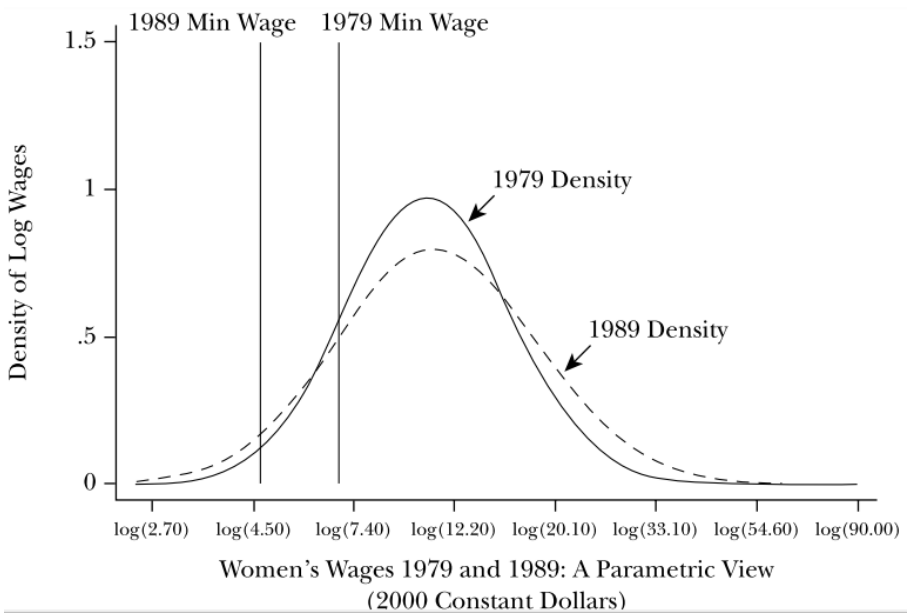
- implicit equilibrium concept: universities rely on tuition fees, so give high marks to get high NSS scores
- casual appeal to evidence: 5× UG degrees since 1990, 4× proportion of 1sts ...

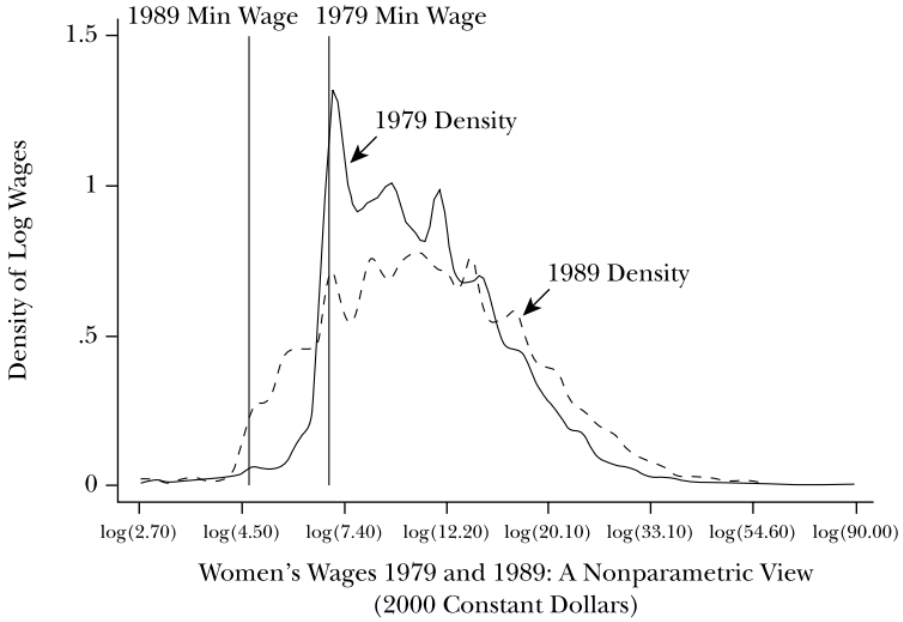
Spence (1973)

- 'early' theory: generally discursive, with simple mathematical examples
- more productive people find it less expensive to buy educational 'signals'

Webber (2014)

- some underlying theory + data + simulation





DiNardo and Tobias (2001)

Walker and Zhu (2013): high returns to education

	non-grad	grad premium
♀	496	+105 (2.ii)
		+190 (2.i, 1)
♂	611	+65 (2.ii)
		+141 (2.i, 1)

Table 15 (Walker and Zhu, 2013)

All figures NPV in £1,000

	♀	♂
medical	454	429
nursing	-7	170
bio/vet/agri	117	174
phys sciences	123	237
maths/comp	243	100
eng'g/tech	680	21
architecture	-193	288
soc study	266	-86
law	120	431
economics	902	335
business/mgt	149	256
mass com	95	3
ling/lang	123	161
hist/phil	113	557
arts/design	111	-111
education	396	103

Table 16 (Walker and Zhu, 2013)

conclusions

- what can we conclude?
- what do we want to conclude, but can't yet?
- what do we need to draw those conclusions?
  - what data?
    - what do we know about degrees in fields with 'hard' performance standards (e.g. medicine)?
  - what theory?
- what is happening to graduate premium?
  - want time series versions of Tables 15, 16 (Walker and Zhu, 2013)
  - how far has Webber's 'moderate convergence' gone?
- what else does what we've learned here help us understand?

Outline

Friedman (1953, ch.1): 'as if' models for predictions

- finite evidence ⇒ "If there is one hypothesis that is consistent with the available evidence, there are always an infinite number that are"
- "Truly important and significant hypotheses will ... have 'assumptions' that are wildly inaccurate descriptive representations of reality"
- "the more significant the theory, the more unrealistic the assumptions"
- what matters is only whether the predictions are "sufficiently good approximations for the purpose in hand"
- more accurate predictions may require more cumbersome models
- famous "as if" example: teleporting leaves
- need experience "in applying the rules": e.g. Euclidean geometry
- assumptions and conclusions aren't immutable
  - from π max'ing assumption, we could predict basing-point pricing
  - from basing-point pricing, then predict "conspiracy in restraint of trade"
- scientific breakthroughs may look crackpot at the time

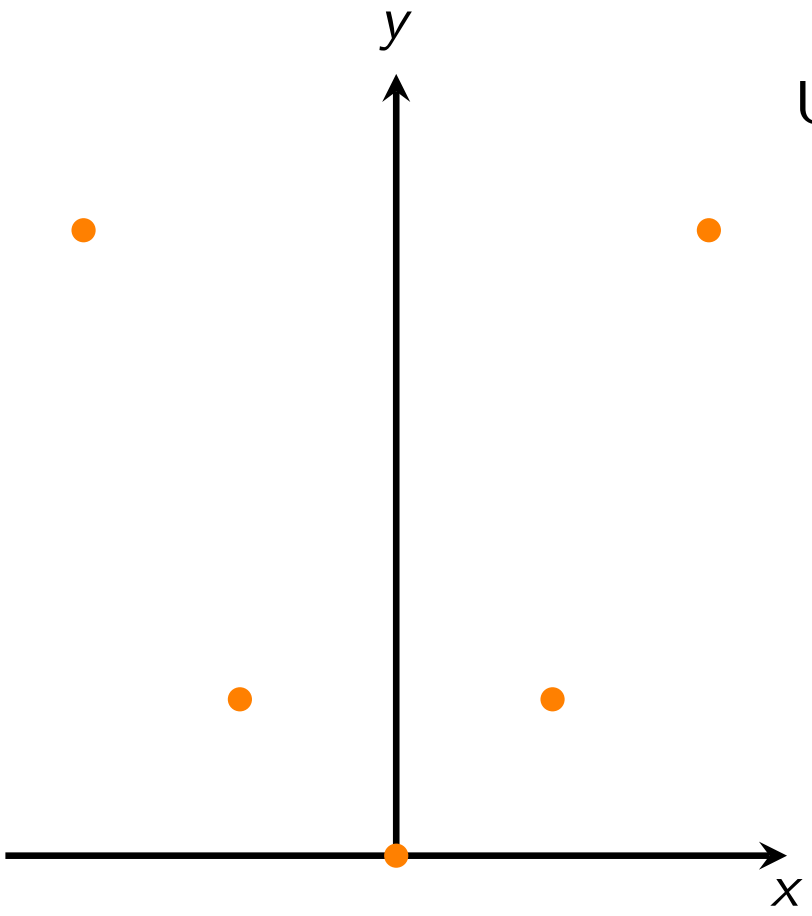
Samuelson (1963): a small sin is not a merit

- doesn't entirely disagree: e.g. Newton - "I don't care to speculate why n-bodies behave in accordance with the inverse-square law of gravity and acceleration; I am content to ...[demonstrate] agreement with the observations of moons, apples, and planets"
- "Some inaccuracies are worse than others, but that is only to say that some sins against empirical science are worse than others, not that a sin is a merit or that a small sin is equivalent to a zero"
- let A be assumptions, B be theory and C conclusions:
  1. then $A \equiv B \equiv C$: just different representations
  2. if $A^+ \supset A$ and $A^+ \backslash A$ is nuts, then C^+ will also contain nuttiness
- often "nature displays a mysterious simplicity if only we can discern it"
- "that nothing is perfectly accurate should not be an excuse to relax our standards of scrutiny of the empirical validity that the propositions of economics do or do not possess"
- "as I was taught to do in Chicago ...": saltwater v freshwater
- "there in reality"

H. A. Simon (1963): explain the macro by the micro

- "it satisfies our feeling that individual actors are the simple components of the complex market; hence proper explanatory elements"
- e.g. microfoundations of macroeconomics
- disagrees that predictions can be tested, but not assumptions
  - how do we know what the profit maximising level of output is?
  - (joint hypothesis: test of C already embeds A; e.g. OLS to parabola)
- "discover and test true propositions"
- "principle of continuity of approximation" over "principle of unreality"

Does this help us?



Using Samuelson's notation:

A $y = \beta_0 + \beta_1 x$

B estimate β_0, β_1 using ordinary least squares:

$$\left(\hat{\beta}_0, \hat{\beta}_1\right) = \arg\min \sum_i \varepsilon_i^2;$$

where $\varepsilon_i \equiv y - \hat{\beta}_0 + \hat{\beta}_1 x$

C (what do we predict about y's dependence on x?)

conclusions

- what can we conclude?
- what do we want to conclude, but can't yet?
- what do we need to draw those conclusions?
  - what data?
    - examples?
  - what theory?
- are Friedman, Samuelson, H. A. Simon competent to discuss this?
  - e.g. Dirac's Nobel banquet speech: "May I ask you to trace out for yourselves how all the obscurities become clear, if one assumes from the beginning that a regular income is worth incomparably more, in fact infinitely more, in the mathematical sense, than any single payment?"

"Like mathematical theory, mathiness uses a mixture of words and symbols, but ...leaves ample room for slippage between statements in natural versus formal language" (Romer, 2015)

- what else does what we've learned here help us understand?

Outline

Arrow (1963): the competitive market benchmark

Welfare theorems:

1. competitive EQ is Pareto optimal
2. any Pareto optimal allocation can be supported by a competitive EQ

   if the conditions of the two optimality theorems are satisfied, and if the allocation mechanism in the real world satisfies the conditions for a competitive model, then social policy can confine itself to steps taken to alter the distribution of purchasing power

- otherwise: "the separation of allocative and distributional procedures becomes, in most cases, impossible"
- thus, goal: compare actual to ideal market
- three necessary conditions for ideal results
  1. *existence* of competitive equilibrium (prices that clear all markets)
  2. *marketability* of relevant goods, services (externalities e.g. vaccination, but focus here on risk-bearing)
  3. *non-increasing returns*

Arrow (1963): paradox of information

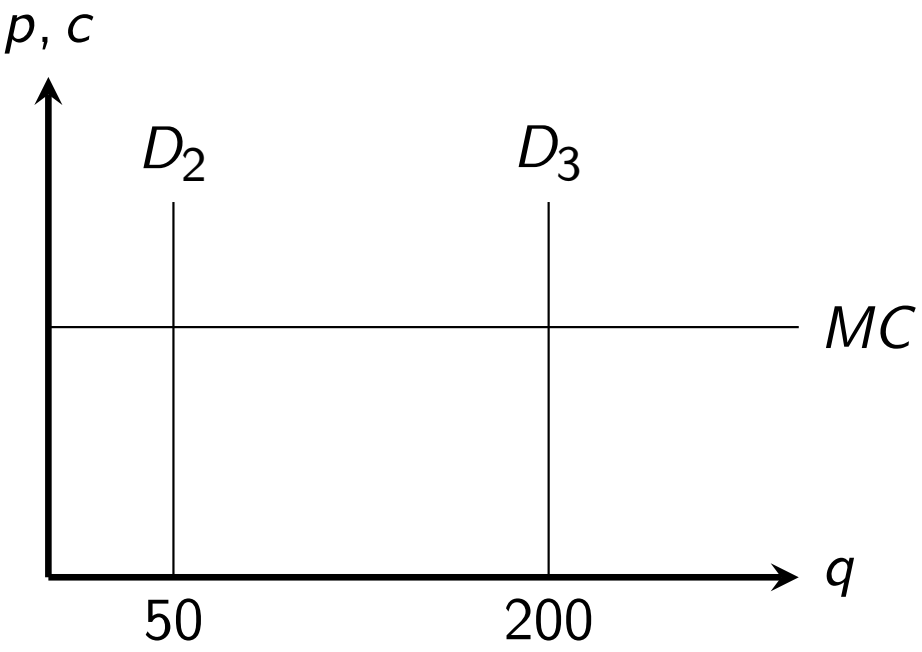
- "When there is uncertainty, information ... becomes a commodity"
- "The value of information is frequently not known in any meaningful sense to the buyer"
  - thus, can't define meaningful demands (maximising utility)
- "when the market fails ... society will ... recognize the gap"

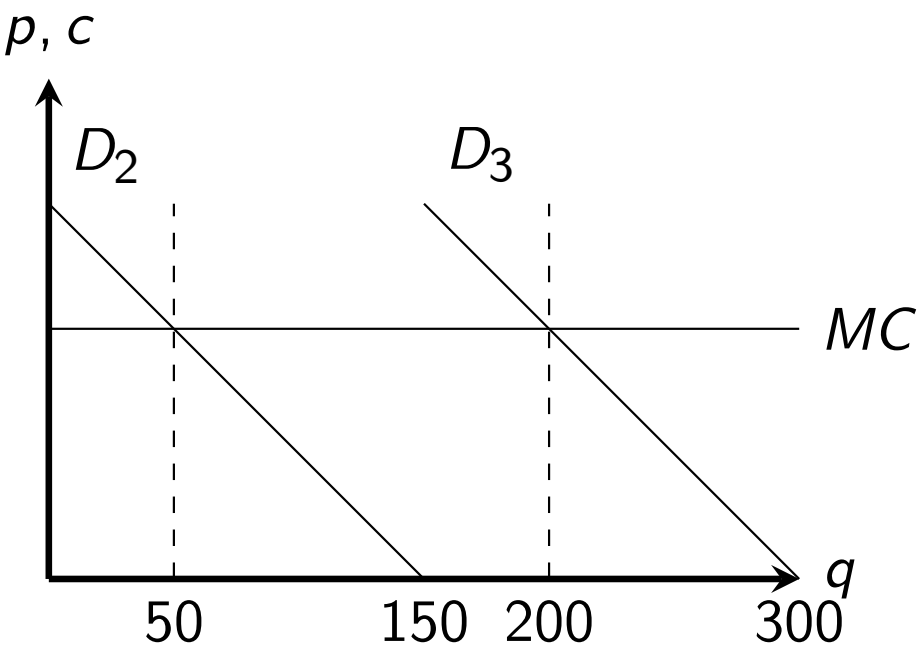
Arrow (1963): optimal insurance

- if risk averse, EU maximisers, 0 transaction costs ⇒ full insurance
  - welfare improvement if risks are independent
  - even with admin costs (significant for individual policies), still have case for insurance — but maybe copay
- pooling of unequal risks: to max social benefit, want single pool
- unregulated market will assortative match: "insurance plans could arise which charged lower premiums to preferred risks and draw them off, leaving the plan which does not discriminate among risks with only an adverse selection of them"
- ideal insurance: allows medical care whenever expected benefits exceed expected costs

Pauly (1968): not all events should be insured against

scenario: $p_1 = \frac{1}{2}$ no illness; $p_2 = \frac{1}{4}$ minor illness; $p_3 = \frac{1}{4}$ major illness;





mean cost (in MC) = fair premium

$$62.5 = \frac{1}{2} \cdot 0 + \frac{1}{4} \cdot 50 + \frac{1}{4} \cdot 200$$

now fair premium is

$$112.5 = \frac{1}{2} \cdot 0 + \frac{1}{4} \cdot 150 + \frac{1}{4} \cdot 300$$

Face risk, or pay premium that accounts for demand for free medical care?

Where do we stand now?

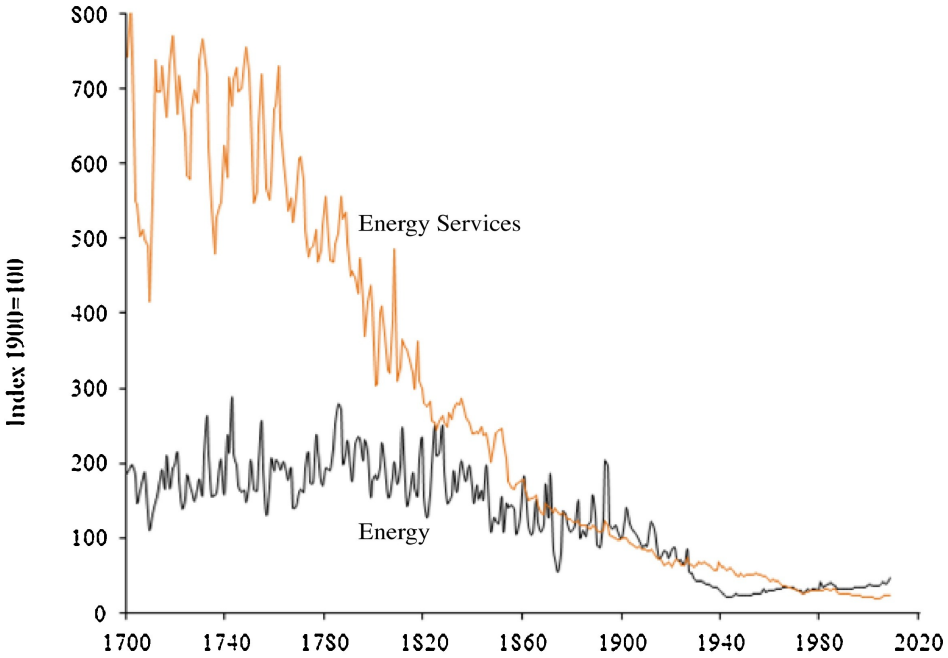
- Arrow (1968) accepts Pauly (1968) argument
- when welfare theorems fail, need to ask if market is still 'constrained optimal'
  - will government intervention improve on the market?
  - theory of the second best (Lipsey and Lancaster, 1956)
- 'Arrow securities' used in theoretical finance, prediction markets
- are important markets missing? 'yes' says Shiller (1994)
- health care expenditures varies hugely by country

Outline

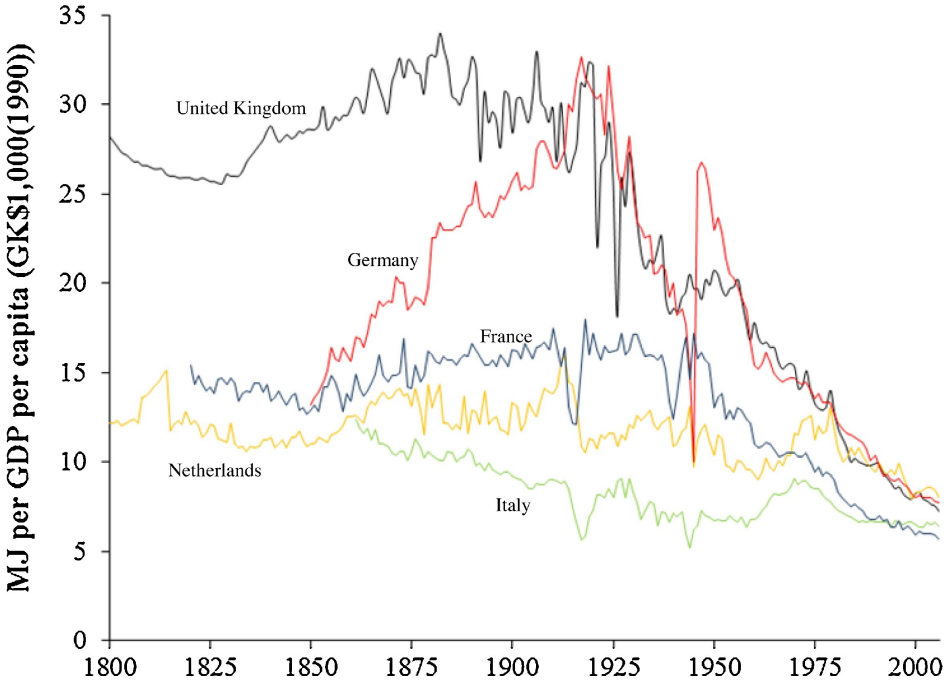
Ehrlich (1981b): growth as humanity's "gravest threat"

- 2nd law of thermodynamics: overall, things mix and run down; perpetual motion is impossible
  1. "Who knows what the second law ... will be like in a hundred years?"
     - how was the universe highly ordered in the first place?
     - how do parts of old adults form 'new' life? (e.g. Schrödinger, 1944)
  2. when does this make a modelling difference?
     - "functioning with no inputs from or outputs to the rest of the world"
     - "Nearly 40% of potential terrestrial net primary productivity is used directly, co-opted, or foregone because of human activities" Vitousek et al. (1986)
     - Dalgaard and Strulik (2011) scale up biological data to estimate limits on how much energy it might take us to distribute energy
- what does this have to do with economic growth?

selective evidence we're doing more with less



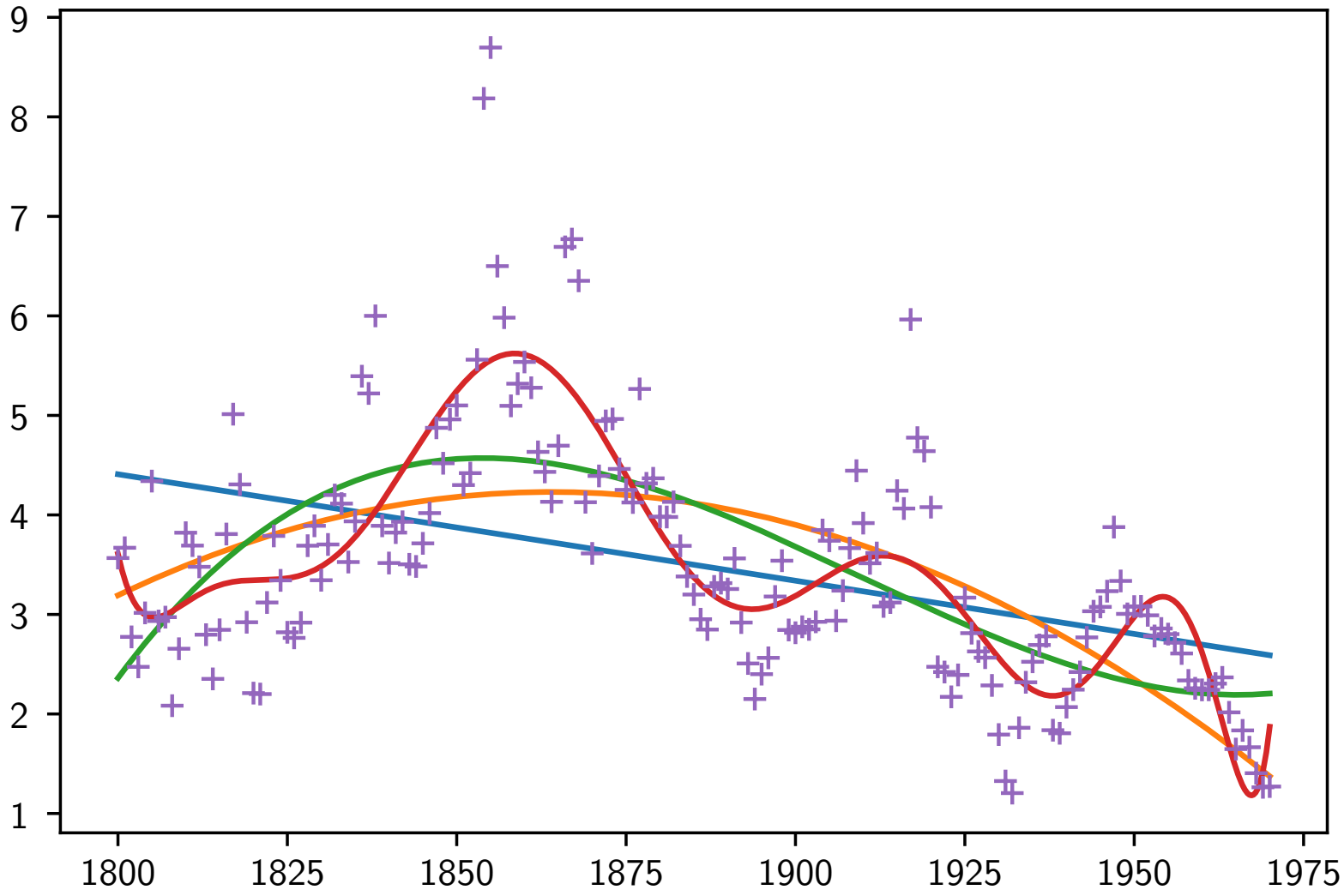
UK energy prices



European energy intensity

Fouquet (2016), building on the light price history in Nordhaus (1996)

J. L. Simon (1981): picking and choosing



Real US wheat prices; linear, quadratic, cubic, ... polynomials

See here on overfitting, and Harvey et al. (2010) on commodity prices

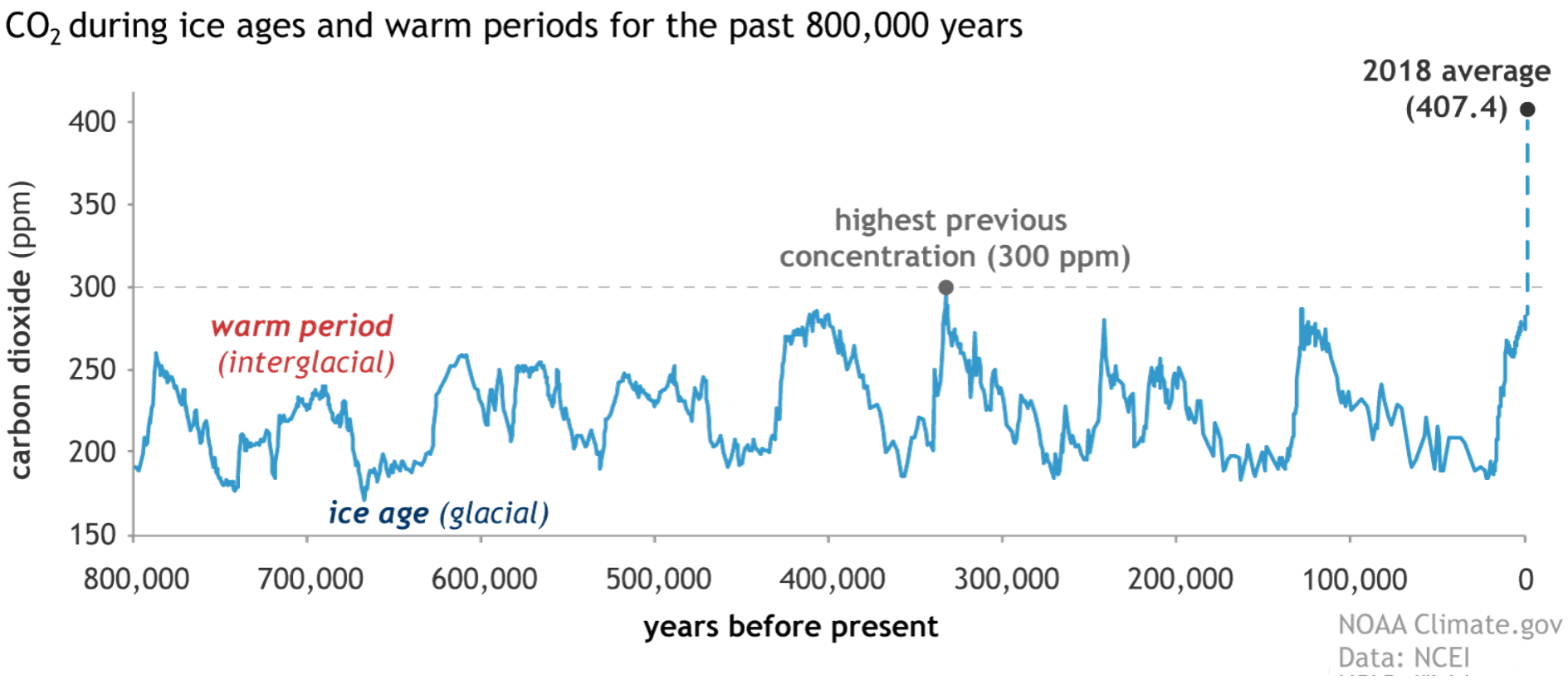
Ehrlich (1981a): "the capacity ...to absorb the punishment"

How do we measure how much of the earth's resources humans are using?

study	HANPP	ref. years
Whittaker & Lyons (1973)	3%	1950s
Vitousek et al. (1986) low	3%	1970s
Vitousek et al. (1986) mid	27%	1970s
Vitousek et al. (1986) high	39%	1970s
Wright (1990)	20 – 30%	70s/80s
Rojstaczer et al. (2001)	10 – 55%	80s/90s
Imhoff et al. (2004)	14 – 26%	1995
Haberl et al. (2007)	24%	2000
Krausmann et al. (2013)	13%	1910
Krausmann et al. (2013)	18%	1950
Krausmann et al. (2013)	25%	2005

Source: Haberl, Erb, and Krausmann, 2014

Ehrlich (1981a): "the capacity ...to absorb the punishment"

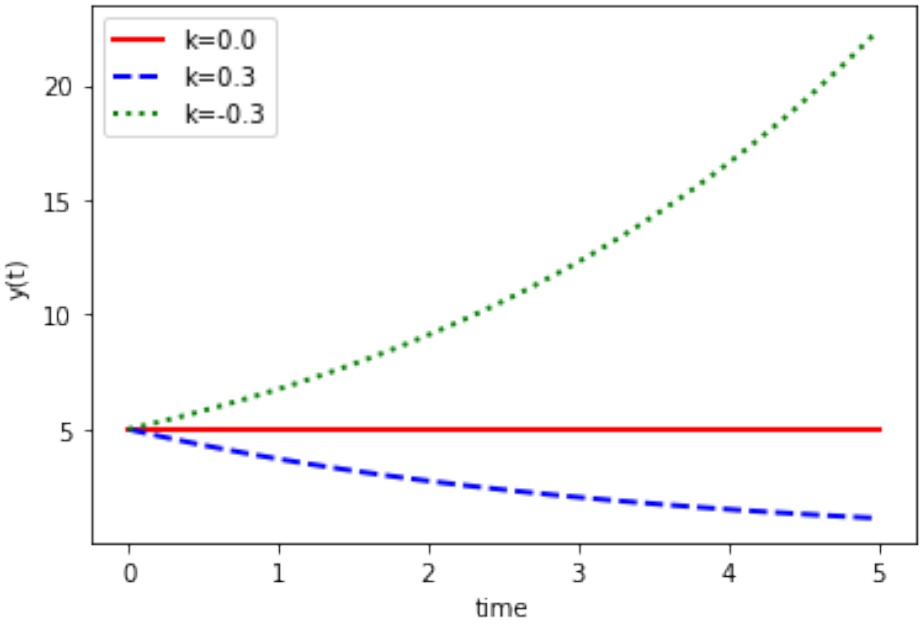


Ehrlich (1981a): "the capacity ...to absorb the punishment"

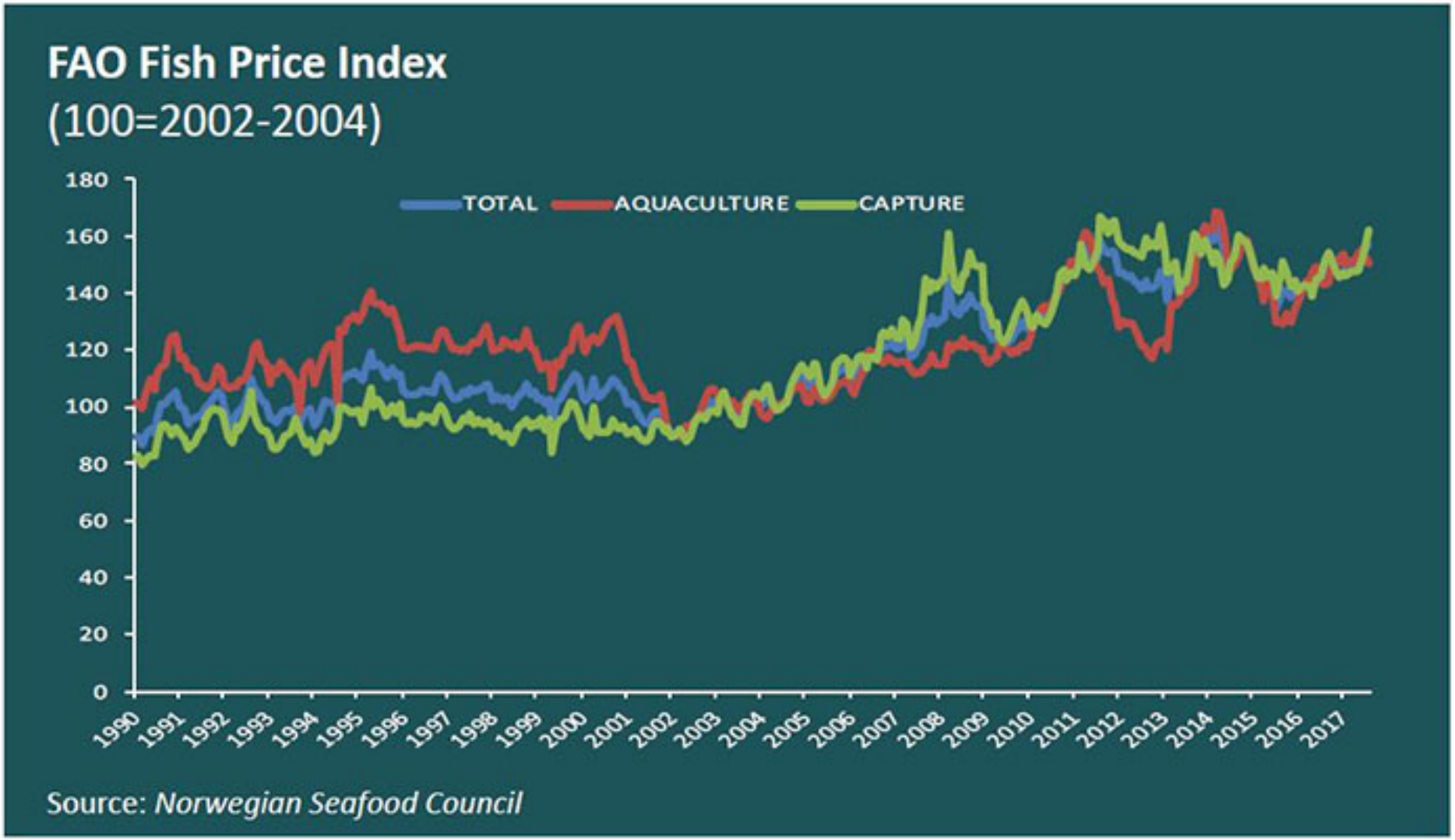
How important are feedback effects in the climate/atmosphere?

$$\frac{dy}{dt} = -ky(t) \Rightarrow y(t) = Ae^{-kt}$$

- $k = 0$: no feedback
- $k > 0$: negative feedback
- $k < 0$: positive feedback

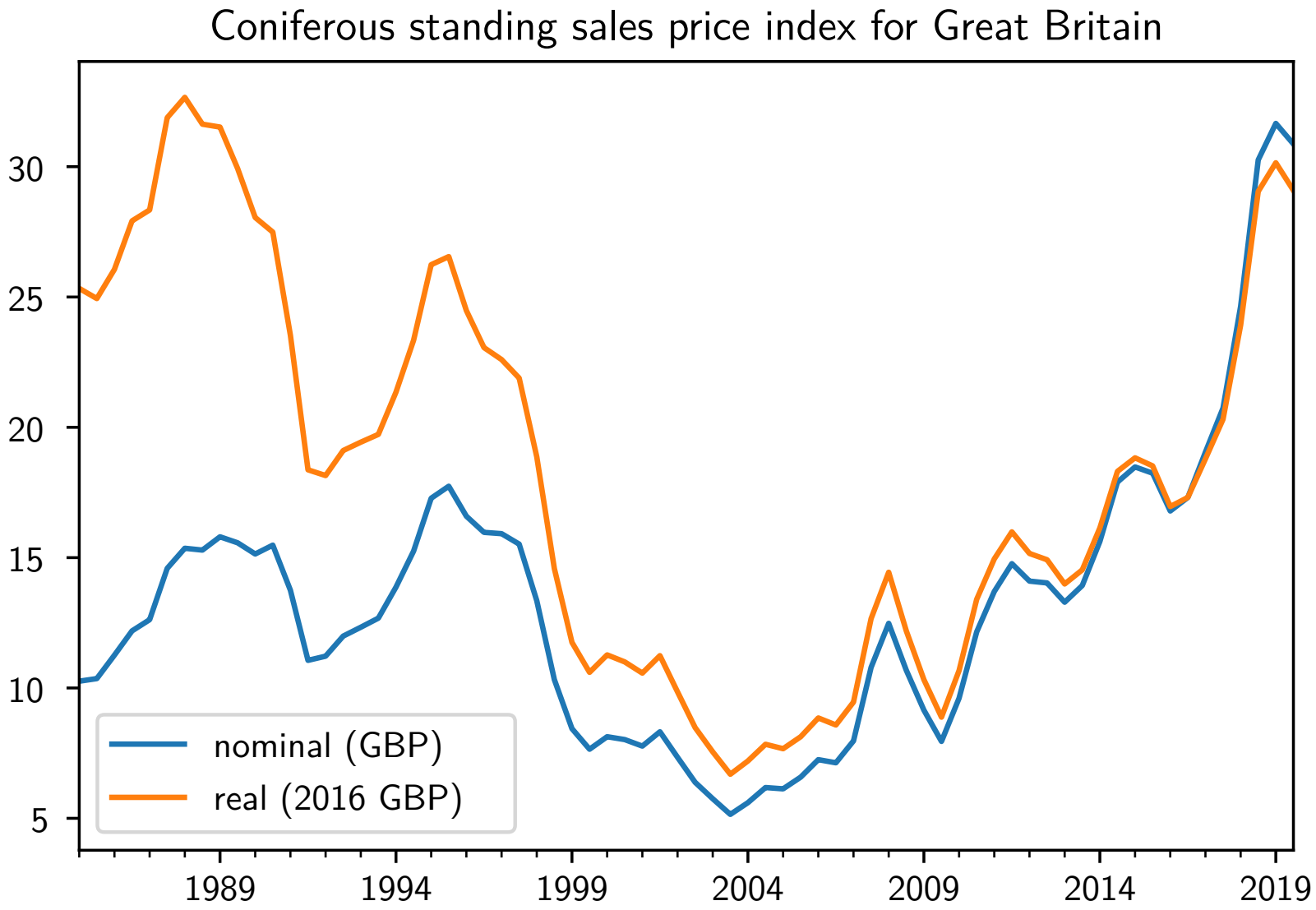


did Ehrlich pick the wrong assets?



source: FAO

did Ehrlich pick the wrong assets?



source: UK Forest Research

Ceballos et al. (2015): the sixth mass extinction

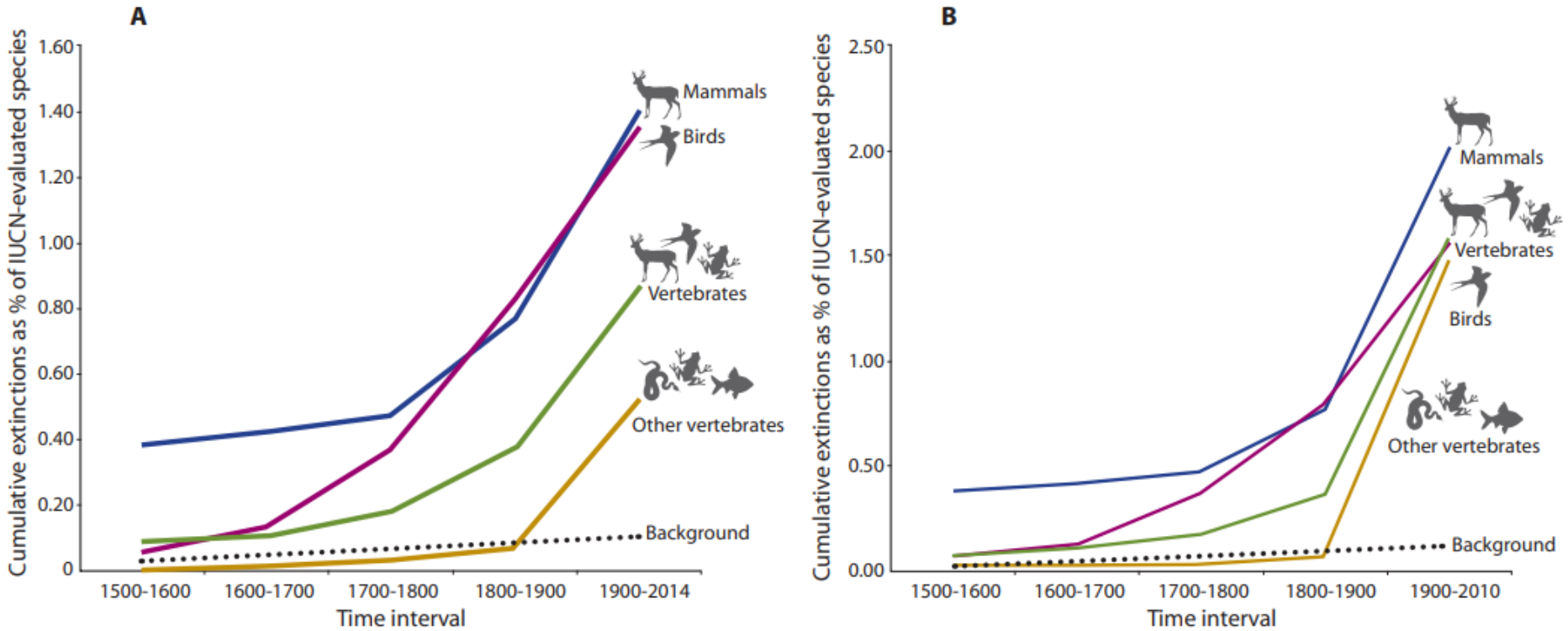


Fig. 1. Cumulative vertebrate species recorded as extinct or extinct in the wild by the IUCN (2012). Graphs show the percentage of the number of species evaluated among mammals (5513; 100% of those described), birds (10,425; 100%), reptiles (4414; 44%), amphibians (6414; 88%), fishes (12,457; 38%), and all vertebrates combined (39,223; 59%). Dashed black curve represents the number of extinctions expected under a constant standard background rate of 2 E/MSY. (**A**) Highly conservative estimate. (**B**) Conservative estimate.

for a Panglossian take on species loss, see The Onion (1998)

Outline

What moves asset prices? (Koudijs, 2016)

- efficient markets: news moves prices
- how can we test when news hits markets?
- 18th century English firms cross-listed in Amsterdam (Koudijs, 2016)
  - news hits Amsterdam when packet boats with newspapers arrive

public news explains more than 50% of the return variance on days ships arrived ... and around 40% of the overall return variance. Private information explains about 25% and 35% of volatility on days with and without boats

  - how do we know that other news isn't getting through?
    1. privately chartered ships? Internet Appendix III.A: no (private correspondence *and* restrict data to days of prohibitive weather following packet ship arrival)
    2. carrier pigeons? Internet Appendix III.B: no ("one of the most important Anglo-Dutch banks of the period did not use carrier pigeons" *and* restrict data to winter, when pigeons fare poorly)
    3. direct info (e.g. from East Indies on Dutch East Indies Company)? Internet Appendix III.C: no ("A closer examination of the *Amsterdamsche Courant* suggests that this concern is of minor importance" *and* restrict data to days w/o direct news)

So what? (Waite, Massa, and Cannon, 2019)

- "Index funds are poised to overtake active management in the U.S. by 2021"
- "Burton Malkiel ... famously compared the prowess of money managers to a blindfolded monkey throwing darts"
- "Jack Bogle, the late founder of Vanguard Group Inc. who popularized index funds, was insistent that most active managers weren't worth the fees"
- "Legg Mason Inc.'s Miller, who beat the S&P 500 for a record 15-year streak starting in 1991 ... failed to beat the ... benchmark index for four out of five years after 2005"
- "Gross retired this year after failing to live up to a stellar four-decade career that earned him the title of " 'bond king' "
- concerns: reduced liquidity left for active managers; reduced shareholder activism (q.v. Malkiel, 2003, p.68)

Grossman and Stiglitz (1980): efficiency's impossibility

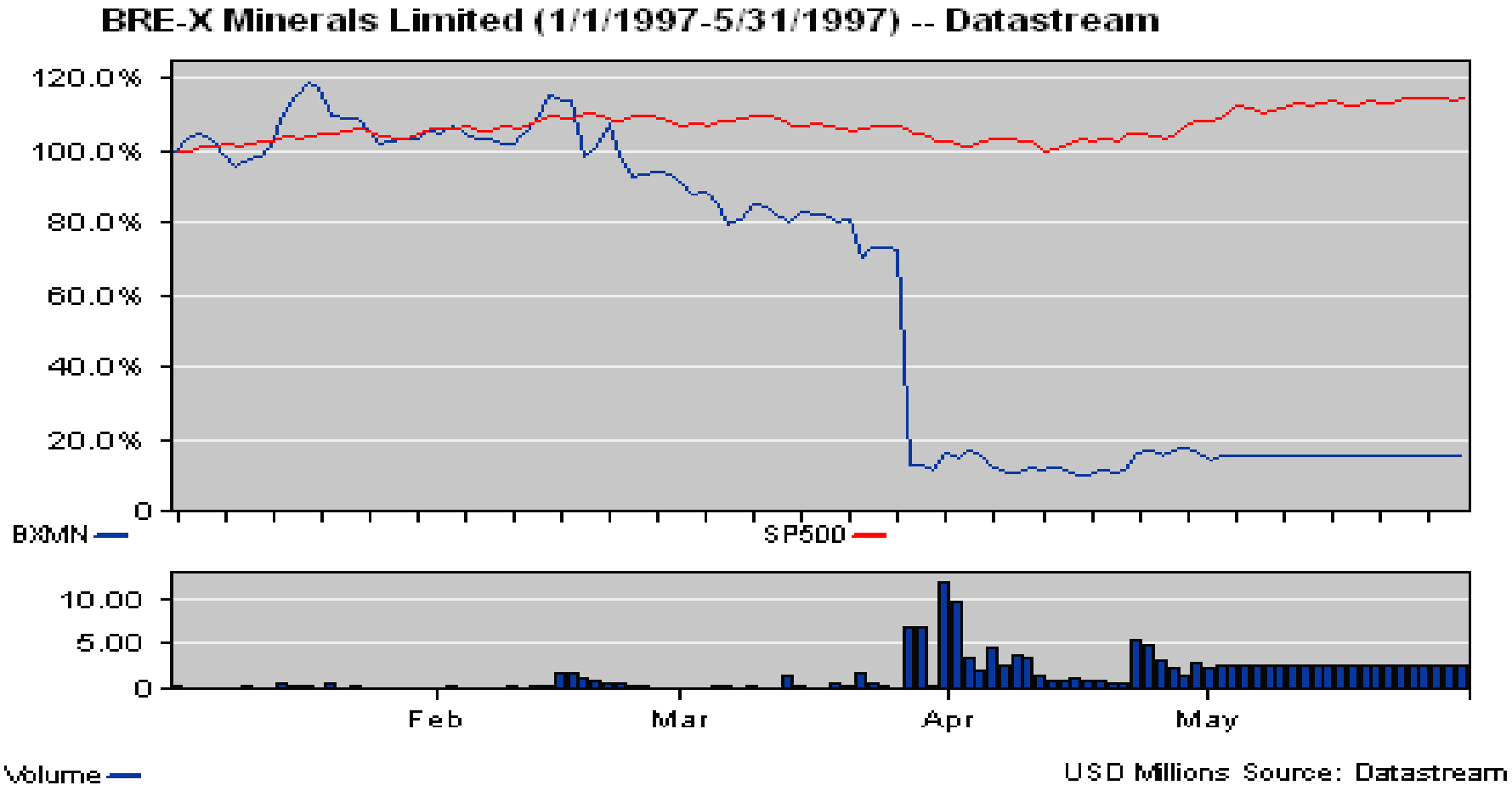
1. efficient markets imply all information rapidly/immediately incorporated into prices
2. no returns to trading on news
3. no financial incentives to gather or analyse news
4. no one places the trades that would incorporate news into prices
5. inefficient markets

Relatedly, Milgrom and Stokey's 'no trade' theorem:

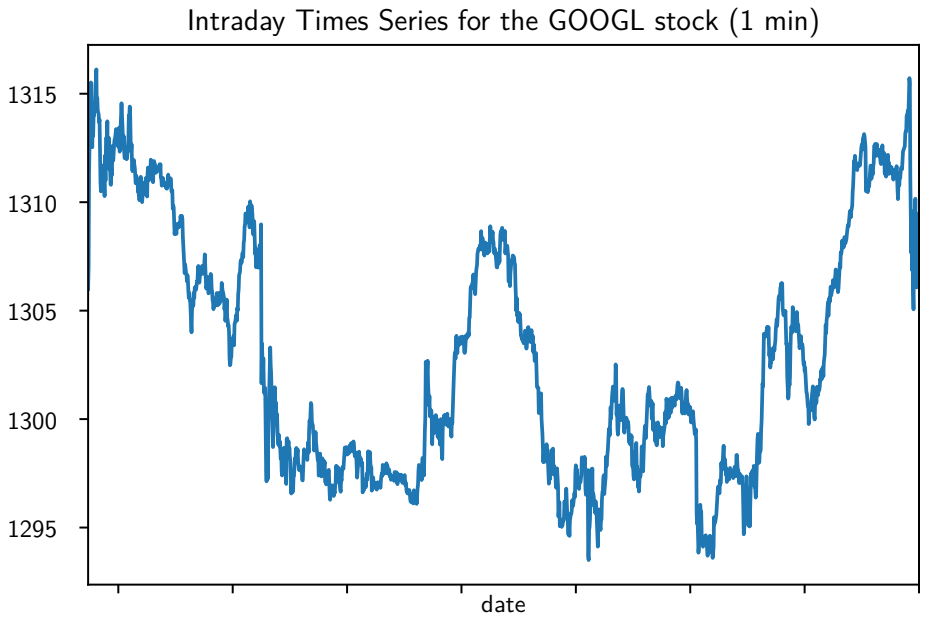
1. two rational traders, with common knowledge of rationality
2. A offers a speculative (rather than hedging) trade to B
3. does B accept?

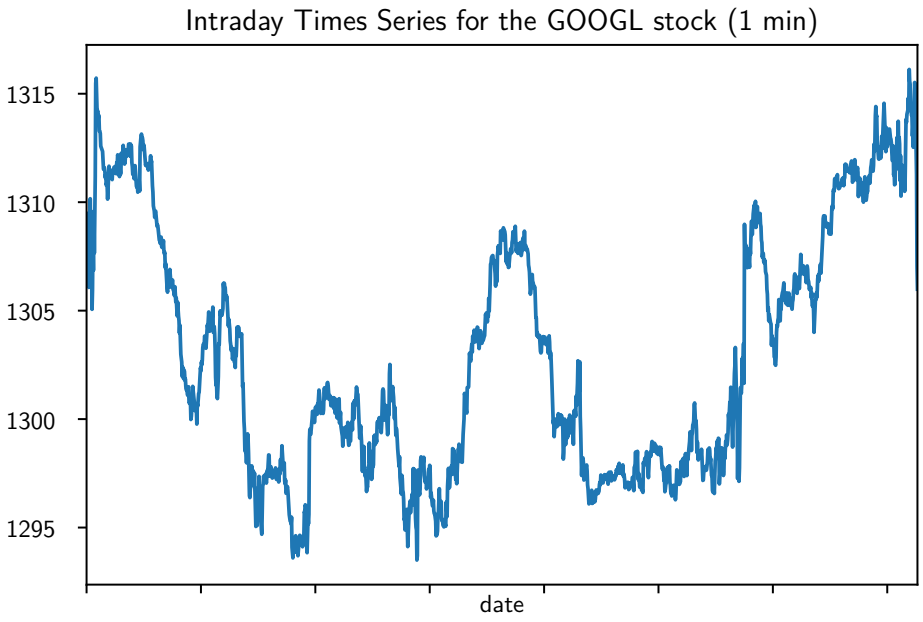
Bre-X

The [EMH] postulates that ... markets are supposed to function without any discontinuity in ... prices ... or, worse, a collapse. (George Soros; FT, 16/06/09)



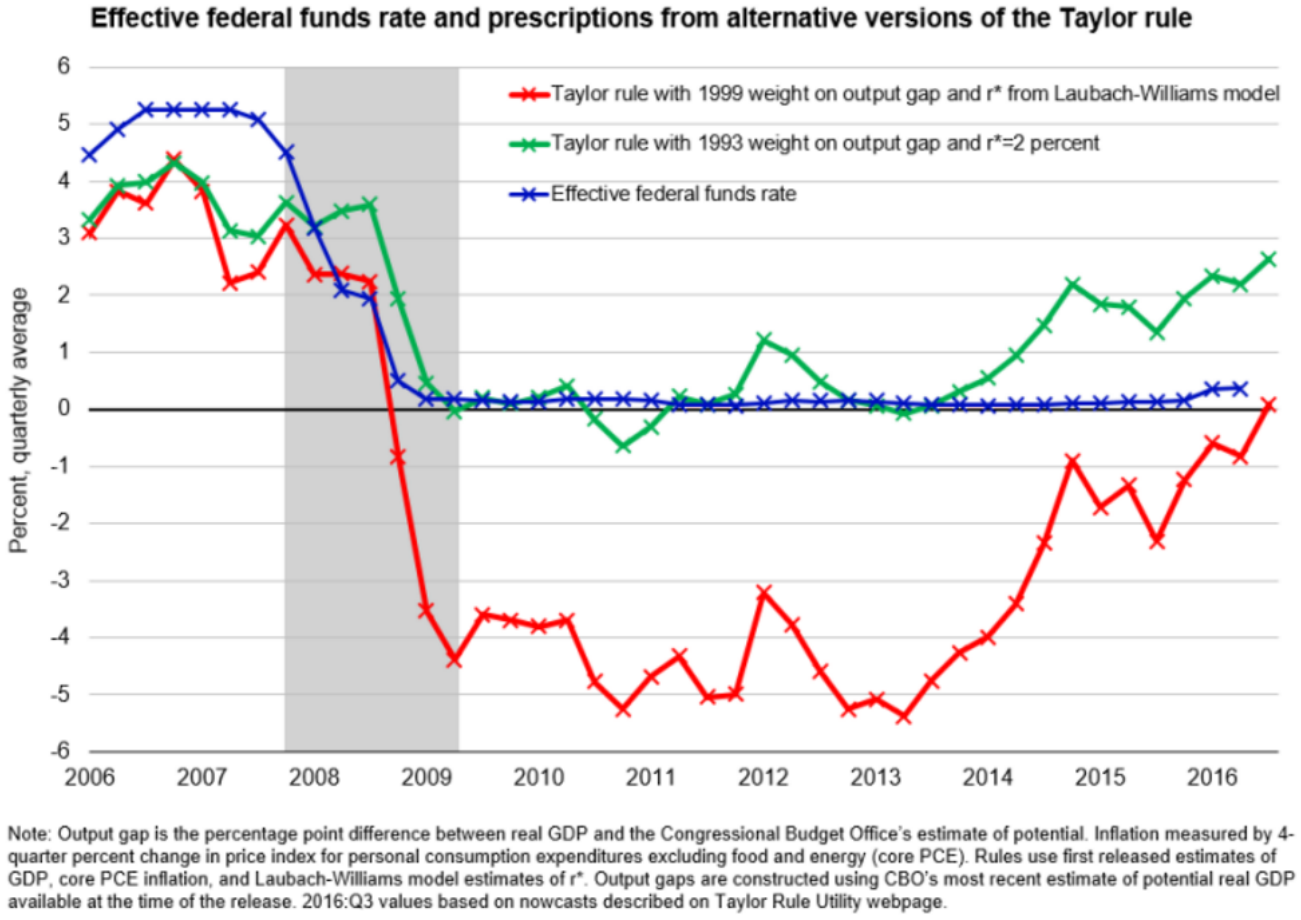
random walk: can't even guess which direction time moves





long-run return reversals

return reversals ... may be quite consistent with [market efficiency] since they could result, in part, from the volatility of interest rates and the tendency of interest rates to be mean reverting (Malkiel, 2003)



source: Wikipedia

how large are financial transaction costs?

asset class	comments	bps
equities	US large cap	3
(broker commission)	US small cap	8
	EU large cap	5
	EU small cap	6
	emerging	8
bonds	AAA government	4–6
(spreads)	EU investment grade	15–30
	EU high yield	50–90
	emerging	100+
listed equity derivatives	(broker commission)	'a few'
sports, forwards, swaps, futures	(exchange & settlement)	'a few'

Table 3 (Novarca International Ltd., 2014)

$\downarrow$ transactions costs $\Rightarrow\uparrow$ information incorporated $\Rightarrow\uparrow$ efficient markets

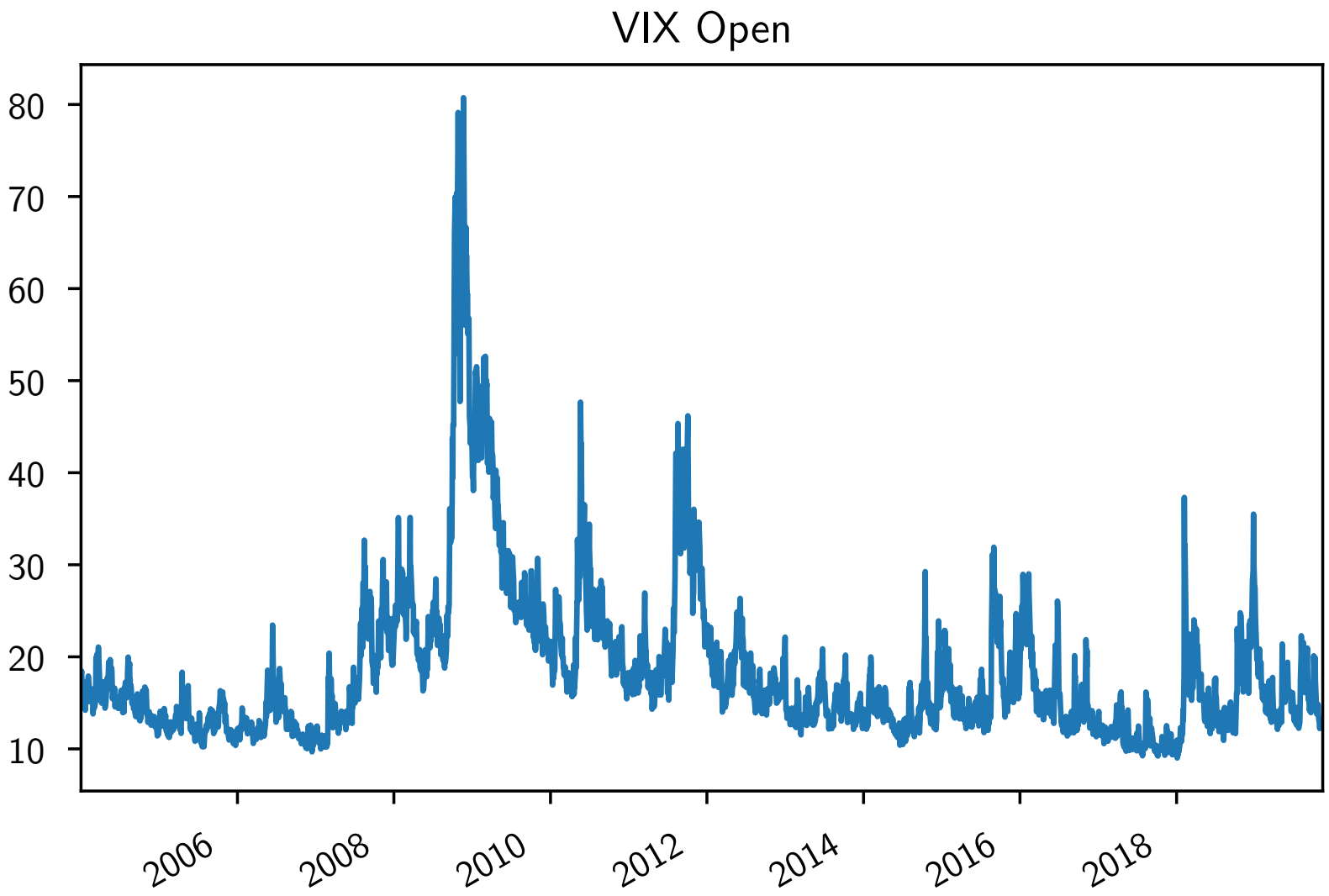
Superinvestors of Graham-and-Doddsville (Buffett, 1984)?

if 225 million orangutans had engaged in a similar exercise, the results would be ... 215 egotistical orangutans with 20 straight winning flips. ... if ... you found that 40 came from a particular zoo in Omaha, you would be pretty sure you were on to something ...
[Schloss] knows how to identify securities that sell at considerably less than their value ... And that's all he does. *(Buffett, 1984)*

In the old days any well-trained security analyst could do a good professional job of selecting undervalued issues ... but in the light of the enormous amount of research now being carried on, I doubt whether in most cases such extensive efforts will generate sufficiently superior selections ... To that very limited extent I'm on the side of the "efficient market" school of thought (Graham, 1976)

Berkshire realized an average annual return of 18.6% in excess of the US T-bill rate, significantly outperforming the general stock market's average excess return of 7.5%. Berkshire Hathaway stock also entailed more risk than the market; it realized a volatility of 23.5%, higher than the market volatility of 15.3%. (Frazzini, Kabiller, and Pedersen, 2018)

The Fear Index: trading on variance?



Can you see a pattern? source: CBOE

Shiller's excess volatility calculation

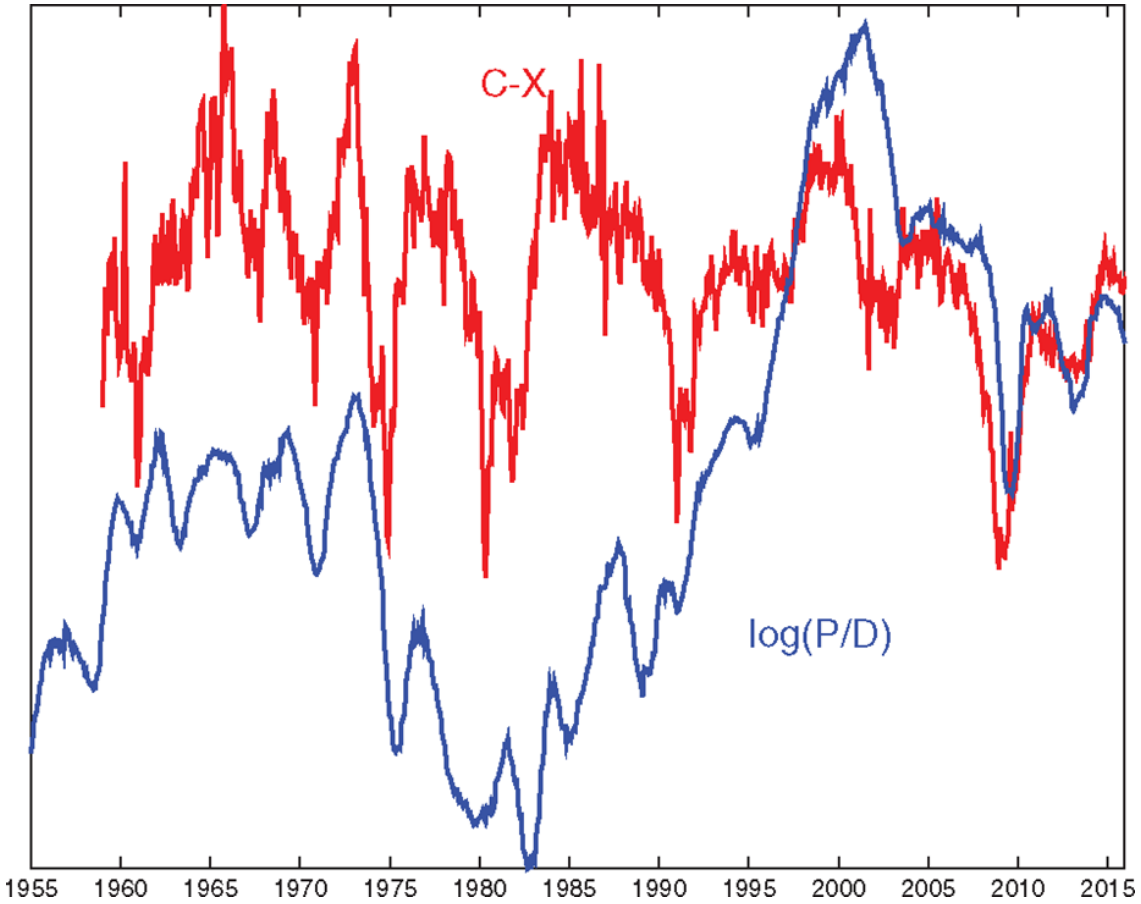
- EMH: $p_t = E_t\left\{p_t^d\right\}$, where
  - p_t: stock price at time t
  - $E_t\{\}$: expected value given time t information
  - p_t^d: present value of the stock's future dividends, discounted to t
- forecast: $p_t^d = p_t + u_t$, where error u_t is independent of p_t
  - otherwise, information in u_t would help predict p_t^d (bad!)
- to simplify the algebra, let $X = Y + Z$ for independent Y, Z

$$\begin{aligned}
\sigma_X^2 &= E\left\{(X - E\{X\})^2\right\} = E\left\{(Y + Z - E\{Y + Z\})^2\right\} \\
&= E\left\{(Y - E\{Y\} + Z - E\{Z\})^2\right\} \\
&= E\left\{(Y - E\{Y\})^2 + (Z - E\{Z\})^2 + 2(Y - E\{Y\})(Z - E\{Z\})\right\} \\
&= E\left\{(Y - E\{Y\})^2\right\} + E\left\{(Z - E\{Z\})^2\right\} + 2E\{(Y - E\{Y\})(Z - \\
&= \sigma_Y^2 + \sigma_Z^2 + 2E\{(Y - E\{Y\})\}E\{(Z - E\{Z\})\} = \sigma_Y^2 + \sigma_Z^2 \geq \sigma_Y^2
\end{aligned}$$

(why?)

Cochrane (2017): stochastic discount factors

stock values fall at particularly inconvenient times ... The brickbats thrown at modern efficient-market finance for being unable to accommodate the financial crisis are simply false.

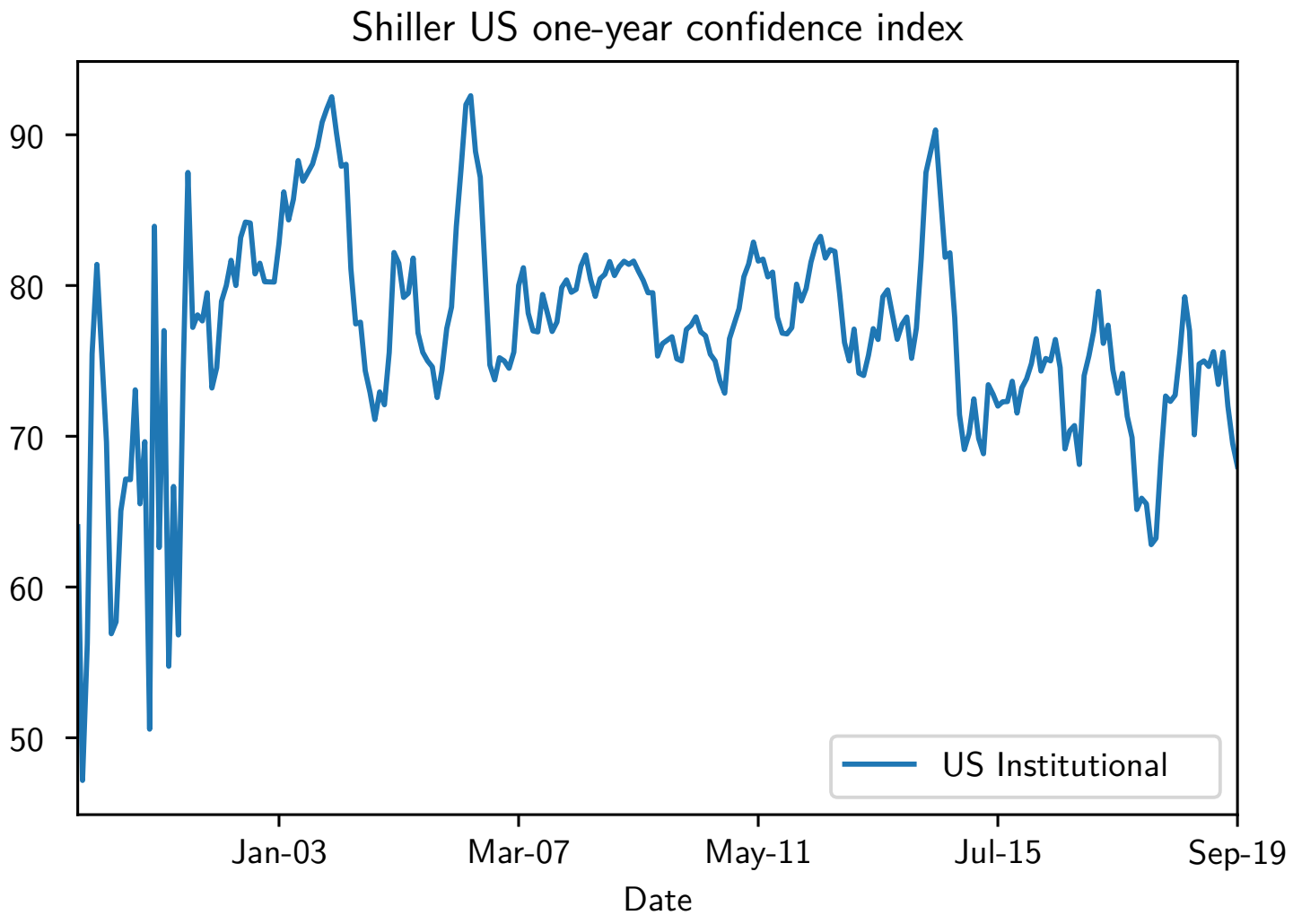


Price-dividend ratio and detrended consumption

feedback models?

source: Kal, The Economist

stock market confidence index



source: Yale International Center for Finance

Outline

Measures of central tendency and outliers

Let $x_1, \ldots, x_n$ be observations. Then:

1. mean / expected value / average ('global' measure): $\frac{1}{n}\sum_{i=1}^{n} x_i$
2. median: re-order the observations so that $x_{(1)} \leq \cdots \leq x_{(n)}$ ('semi-local' measure): $x_{\left(\frac{n}{2}\right)}$

Example

Let $x_1 = 1, x_2 = 2, x_3 = 3, x_4 = 4$, and $x_5 = 5$.
The mean is therefore 3. As the observations are already ordered, the median is $x_{(3)} = x_3 = 3$.
Now let $x_5 = 10$. What happens to the mean and median?

Replication projects

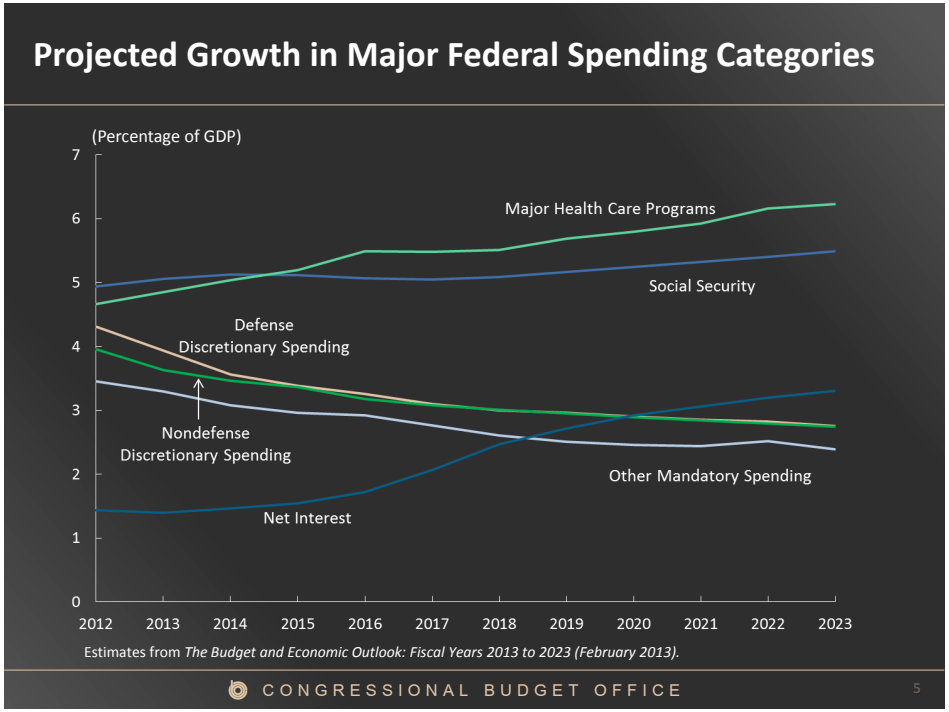
Simulations show that for most study designs and settings, it is more likely for a research claim to be false than true. ...for many current scientific fields, claimed research findings may often be simply accurate measures of the prevailing bias. (Ioannidis, 2005)

- Duvendack, Palmer-Jones, and Reed (2017):
  1. 'HARKing' (hypothesising after results are known)
  2. data-mining/p-hacking until a 'significant' result is found
  3. data error & fraud: "only one economist makes [Retraction Watch's] Top 30 list"
  4. publication bias: editors publishing 'significant' results

  Types of replication studies
  1. "narrow sense": check for errors, computational discrepancies
  2. "wide sense": do the results hold up on other data?

  but other researchers identify up to six different types
- Replication Wiki
- Replication Network
- 'worm wars' arising from Miguel and Kremer (2004)

Hamilton blog: CBO projected federal spending categories



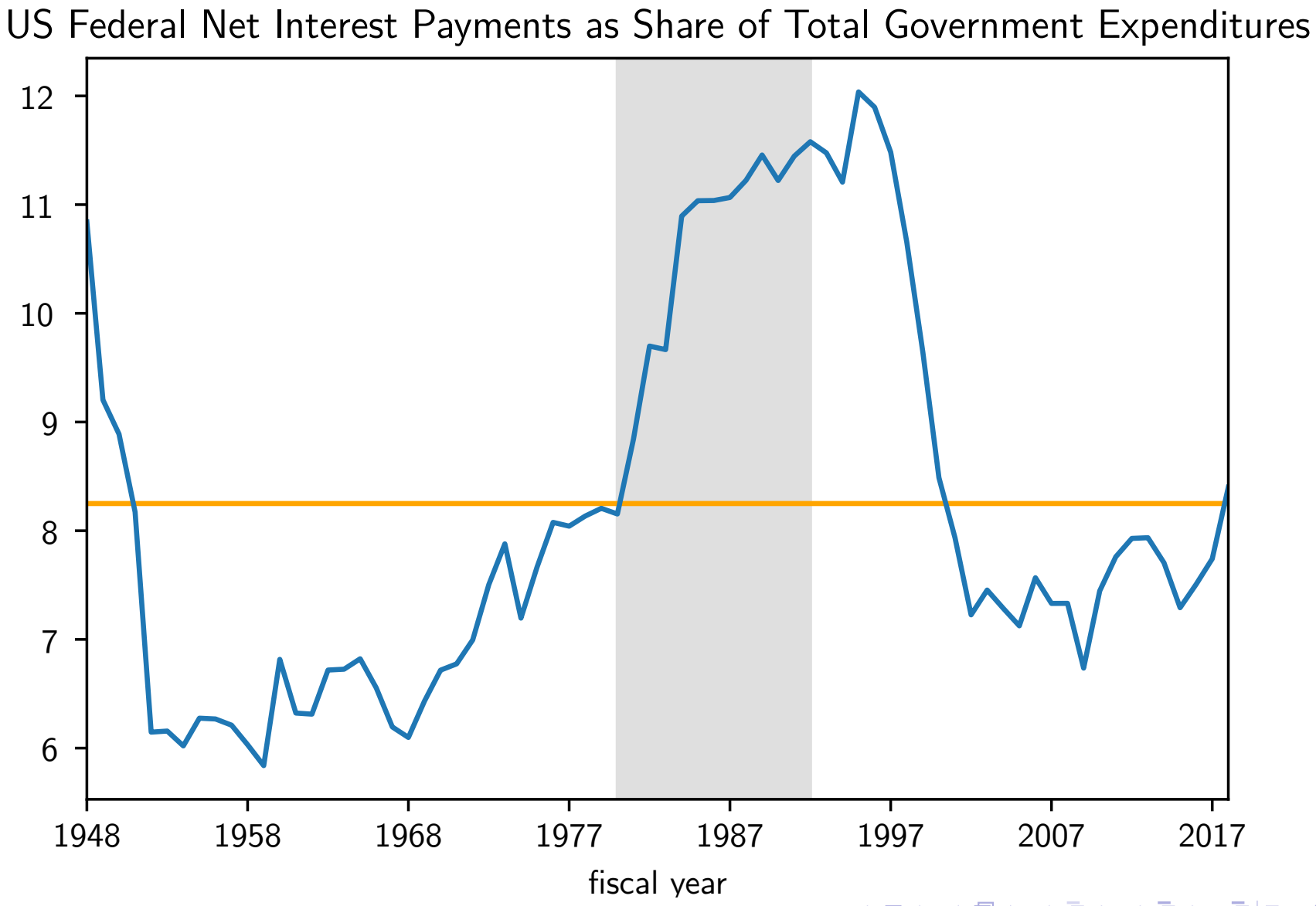
source: CBO (2013)

	2019	2029
Social Security	4.9%	5.9%
Major Health Care	5.3%	6.6%
Other Mandatory	2.6%	2.3%
Defense Discretionary	3.2%	2.8%
Nondefense Discretionary	3.1%	2.8%
Net Interest	1.8%	2.6%

Projected outlays (% GDP)

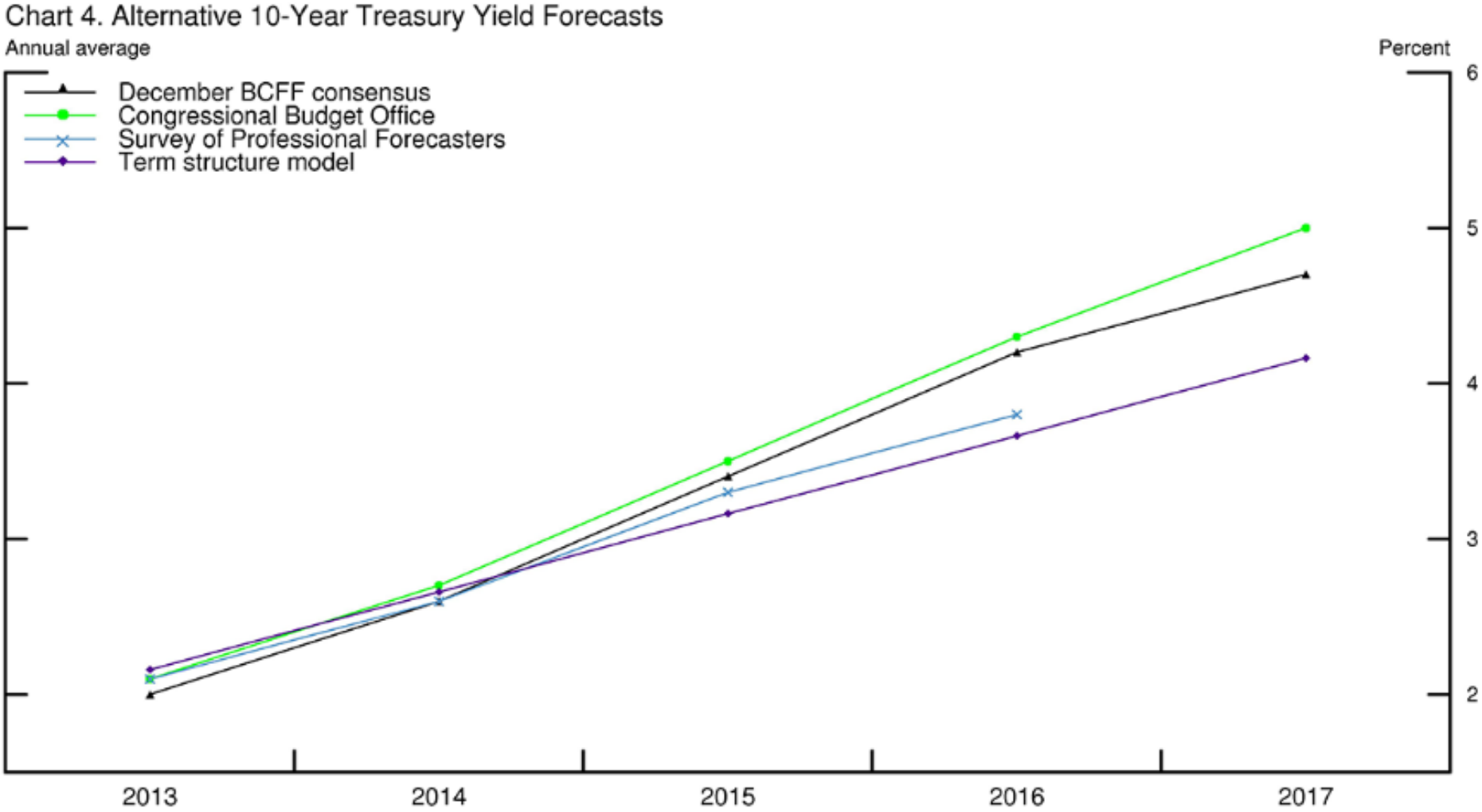
source: CBO (2019)

Pollin & Ash: US interest payments are not high



source: OMB

Hamilton blog: forecast 10-year treasury yields

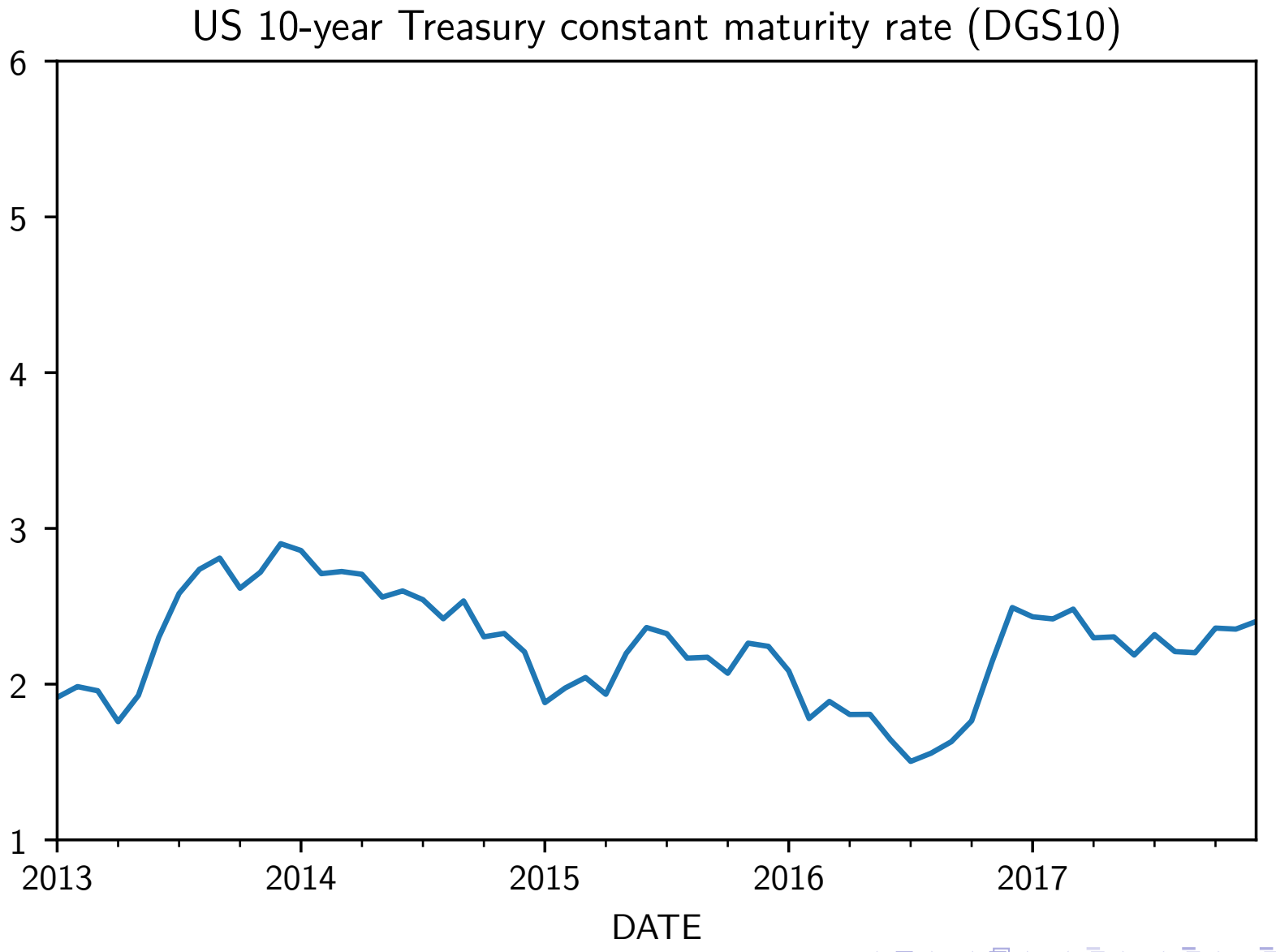


Note: The term structure model forecast assumes that the expected real rate and term premium components of the 10-year nominal yield as shown in chart 2 revert to their respective pre-crisis means over a 5-year period while the expected inflation component remains constant at the level at the end of 2012.

Source: For December BCFF consensus, Blue Chip Financial Forecasts (BCFF) survey, December 2012; for Congressional Budget Office, Congressional Budget Office (2013), *The Budget and Economic Outlook: Fiscal Years 2013 to 2023* (Washington: CBO), February 5; for Survey of Professional Forecasters, Survey of Professional Forecasters for 2013:Q1.

source: Bernanke (2013)

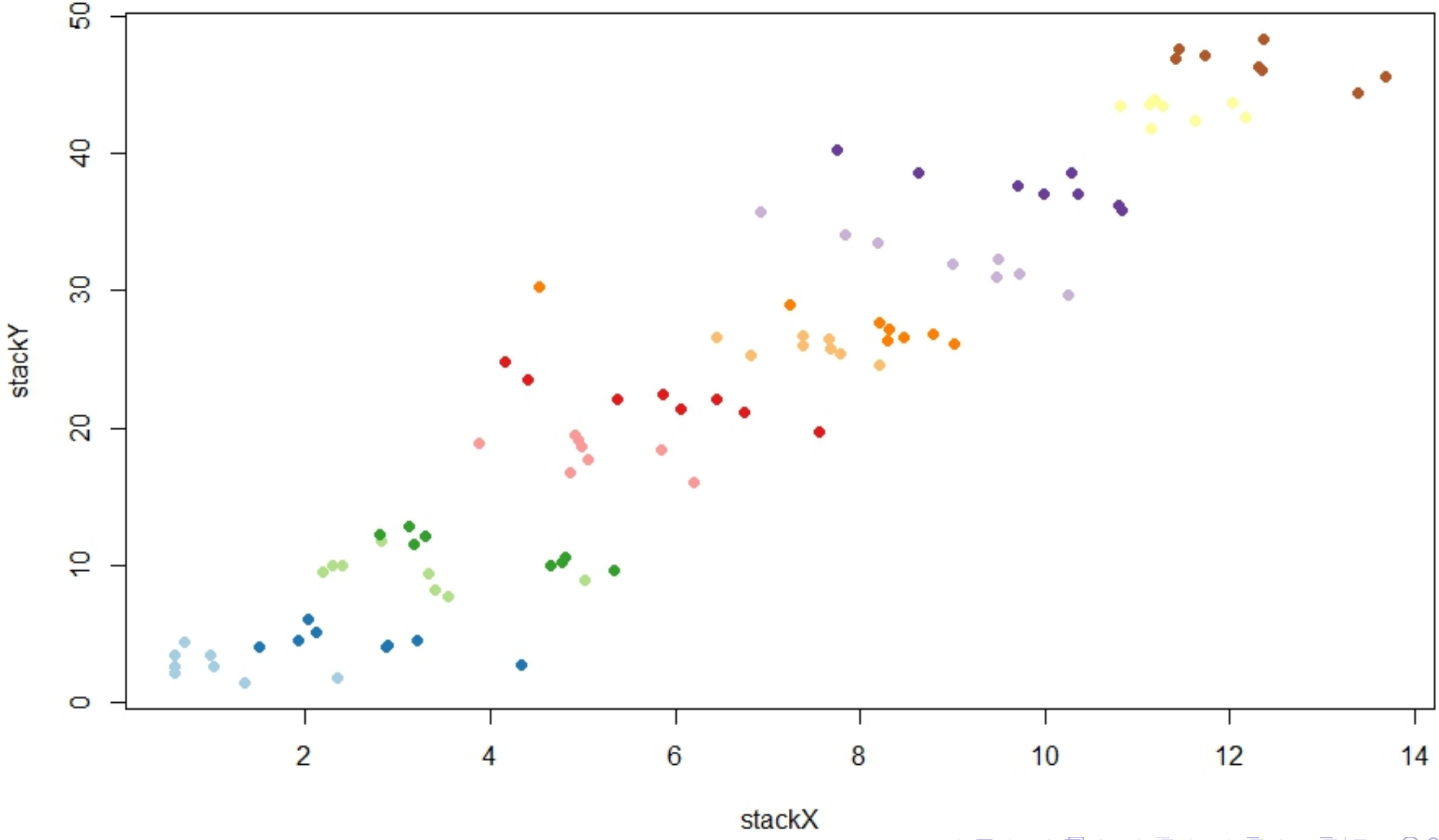
Hamilton blog: actual 10-year treasury yields



source: FRED

Panel data

fixed effects: slopes fixed 'within' random effects: mixes 'within', 'between'

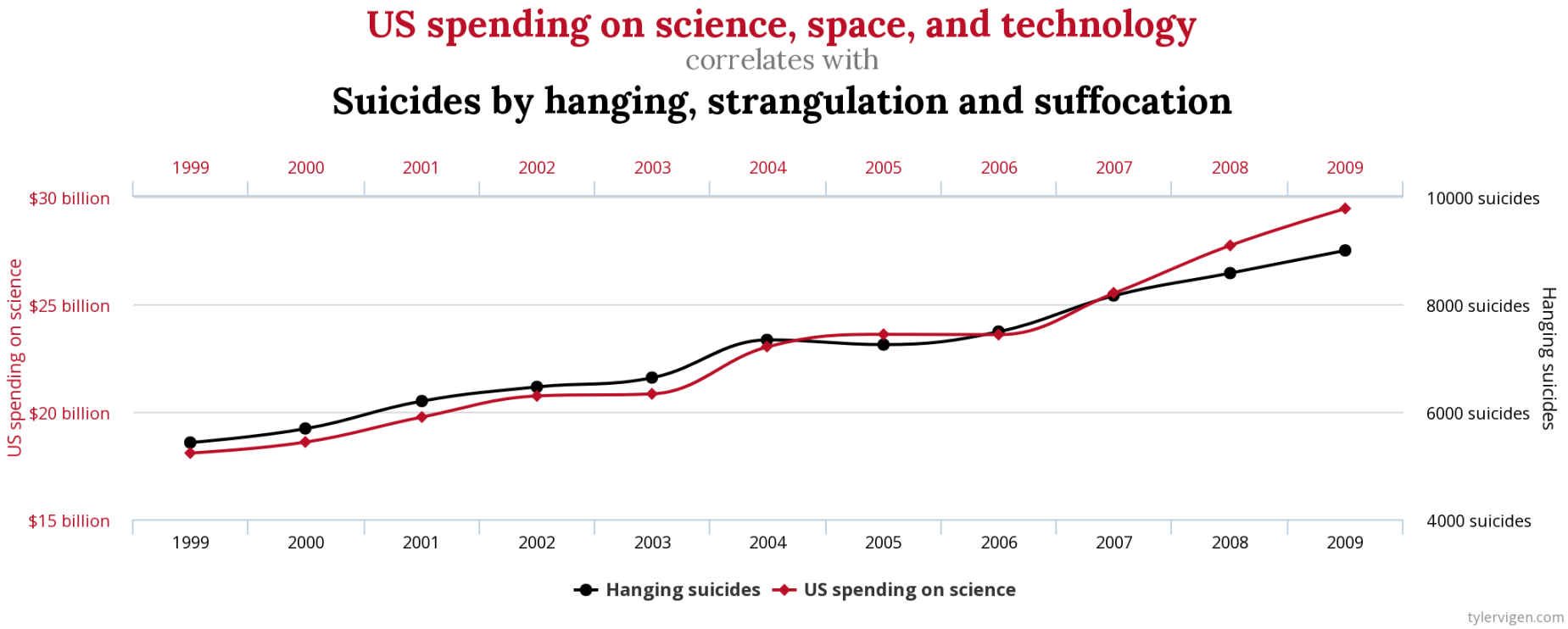


source: Christoph Hanck

Correlation does not imply causality

source: Tyler Vigen

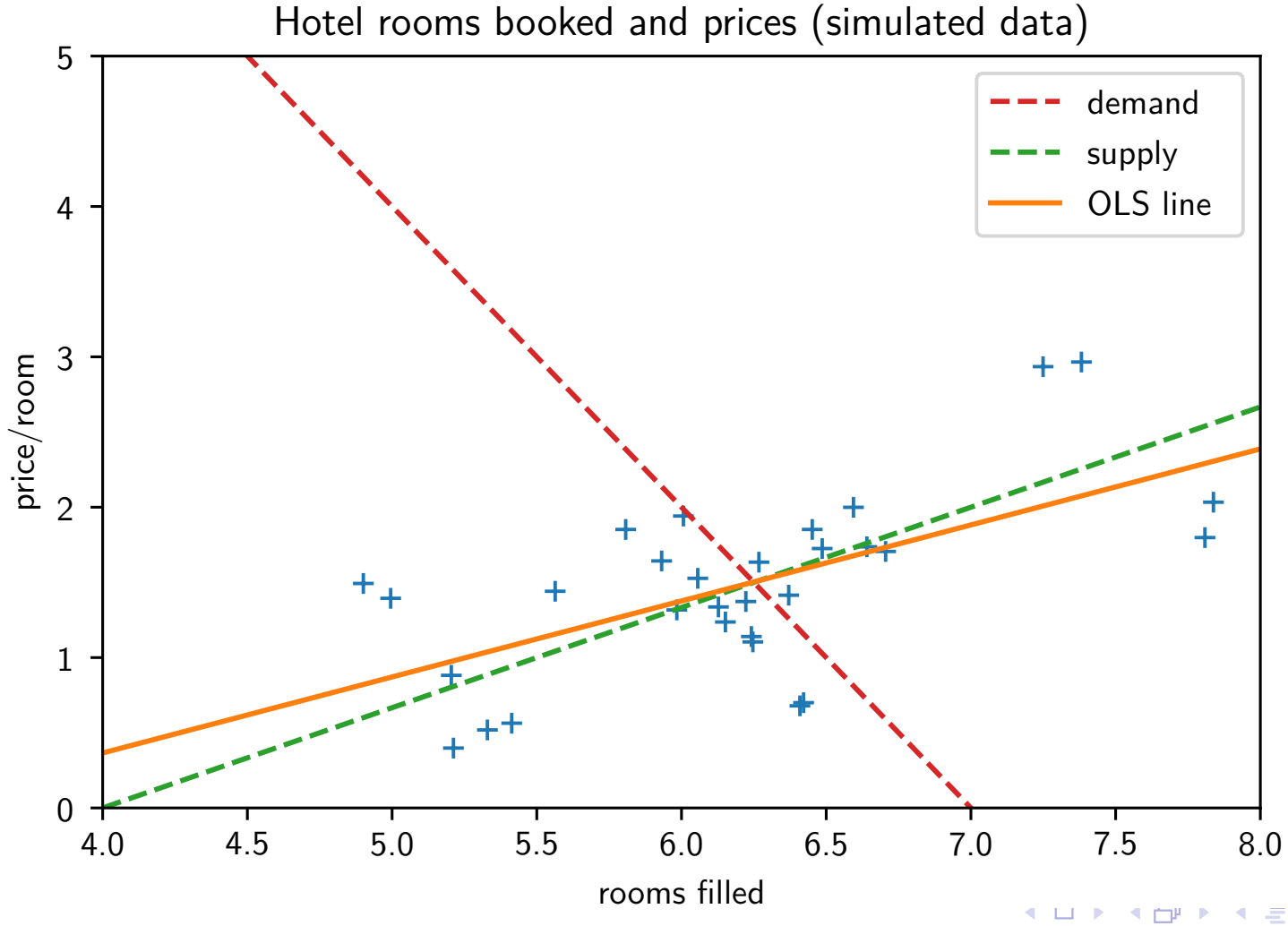
Correlation does not imply causality



source: Tyler Vigen

Misunderstanding causality can lead to big mistakes

- demand: $q_t = 7 - \frac{1}{2}p_t + \varepsilon_{1t}$ (downward sloping)
- supply: $q_t = 4 + \frac{3}{2}p_t + \varepsilon_{2t}$ (upward sloping)



inspiration: Daniel McFadden

Outline

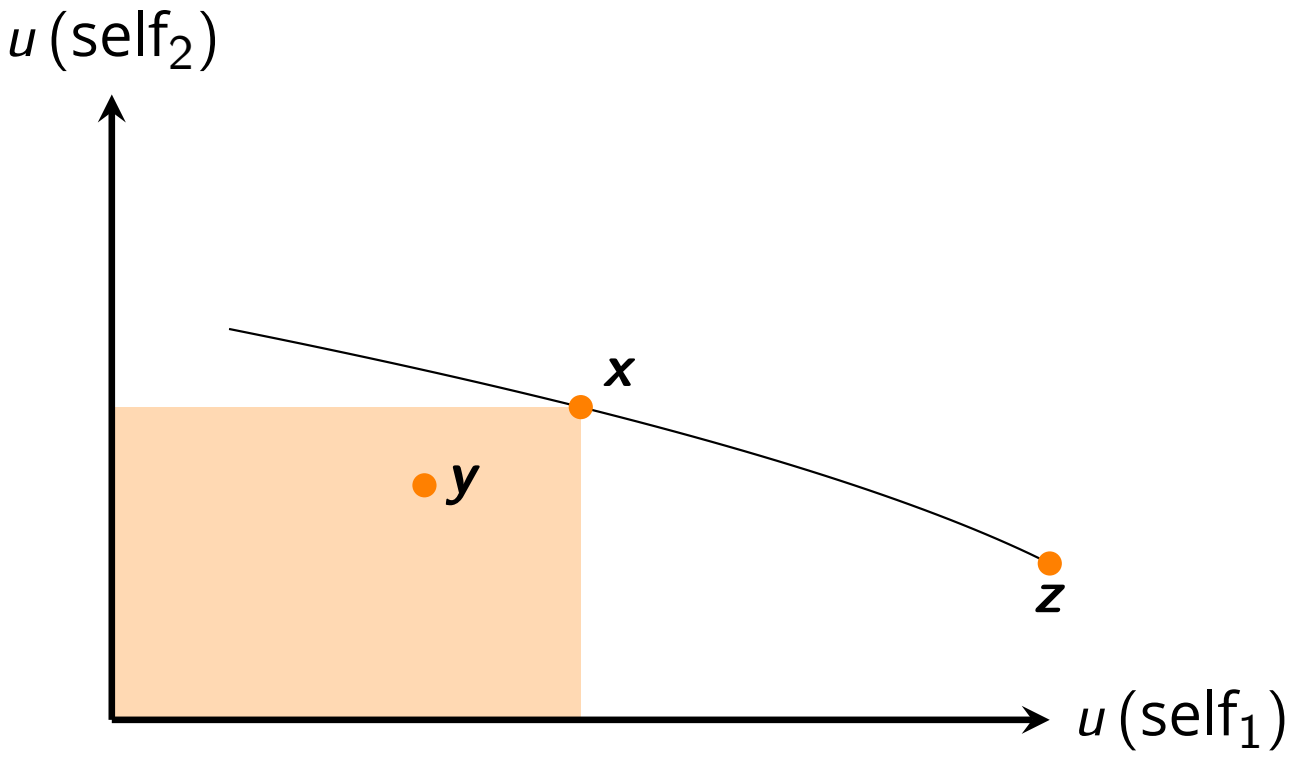
Nudges: a deepening understanding

- UK Behavioural Insights Team
  - long list of successful interventions
  - academic affiliates include Sunstein, Thaler
- more recently, research into distributional effects:

  the nudge … reduc[es] spending by tightwads, who already spend too little, while it entirely fails to reduce the spending of those who would have benefited from a spending reduction … Overall, the nudge therefore might reduce consumer welfare. (Thunström, Gilbert, and Ritten, 2018)

  Investors with mistaken beliefs responded to the nudge, and were more likely to work with mass-market advisors who steer them into high-fee funds. They underperform as a result. By comparison, those who either possess financial literacy or else understand that they do not possess financial literacy were less likely to respond … They avoided advisors, stayed with the low-cost default fund, and therefore accumulated retirement savings more quickly. (Anderson and Robinson, 2018)

the Pareto principle: incomplete rankings



$\boldsymbol{x} \succ \boldsymbol{y}$ but we don't know whether $\boldsymbol{x} \succ \boldsymbol{z}$ or $\boldsymbol{y} \succ \boldsymbol{z}$

Glazer and Rubinstein (1998): a paradox of paternalism?

Experts receive noisy signals about the best public policy. Compare:

1. experts only seek to implement the right public policy $\Rightarrow$ all mechanisms have an equilibrium that doesn't implement the policy target
   Intuition: given three experts, if two opt for one policy, the third will give their two signals more weight than its one signal, and vote with them. In equilibrium, they could all vote for a policy other than that corresponding to their signal.
2. experts also care that their recommendation is accepted $\Rightarrow$ there is a mechanism whose unique equilibrium implements the policy target
   Intuition: the mechanism allows some expert votes to be ignored; an expert expecting to be ignored still cares that their recommendation is the one adopted, so votes honestly

Introspection: frustration when friends are 'polite', trying to reach consensus rather than stating their preferences

When is libertarian paternalism plain ol' paternalism?

1. "Obesity is a nationwide problem, and ... public health officials are wringing their hands saying, 'Oh, this is terrible,' ... New York City is not about wringing your hands; it's about doing something ... I think that's what the public wants the mayor to do" (Mayor of New York, 31/05/12)

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4. "If I let him have his way every time my son acted like that … things might be OK between us in the short term. But if I indulge his wayward behaviour, he might regret it when he grows up." (Chief Executive, Hong Kong SAR, 12/06/19)

Sugden's elephant: privileging the "acting self"?

> *it is usually sensible ... to privilege our acting selves Sugden (2008)*

> *this modelling strategy ... allows us to represent cases in which an individual's preferences vary with exogenous changes in her perception ... but not ones in which that perception can be deliberately influenced by other economic agents in pursuit of their own objectives*

Shoshana Zuboff on 'surveillance capitalism':

> *the most predictive behavioural data comes from ... systems [that] are designed to ... actually modify behaviour, shaping it toward desired commercial outcomes (Naughton, The Observer, 20/01/19)*

1. Kramer, Guillory, and Hancock (2014): "We show, via a massive ($N = 689,003$) experiment on Facebook, that emotional states can be transferred to others ... leading people to experience the same emotions without their awareness"
2. Pokémon Go

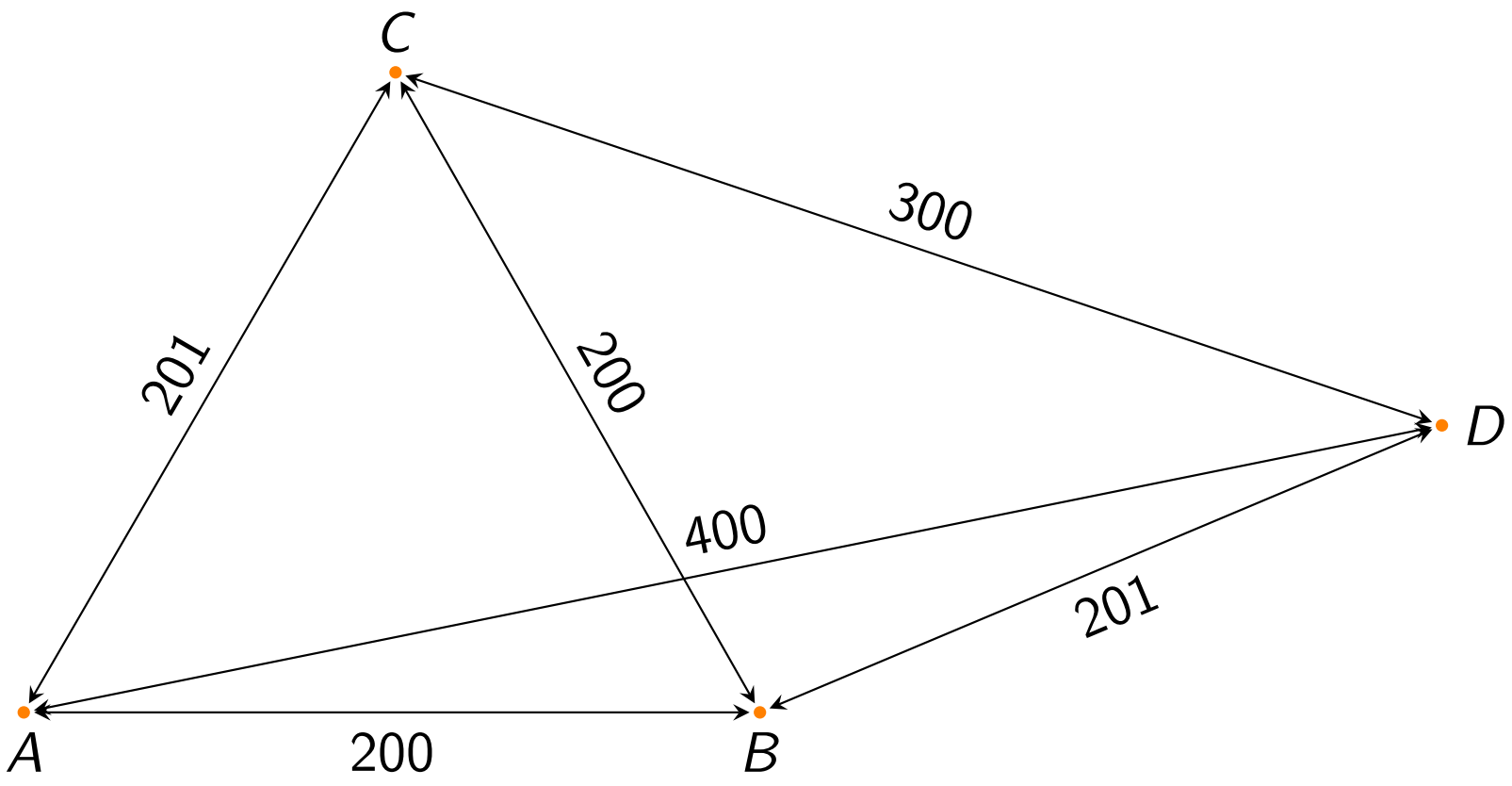
Gentzkow and Shapiro (2010): an example from the media

A firm's room to manoeuvre is the degree to which it can pursue non-profit-maximising strategies without being taken over or going bankrupt (Sugden, 2008)

We construct a new index of media slant that measures the similarity of a news outlet's language to that of a congressional Republican or Democrat. ... We find that readers have an economically significant preference for like-minded news. Firms respond strongly to consumer preferences, which account for roughly 20 percent of the variation in measured slant in our sample. By contrast, the identity of a newspaper's owner explains far less of the variation in slant. (Gentzkow and Shapiro, 2010)

How good are 'rules of thumb'?

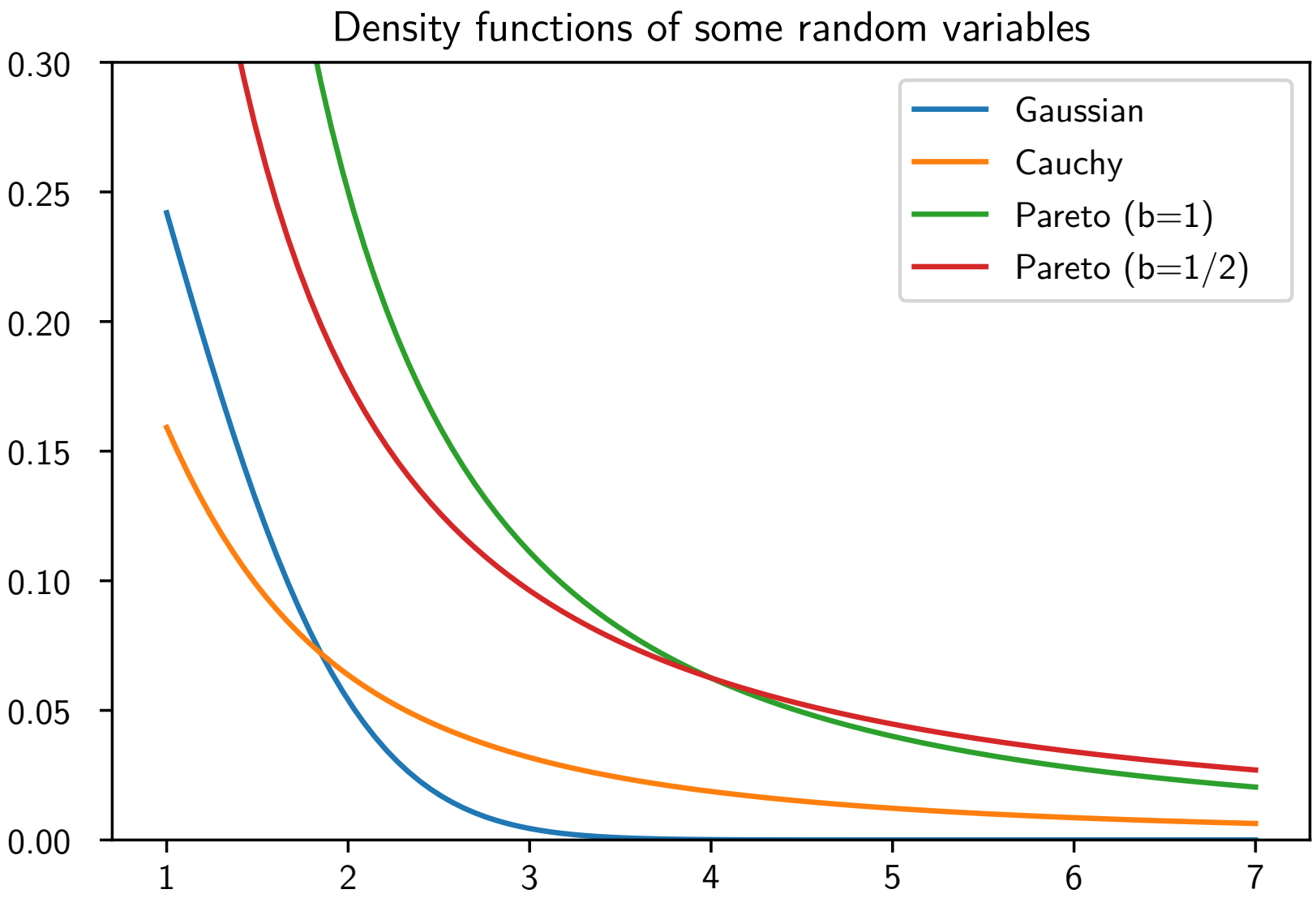
A salesperson, starting at A, seeks the shortest route that visits every city and returns to A. Rule of thumb: travel to the closest unvisited city.



source: Gutin and Yeo (2007) via Rahul (word of the day: anti-matroid)

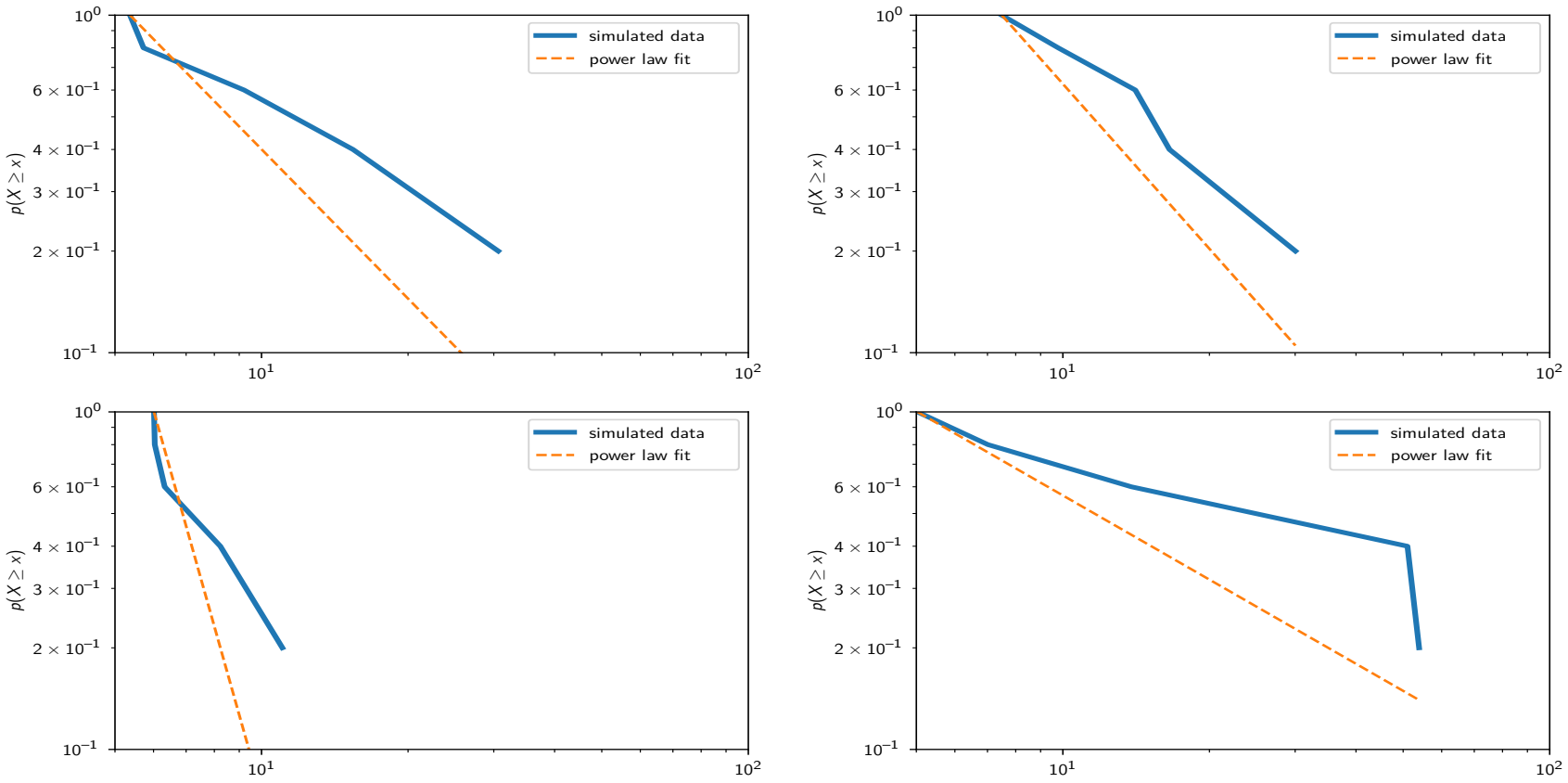
Outline

Tails: fat and thin



Fitting tails: $n = 5$ from the same Pareto distribution

any curve-fitting exercise attempting to attribute probabilities to $S \geq 4.5\,^{\circ}\mathrm{C}$ … is little more than conjectural speculation. … critical results can depend on seemingly casual decisions about how to model tail probabilities (Weitzman, 2011)



Fat tails: a technical problem

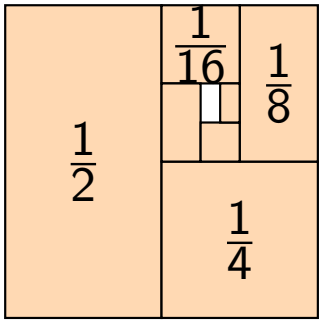
There is a race being run in the extreme tail between how rapidly probabilities are declining and how rapidly damages are increasing (Weitzman, 2011)

- recall: mean/average/expected value is probability weighted average

$$E\{x\} = \sum_i p(x_i) \cdot x_i$$

where x_i are the possible values, and $p(x_i)$ the probabilities

- St Petersburg Paradox: toss a fair coin for an initial stake of £2
  1. if tails, win the stake and end the game;
  2. if heads, double the stake and toss a fair coin for the new stake ...



$$\begin{aligned} E\{x\} &= \frac{1}{2} \times 2 + \frac{1}{4} \times 4 + \cdots + \frac{1}{2^k} \times 2^k + \cdots \\ &= 1 + 1 + 1 + 1 + \cdots \end{aligned}$$

Are there alternatives to cost-benefit analysis?

1. scenario planning (Wilkinson and Kupers (2013) on Shell)
   1. "Make It Plausible, Not Probable"
   2. "Strike a Balance Between Relevant and Challenging [the 'official' future]"
   3. "Tell Stories That Are Memorable Yet Disposable"
   4. "Add Numbers to Narrative"
   5. "Scenarios Open Doors ... [to] exchange of perspectives and insights"
   6. "Manage Disagreement as an Asset" [to consider the unexpected]
   7. "Fit into a Broader Strategic Management System"
2. Delphi method: a facilitator iterates with anonymous experts
3. prediction markets (Wolfers and Zitzewitz, 2004)
4. case-based decision theory: how close is this to previous situations we've seen (Gilboa and Schmeidler, 1995)?

CRRA, elasticities of substitution, additive welfare

A standard CRRA utility function is $\frac{c^{1-\gamma}}{1-\gamma}$. Weitzman sets $\gamma = 2$ and welfare additive in temperature change, t:

$$U(c,t) = -\frac{1}{c} - t^2 = -c^{-1} - t^2.$$

The elasticity of substitution is (h/t Stan Shunpike via Pigou (1934))

$$\sigma = \frac{\frac{d(t/c)}{t/c}}{\frac{d(U_c/U_t)}{U_c/U_t}};$$

where U_c and U_t are partial derivatives w.r.t. c and t, so that:

$$U_c = c^{-2}, U_t = -2t, d(U_c/U_t) = \frac{1}{2c^2 t}\left(\frac{2dc}{c} + \frac{dt}{t}\right).$$

The differential $dU = 0$ yields $\frac{dt}{dc} = \left(2c^2 t\right)^{-1}$. Put the pieces together for

$$\sigma = \frac{2ct^2 - 1}{4ct^2 - 1} \approx \frac{1}{2}$$

Bayesian updating: an intuition

- prior: the probability of a climate disaster, $d = 1$, is p
  - thus, the probability of a climate non-disaster, $d = 0$, is $1 - p$
- research gives us a noisy signal, s:

$$P(s = 1 \,|\, d = 1) = P(s = 0 \,|\, d = 0) = q > \frac{1}{2}$$

- Bayes' rule: $P(A \,|\, B) = \frac{P(B|A)P(A)}{P(B)}$ for events A, B
- use Bayes' rule to calculate the posterior

$$P(d = 1 \,|\, s = 1) = \frac{P(s = 1 \,|\, d = 1)\, P(d = 1)}{P(s = 1)}$$

where
$P(s = 1) = P(s = 1 \,|\, d = 1)\, P(d = 1) + P(s = 1 \,|\, d = 0)\, P(d = 0)$
so that

$$P(d = 1 \,|\, s = 1) = \frac{pq}{pq + (1 - p)(1 - q)}$$

- is the posterior larger/smaller than the prior, $P(d = 1 \,|\, s = 1) \gtrless p$?

VSL: valuing statistical lives

> *the monetary premium ΔM a person would be willing to pay to avoid exposure to a tiny increased probability of death, Δq (Weitzman, 2011)*

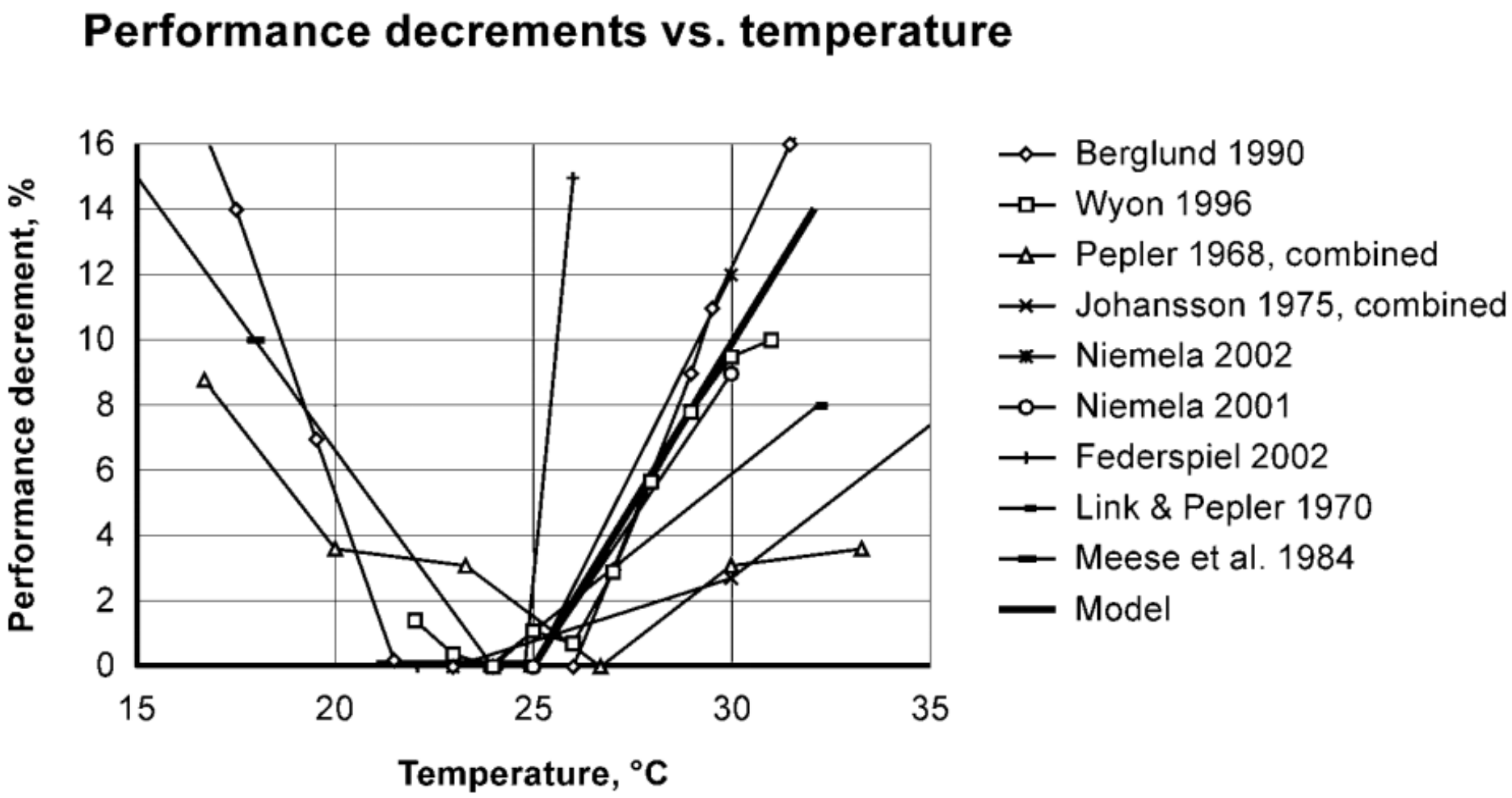
How do we estimate this (Viscusi, 2012)?

1. behaviour (revealed preference): "compensation workers receive for fatality risks, price cuts consumers receive for houses in dangerous or polluted neighborhoods, and price premiums commanded by safer used automobiles"
2. surveys (stated preference): willingness to accept (WTA) for increase $\neq$ willingness to pay (WTP) to decrease

Paradox: revealed preference VSL often higher stated preference VSL

Quality-adjusted life year (QALY): years $\times$ health $\in [0, 1]$; evaluate medical interventions

How does heat affect our productivity?



source: Seppanen, Fisk, and Faulkner (2004), Figure 1

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