# Confronting Uncertainty

## in a Changing Environment

Lars Peter Hansen
University of Chicago
February 10, 2016
50 Years of CORE

# Probability and Games of Chance

**Blaise Pascal** (above)
(1654)

# Probability meets Social Science

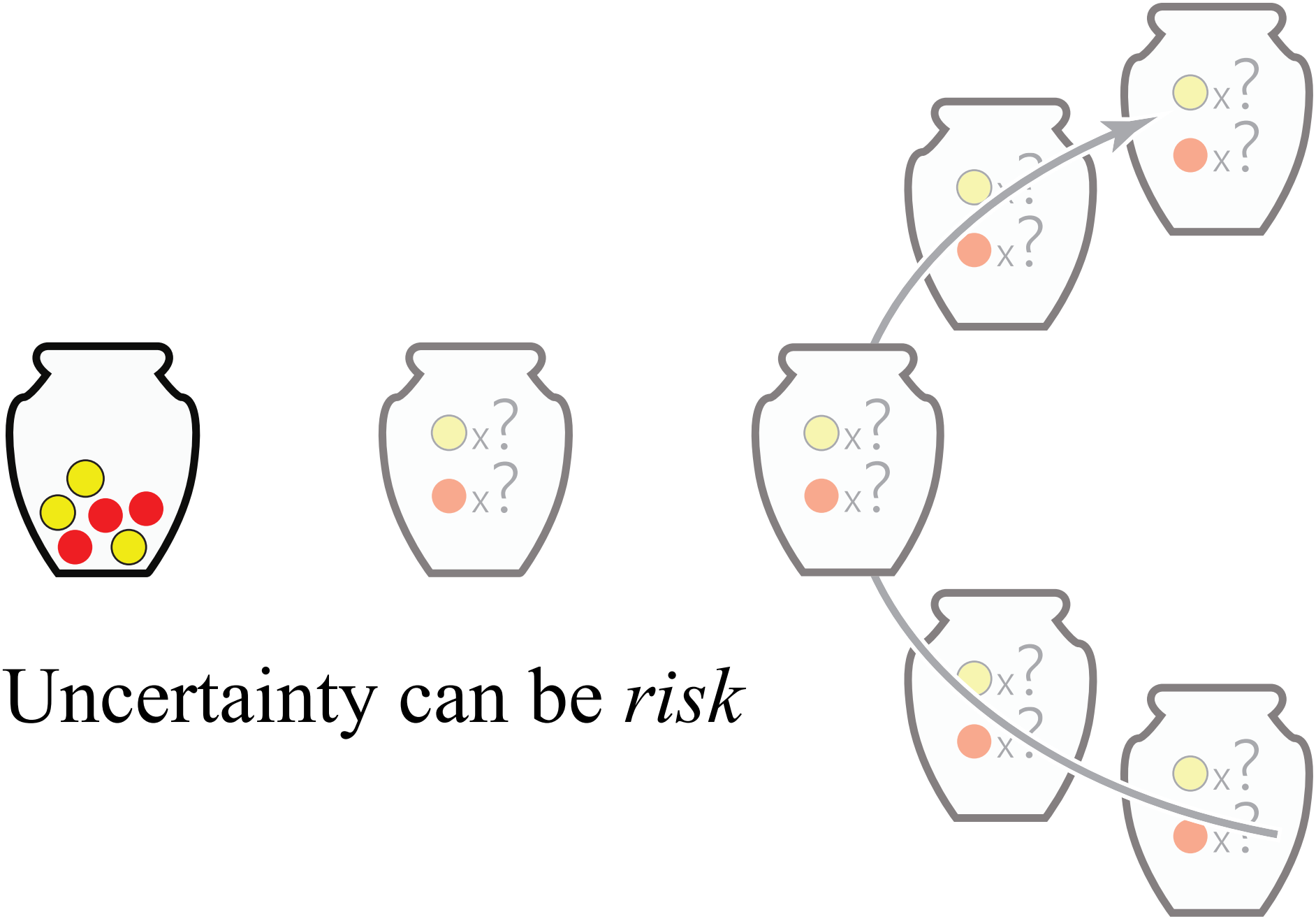
**Jacob Bernoulli** (left)

*Law of Large Numbers*: how unknown probabilities are revealed (1713)

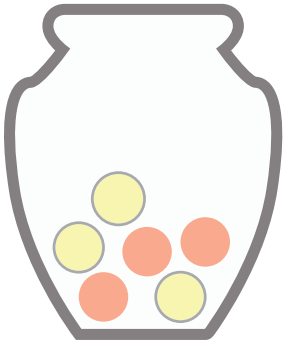
# Uncertainty in Economic Analysis

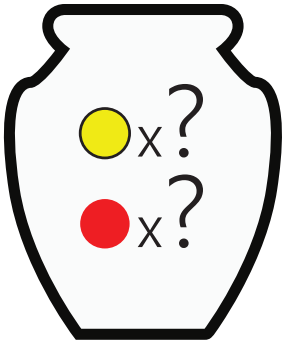
- *Outside a model*
  *Given* a dynamic economic model, researchers:
  - ▷ estimate unknown parameters
  - ▷ assess model implications

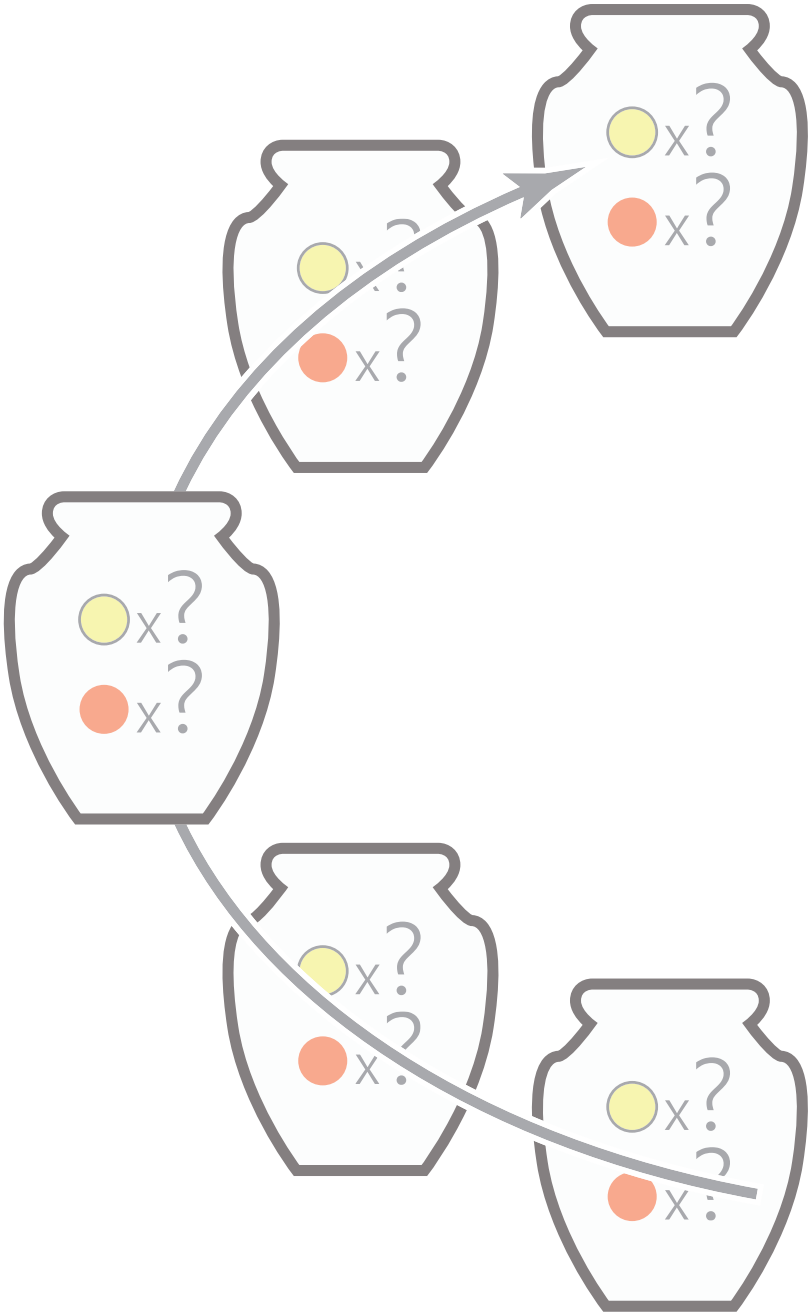
- *Inside a model*
  When *constructing* a dynamic economic model, researchers:
  - ▷ depict economic actors (consumers, enterprises) as they cope with uncertainty
  - ▷ deduce the consequences for market outcomes and resource allocations



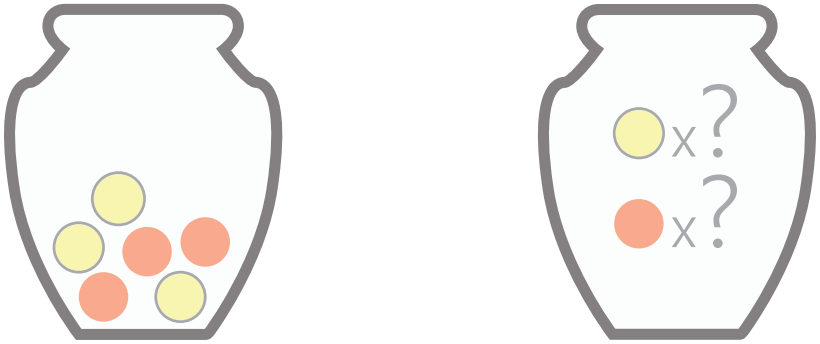
Uncertainty can be *risk*

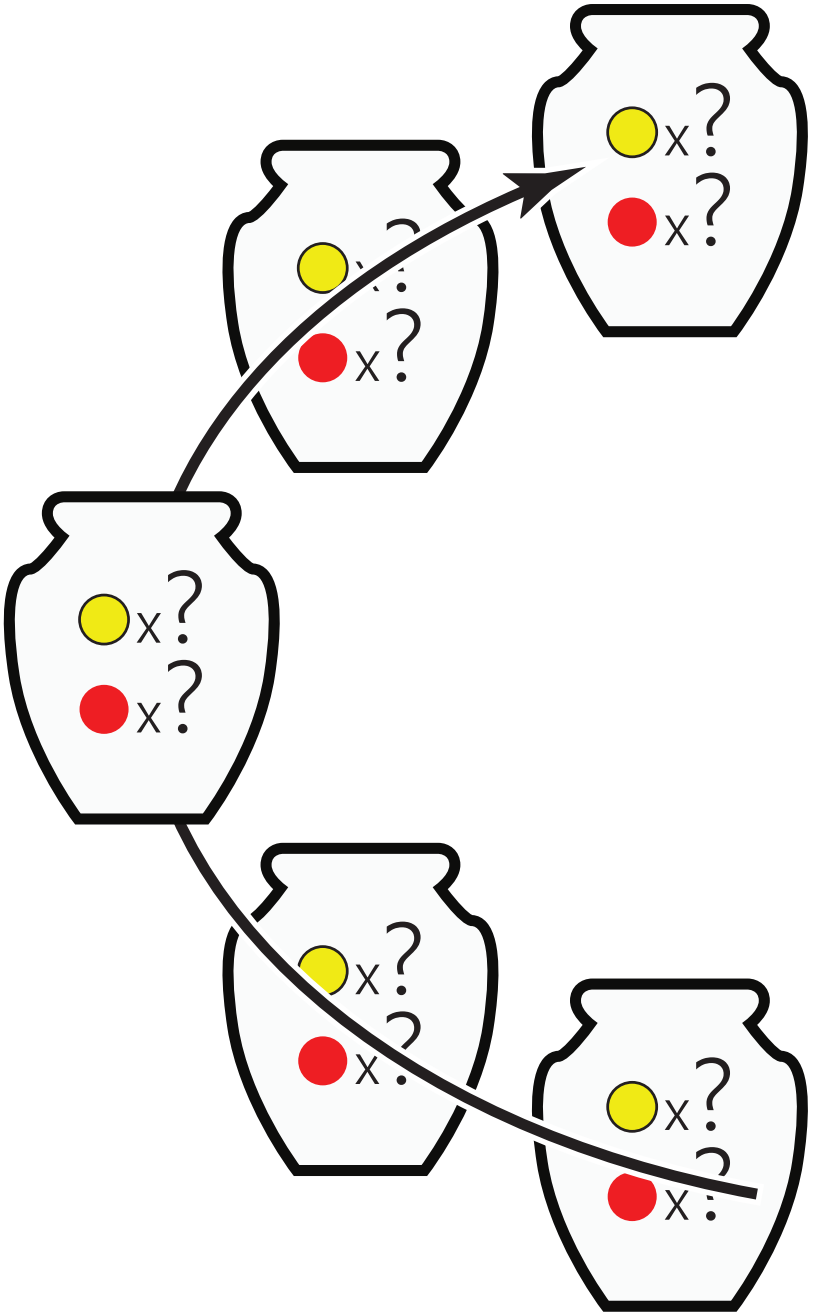





Uncertainty can be *ambiguity*




Uncertainty can even *change over time*

# Multiple Components to Uncertainty

- Model *risk* - what probabilities does a model assign to events in the future?

# Multiple Components to Uncertainty

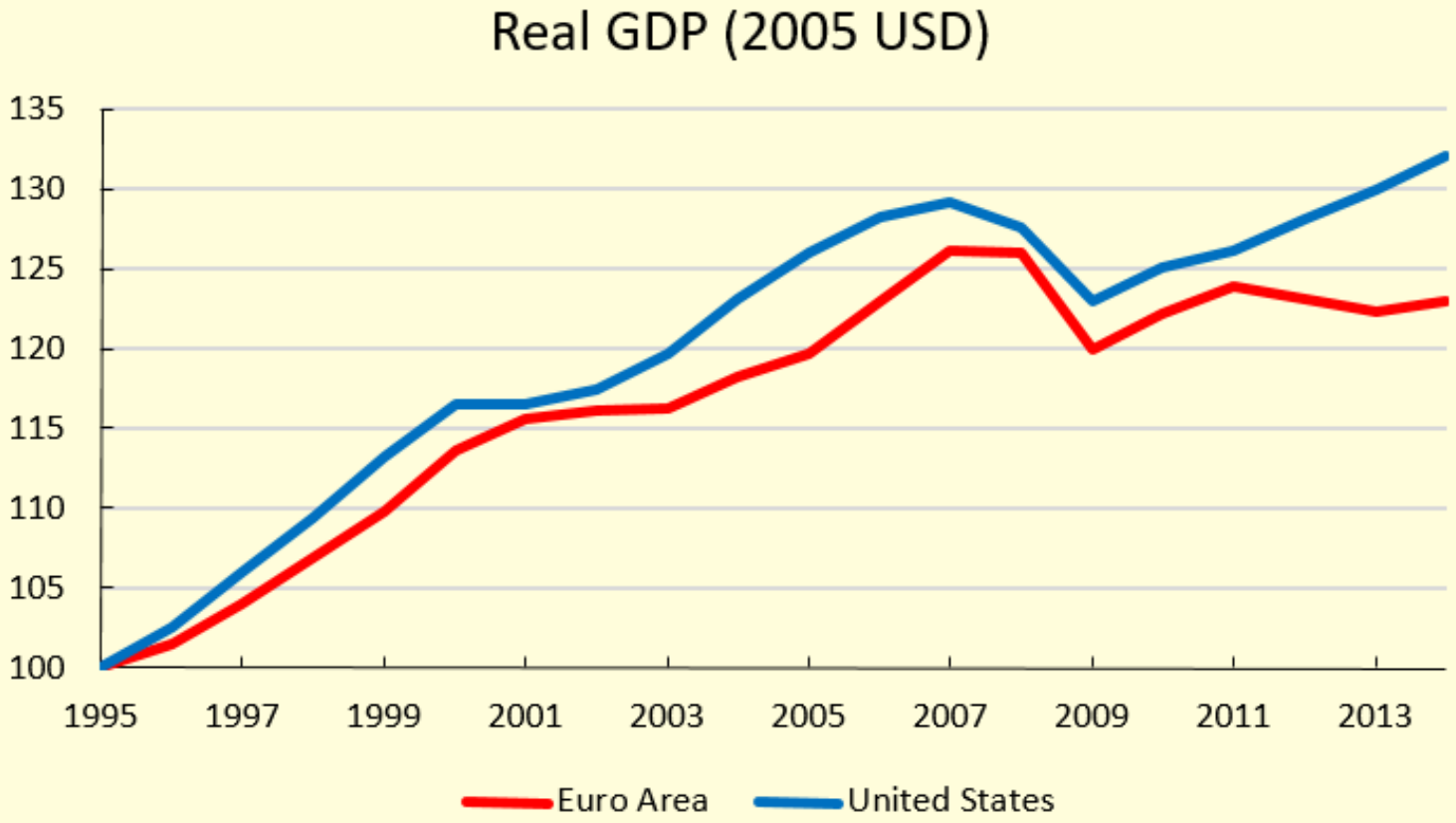
- Model *risk* - what probabilities does a model assign to events in the future?
- Model *ambiguity* - how much confidence do we place in each model?

# Multiple Components to Uncertainty

- Model *risk* - what probabilities does a model assign to events in the future?
- Model *ambiguity* - how much confidence do we place in each model?
- Model *misspecification* - how do we use models that are not perfect?

# Uncertainty and Skepticism

# Evidence from Macroeconomic Data




Source: World Bank

# Secular Stagnation?

Joel Mokyr

"There are a myriad of reasons why the future should bring more technological progress than ever before – perhaps the most important being that technological innovation itself creates questions and problems that need to be fixed through further technological progress." (2013)

Robert Gordon

"…the rise and fall of growth are inevitable when we recognize that progress occurs more rapidly in some time periods than others…The 1870-1970 century was unique: Many of these inventions could only happen once, and others reached natural limits." (2016)

# Evidence from Financial Market Data

Private sector observation: Risk-On Risk-Off

- Investors' appetites for risk rise and fall over time

Academic research: Time-varying expected returns

- Measured risk-return tradeoffs from financial markets fluctuate over time
- "Risk-prices" are bigger in magnitude sometimes than others

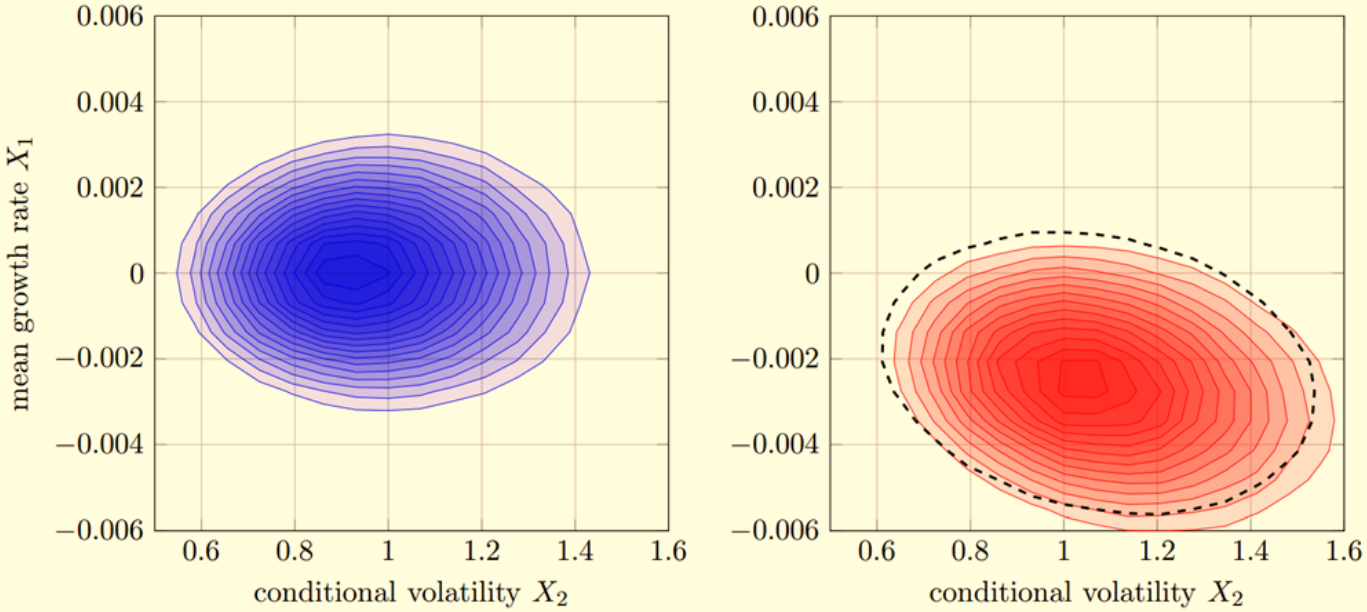
What explains these movements?

# Market Adjustments for Long-term Uncertainty

Use a structural model and empirical evidence to extract "prices" of exposure to long-term uncertainty

- Asset pricing evidence suggest that long-term "risk adjustments" are prominent in asset prices (Alvarez and Jermann)
- Depict Investor preferences using recursive utility specification with a concern for the intertemporal composition of risk (Epstein and Zin and Bansal and Yaron)
- Reinterpret findings by expressing investor concerns about model misspecification (Hansen and Sargent)
- Represent long-term uncertainty prices using a long-term risk neutral probability measure characterized by (Hansen and Schienkman)

# Market Adjustments for Long-term Uncertainty




Left-hand side (blue) are the actual probabilities and right-hand side (red) includes market adjustments for long-term uncertainty. Source: Borovicka, Hansen and Scheinkman.

# Pushing Uncertainty to the Forefront of Economic Analysis

- Increase the *exposure to uncertainty*

# Pushing Uncertainty to the Forefront of Economic Analysis

- Increase the *exposure to uncertainty*
- Enhance decision-maker *concerns about uncertainty*

# Pushing Uncertainty to the Forefront of Economic Analysis

- Increase the *exposure to uncertainty*
- Enhance decision-maker *concerns about uncertainty*
- Impose *frictions* in financial markets and "shocks" to those frictions

The *interplay* among these factors has *important consequences*.

# Placing Uncertain Investors Inside an Economic Model

When *constructing* a dynamic economic model, researchers:

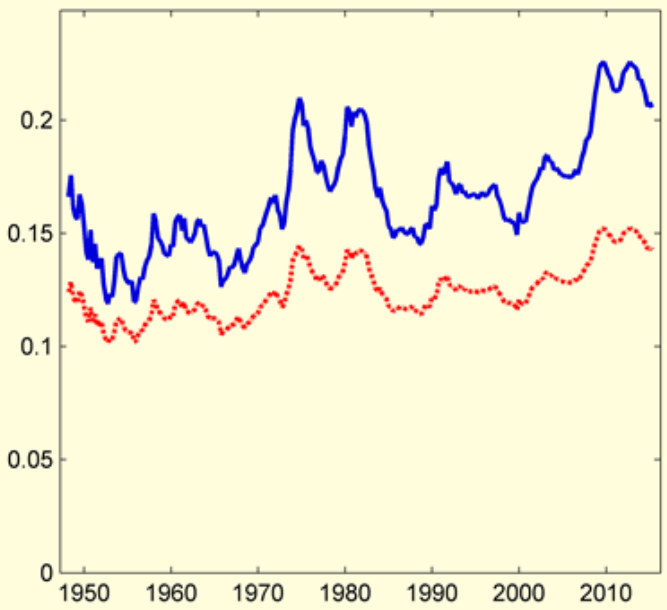
- depict economic actors (consumers, enterprises) as they cope with uncertainty when making economic decisions with future consequences
- deduce the resulting market responses and consequences for resource allocations

# Broadening the Notion of Uncertainty

- Investors struggle with how to perceive the future in a meaningful way
- They approach this struggle with differing degrees of confidence in their beliefs
- The impact of the struggle varies over time as new evidence or perspectives emerge

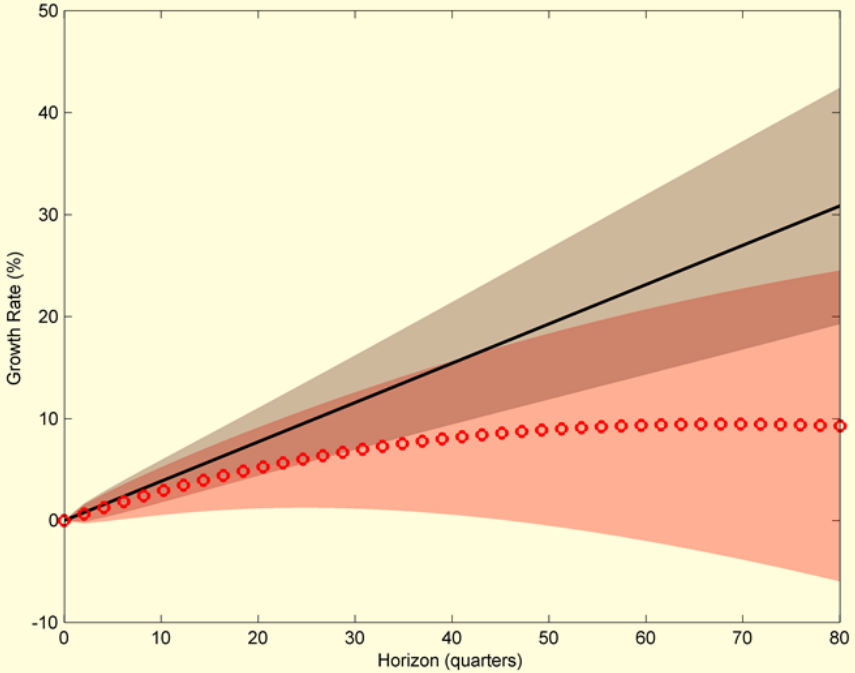
*Outcome:* New sources for fluctuations in *uncertainty prices* emerge in models of financial markets. Concerns about long-term uncertainty influences even short-term pricing.

# Uncertainty Price Time-Series




Uncertainty prices predicted from estimation with aggregate data and inferred without direct use of asset market return data. Source: Hansen and Sargent.

# Investor Perceptions Induced by Caution




Gray gives the benchmark quintiles and red gives uncertainty adjusted quintiles. Source: Hansen and Sargent.

# Friedrich Hayek (1974)

"Even if true scientists should recognize the limits of studying human behaviour, as long as the public has expectations, there will be people who *pretend* or *believe* that they can do more ... than what is really in their power."
(From Hayek's Nobel address)

# Macroeconomic Policy

Milton Friedman

"As Josh Billings wrote many years ago, 'The trouble with most folks isn't so much their ignorance, as knowing so many things that ain't so.' Pertinent as this remark is to economics in general, it is especially so in monetary economics." (1965)

Kenneth Rogoff

"It's wrong to vilify the Fed for hiking, and it's wrong to vilify it for not hiking; if it is such a close call, it probably doesn't matter so much. But, at this critical point, it is fair to ask the Fed for a much clearer message about what its strategy is, and what this implies for the future." (2015)

# Do complicated problems require complicated solutions?

Financial market oversight is arguably a complicated problem

- Acknowledge limits to our understanding of the linkages between financial markets and the macroeconomy.
- Specific models could imply alternative complex solutions.
- "Robust" policies perform well across alternative models.
- Simple robust policies avoid adding uncertainty to the economic environment.

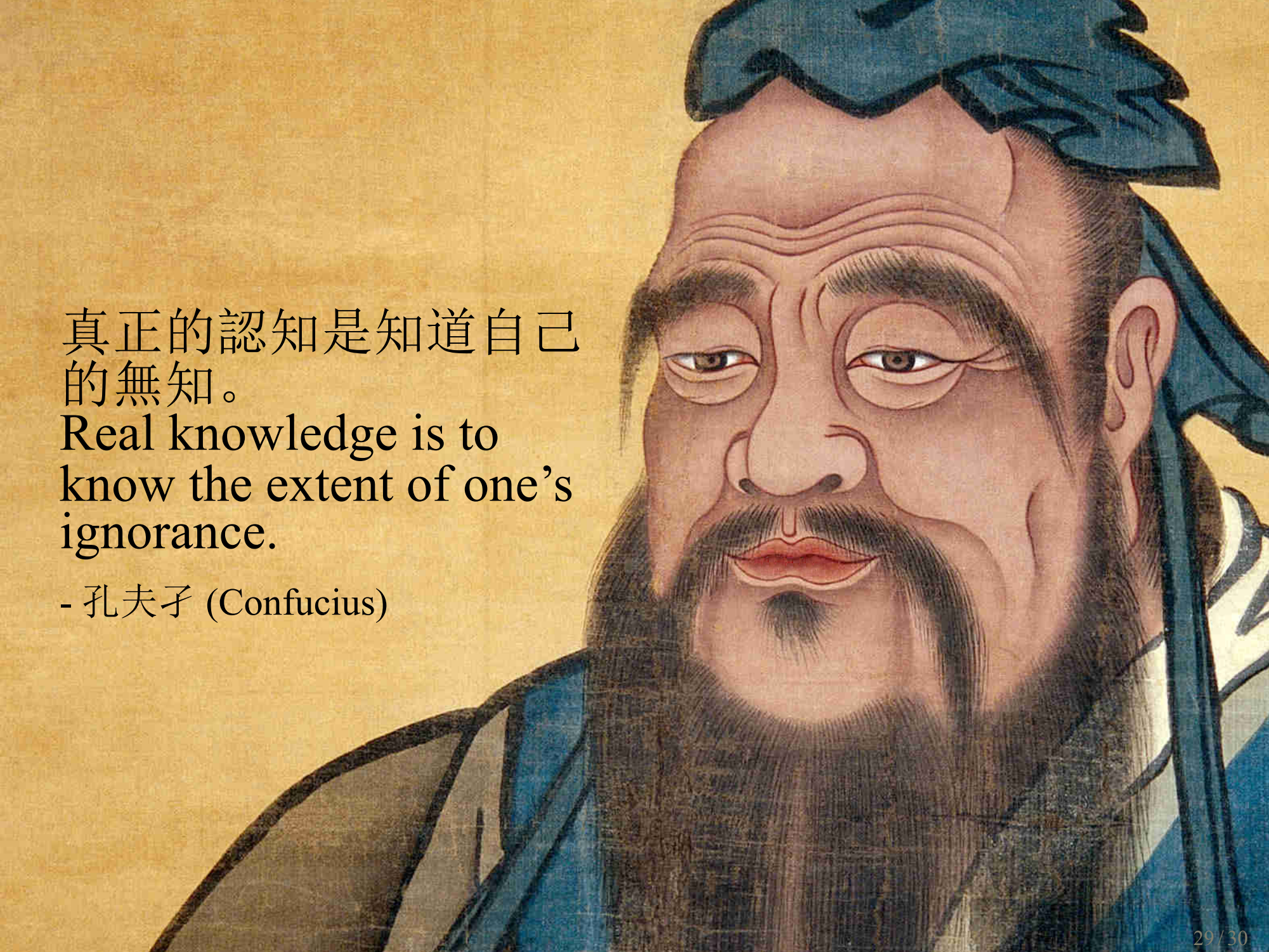
# Uncertainty and Climate Change Policy

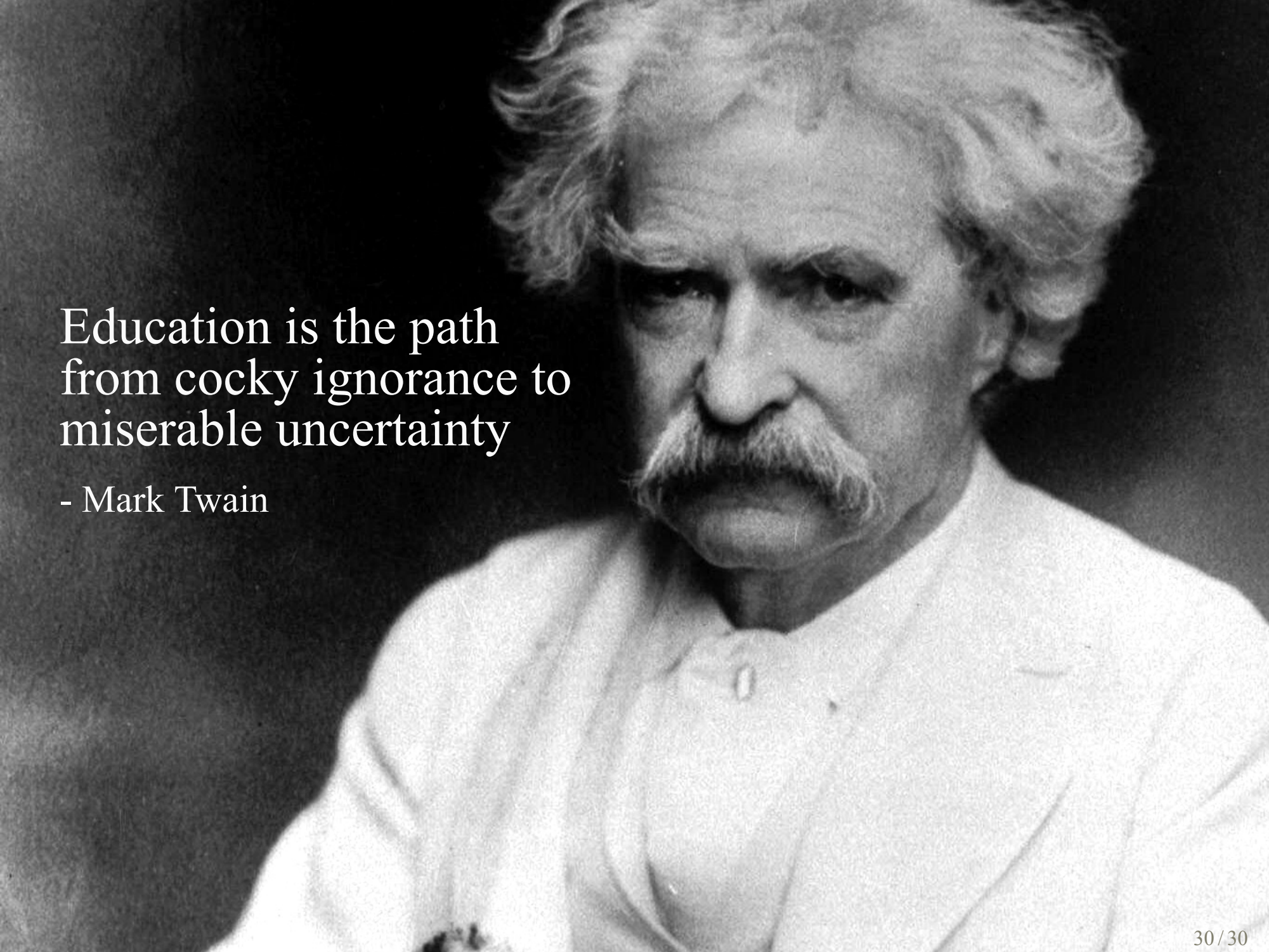
"Any serious discussion of the changing climate must begin by *acknowledging* not only the scientific certainties but also the *uncertainties*, especially in projecting the future. Recognizing those limits, rather than ignoring them, will lead to a more *sober* and ultimately more *productive* discussion of climate change and climate policies."

Steven E. Koonin (2014, former undersecretary for science in the US Department of Energy)

# Summary

- Two perspectives on uncertainty: *outside* the model and *inside* the model
- Enriching our models of uncertainty changes how we
  - ▷ Measure exposure to uncertainty
  - ▷ Measure the price of uncertainty
  - ▷ Approach economic policy


真正的認知是知道自己的無知。
Real knowledge is to know the extent of one’s ignorance.
- 孔夫子 (Confucius)


Education is the path
from cocky ignorance to
miserable uncertainty
- Mark Twain