The Innovation Dilemma
Uncertainty and Economic Policy

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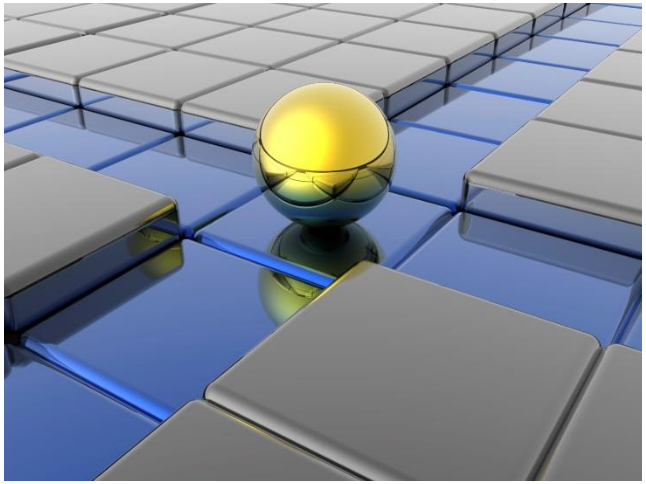


Outline

Innovation dilemma: Definition and examples.

Severe uncertainty:

- The idea of an info-gap.
- Shackle-Popper indeterminism.

Info-gap robust satisficing:

Resolving the dilemma.

Example: Monetary policy selection.

Example: The innovation dilemma of rural poverty.

Innovation dilemma: The Idea

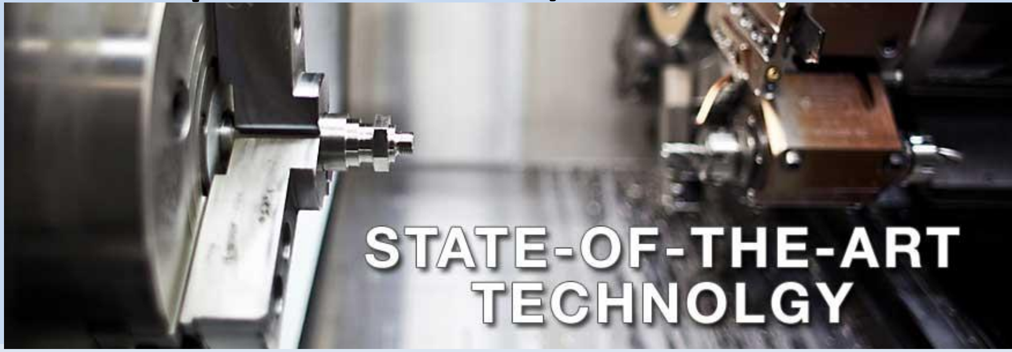
Choose between 2 options:

Option 1: (paradigm: new technology)

- New and innovative.
- Very promising.
- Higher uncertainty.

Option 2: (paradigm: standard procedure).

- State of the art.
- Less promising.
- Lower uncertainty.



Dilemma due to uncertainty.

Innovation dilemma: Examples

Automobile steering and collision control:

- Autonomous sensor-based computer control (innov).
- Human steering and foot-break system (SotA).

Monetary policy:

- New tools for new situations (innov).
- “A little stodginess at the CB” (Blinder) (SotA).

Peace or War:

- Bold diplomatic initiative (Sadat to Jerusalem, ‘77) (innov).
- Conventional diplomatic-military cycle (SotA).

Risk taking or avoiding:

- Nothing ventured, nothing gained (innov).
- Nothing ventured, nothing lost (SotA).

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Risk and Uncertainty

Probabilistic risk

or

Knightian "true uncertainty"

Probabilistic Risk

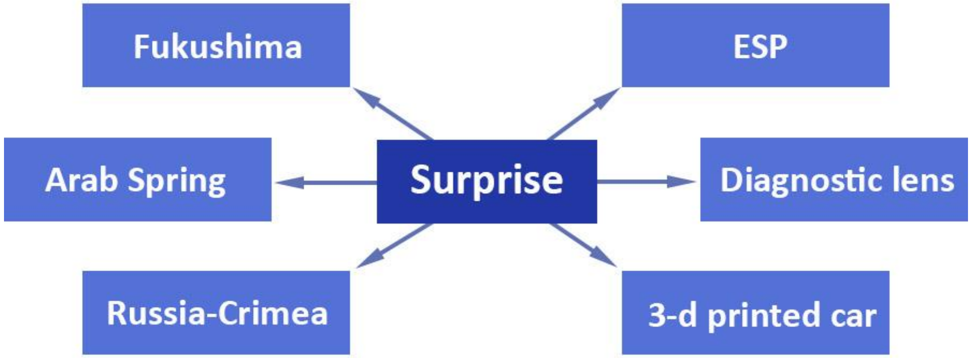
Consequence	Probability
Drought	Stochastic process
Industrial accident	Actuarial tables
Tsunami	Historical data
Faulty air filters	Quality control data
Deception, scam	Sociological data

Risk is:

- Structured: known event space
- Modeled with probability
- Manageable (but still risky)

Frank Knight's "true uncertainty"

"The uncertainties which persist … are **uninsurable** because there is **no objective measure of the probability**".



Wheeler’s Island

“We live on an island of knowledge
surrounded by a sea of ignorance.
As our island of knowledge grows,
so does the shore of our ignorance.”
John A. Wheeler

Non-probabilistic true uncertainty

D Discovery

- America
- Nuclear fission
- Martians (not yet?)

Non-probabilistic true uncertainty

D Discovery

I Invention/Innovation

- Printing press: material invention.
- Ecological responsibility: conceptual innovation.
- French revolution: social innovation.

Non-probabilistic true uncertainty

- **D** Discovery
- **I** Invention/Innovation
- **S** Surprise (Asymmetric uncertainty)
  - Ambush
  - Competitor’s innovation
  - Natural catastrophe

Non-probabilistic true uncertainty

D Discovery

I Invention/Innovation

S Surprise (Asymmetric uncertainty)

What's the next D I or S ???

Knightian uncertainty:

- Unstructured: unknown event space.
- Indeterminate: no laws.
- Barely manageable.

Info-gap uncertainty: examples

- Transcendental probability.
- ECB interest rate.
- Phillips curve.
- Many more (info-gap.com).

Carroll's Transcendental Probability

Riddle from *Pillow Problems*:

"A bag contains 2 counters, as to which nothing is known except that each is either black or white. Ascertain their colours without taking them out of the bag."

Answer: "One is black, and the other white."

Charles Dodgson

Alice

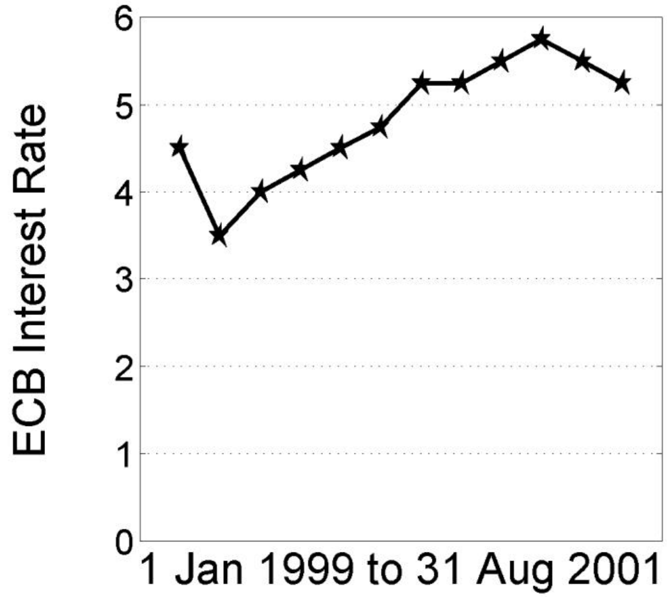
ECB Interest rate after 9/11

Rate fairly constant through Aug 2001.

After 9/11 ECB will reduce the rate.

Info-gaps:

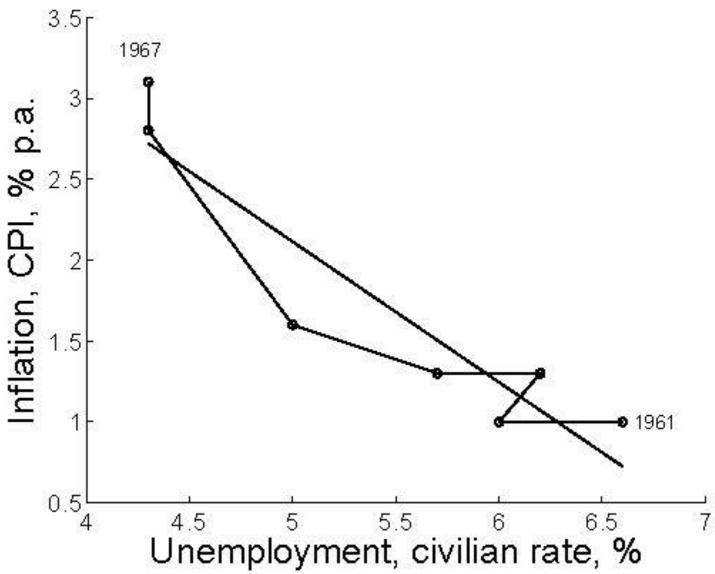
- By how much will ECB reduce interest?
- What is ECB decision model?

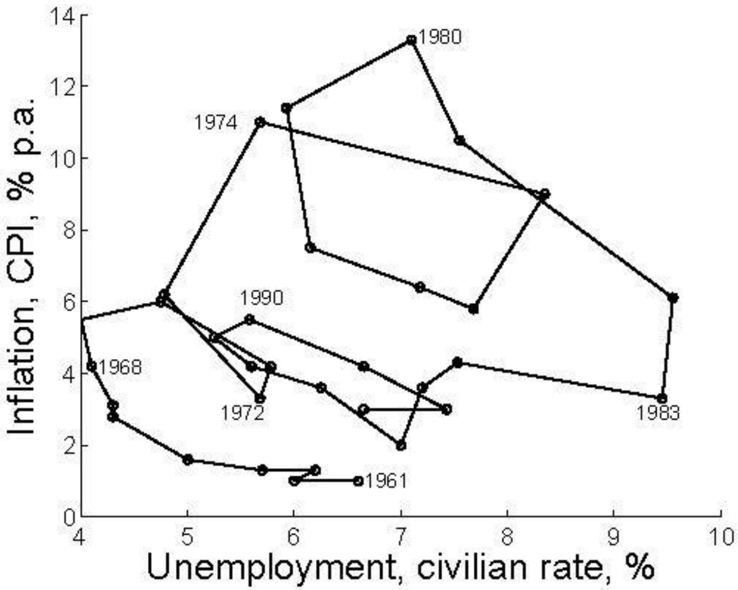


Phillips Curve

Linear? Quadratic?

Info-gaps: data, processes, functional relations.





Inflation vs unemployment US, ’61-’67.

Inflation vs unemployment US, ’61-’93.

What is an info-gap?

Info-gap:

Disparity between what one

does know

and what one

needs to know

in order to make a

responsible decision.

Two elements: **uncertainty** and **consequence**.

Distinct from probability.

What is an info-gap?

Role a fair dice:

- Equal probabilities of 1 , . . . , 6.
- Known event space; known likelihoods.

Response to next financial crisis. The event space?

- 2 events: Either collapse or not.
- 8 events: collapse or not, short or long, local or global.
- More possibilities.
- Rolling an N-sided dice, but:
  Unknown event space; unknown likelihoods.

What is an info-gap?

Probabilistic thinking sometimes useful:

- Israel 1984 inflation: 450% and growing.
- Moda'i/Bruno 5-point consensus plan:
  Budget cuts, wage and price control,
  ILS devalued and forex rigid, no ILS printing.
- Stabilization likely.
- Hence "No stabilization" unlikely.

Binary logic:

- Proposition either true or false.
- Excluded middle: proposition can't be both T and F.

Probability applies excluded middle to uncertainty:

Proposition can't be both 'likely' and 'unlikely'.

What is an info-gap?

In economics we can't always exclude the middle.

Example: Policy based on regressing inflation vs employment.

- Theory-based structural trade off.
  Historical evidence.
  Likely basis for policy success.
- Lucas critique:
  Agents' responds to policy.
  Agents' response uncertain.
  Unlikely basis for policy success.

The policy maker faces an info-gap.

What is an info-gap?

Ignorance or ambiguity or potential for surprise.

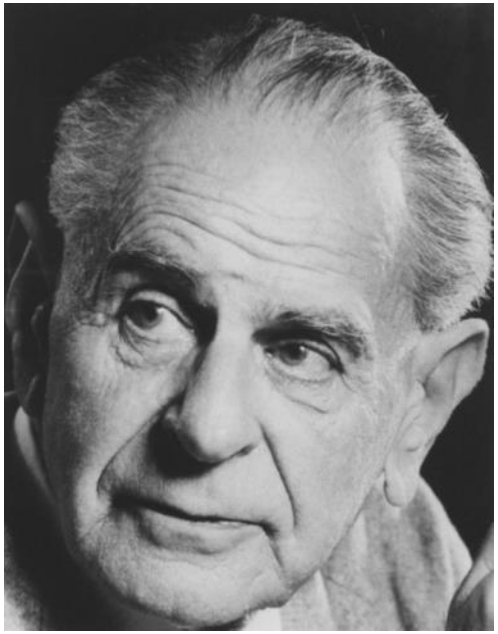
Two elements: **uncertainty** and **consequence**.

Distinct from probability.

In human affairs, info-gaps result from **Shackle-Popper indeterminism**.

Shackle-Popper indeterminism

GLS Shackle, 1903-1992



Karl Popper, 1902-1994

Shackle-Popper Indeterminism

Intelligence:

What people **know**, influences how they **behave**.

Discovery:

What will be **discovered tomorrow** can't be **known today**.

Implies

Indeterminism:

Tomorrow's behavior can't be fully modelled today.

- Info-gaps, indeterminism: **unpredictable.**
- **Ignorance is not probabilistic.**

Outline

✓ **Innovation dilemma: Definition and examples.**

✓ **Severe uncertainty:**

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Info-gap robust satisficing:

Resolving the dilemma.

Example: Monetary policy selection.

Example: The innovation dilemma of rural poverty.

Robust Satisficing

Two questions for decision makers:

1. What are our goals?
2. How much error/surprise can we tolerate?

Robust Satisficing

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1. Satisficing: Achieving critical outcomes.

- Essential goals.
- Worst acceptable outcomes.
- Modest or ambitious.

Robust Satisficing

Two questions for decision makers:

1. What are our goals?
2. How much error/surprise can we tolerate?

1. Satisficing: Achieving critical outcomes.

2. Robustness: Greatest tolerable error.

- Immunity to ignorance.
- Greatest tolerable error or surprise.

Robust Satisficing

Two questions for decision makers:

1. What are our goals?
2. How much error/surprise can we tolerate?

1. Satisficing: Achieving critical outcomes.

2. Robustness: Greatest tolerable error.

Optimize robustness; satisfice goals:

Procedural (not substantive) **optimization.**

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Monetary policy selection

Collaborators:

- Maria Demertzis (Bruegel).
- Jan Willem Van den End (DNB).

The question:

Include financial stability objectives in monetary policy?

Or

Leave financial stability to macro-prudential policy?

Method: Info-gap robustness analysis.

Monetary policy selection

Model of economic dynamics, *M*:

- Inflation gap, π_t.
- Output gap, y_t.
- Other variables.
- Loss function $L(\pi_t, y_t)$.
- 4 Policy rules:
  - R0: benchmark. Standard macro, aggregate demand, Phillips curve, traditional Taylor rule.
  - R1: R0 + monetary policy reacts to financial stress.
  - R2: R0 + financial imbalance and debt in demand curve.
  - R3: full model; all of the above.

Monetary policy selection

Uncertainties:

- Model coefficients, *c*.
- Shock amplitudes, ε_t .
- Shock times, t_s.

Info-gap model of uncertainty, *U(h)*:

- Unbounded family of nested sets of *c*, ε_t, t_s.
- No known worst case. Unbounded horizon of uncertainty.
- No probabilistic information.

Monetary policy selection

Robustness combines:

- **Performance requirement:** loss, *L*, acceptably small.
- **System model** of economic dynamics, *M*.
- **Uncertainty model,** *U(h).*

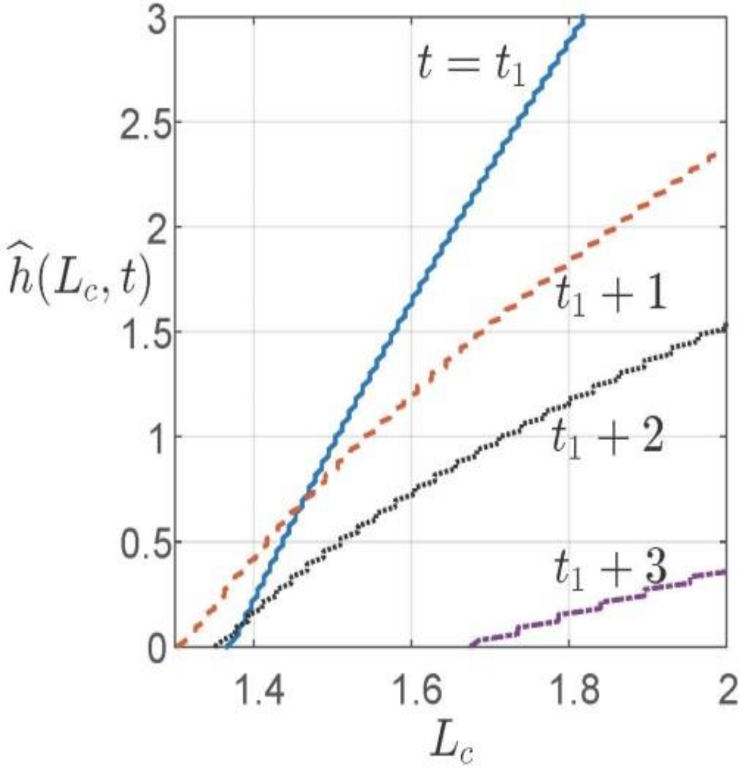
Robustness. Maximum tolerable uncertainty:

Maximum horizon of uncertainty, *h*, such that
Performance requirement on *L* satisfied by
System model *M* for all realizations in
Uncertainty model *U(h).*

Monetary policy selection

Robustness curve (R3):

- **Performance requirement:** Horizontal axis.
- **Robustness:** vertical axis.
- **Trade off** (pessimist's thm)**:** Robustness vs performance.
- **Zeroing:** No robustness at predicted outcome.
- **Time horizon:** reduces robustness.

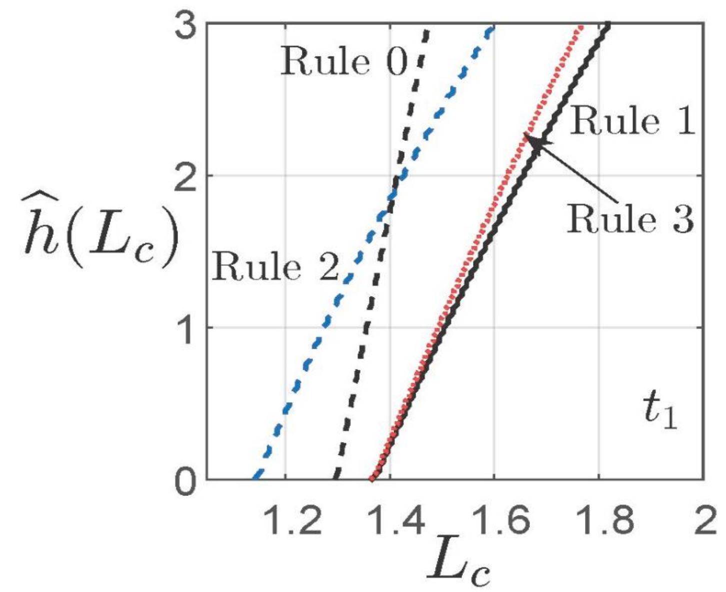


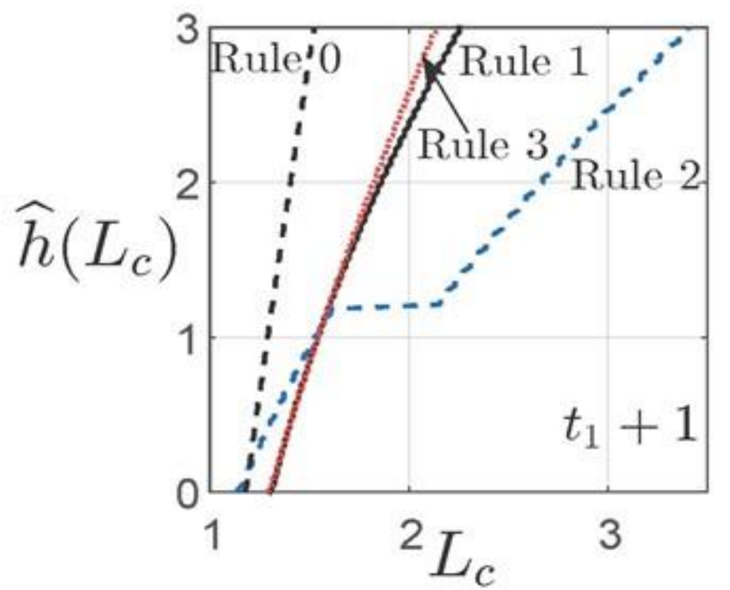
Monetary policy selection

Robustness: 4 policy rules.

- **Trade off, zeroing:** all 4 rules.
- **R0 Robust dominant** at $t_1 + 1$...
- **Robustness decreases with time.**
- **Innovation dilemma** at t_1 :

  Preference reversal of R0, R2.
- **Resolution of innov. dilemma:**
  – Maximize robustness.
  – Satisfice loss.

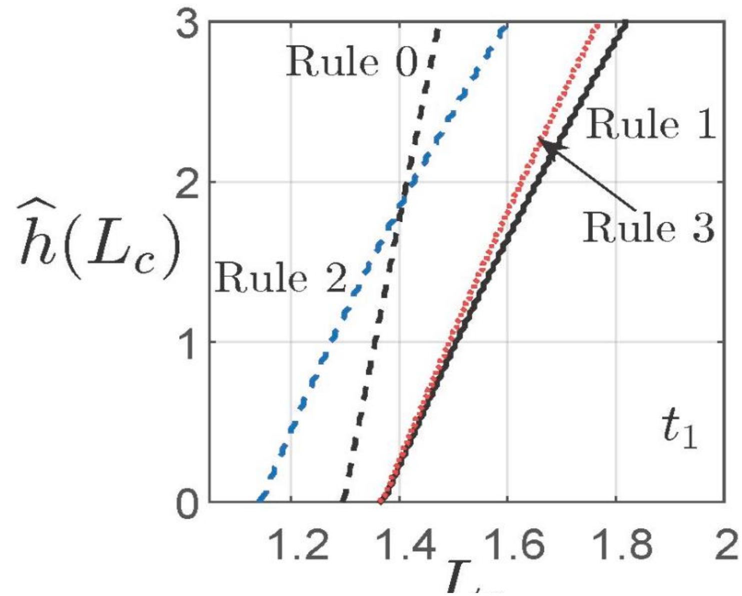


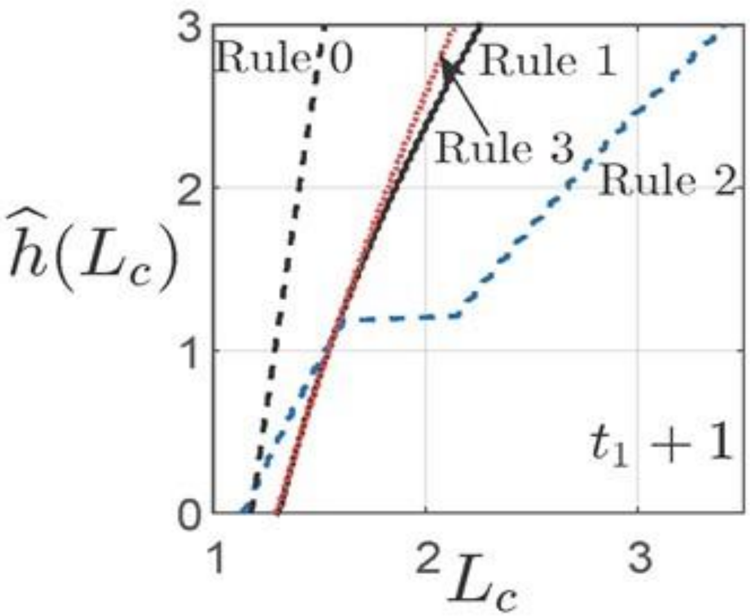


Monetary policy selection

Conclusions:

- **R0 more robust at $t_1 + 1 \ldots$:**
  Less true; less vulnerable to error.
  Simple rule more robust (usually).
- **Robustness decreases with time.**
- **Innovation dilemma** at t_1:
  Preference reversal of R0, R2.
  Simple rule not always more robust.





Innovation dilemma of poverty

Rural poverty:

- Low agricultural productivity.
- High mortality/morbidity.
- Resentment and suspicion of government and NGOs.
- Local barons or warlords.

Innovative hi-tech proposal:

- New strains of plants.
- Better irrigation.
- Better fertilizers.
- Mechanization of field work.

Innovation dilemma of poverty

Potential gains from innovation:

- Higher agricultural productivity.
- Higher standard of living.
- Less arduous field work.

Potential losses from innovation:

- Failure of innovative crops, causing starvation.
- Social reorganization and upheaval.
- Rapid population growth, canceling gains (Malthus).

Dilemma: Innovation could be **much better**, or much worse.

How to choose?

Innovation dilemma of poverty

Basic questions:

- What are the **goals**?
- What is our **knowledge**?
- What are the **uncertainties**?

Robustness of an option:

Maximum tolerable uncertainty.

The knowledge-bifurcation. Is your knowledge:

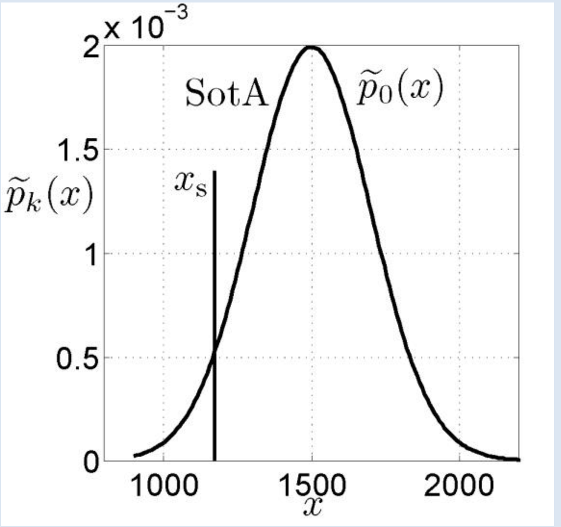
- **Quantitative:** data and equations?
- **Qualitative:** mainly insight and understanding, (perhaps with some numbers)?

We will consider both situations.

Poverty dilemma: quantitative

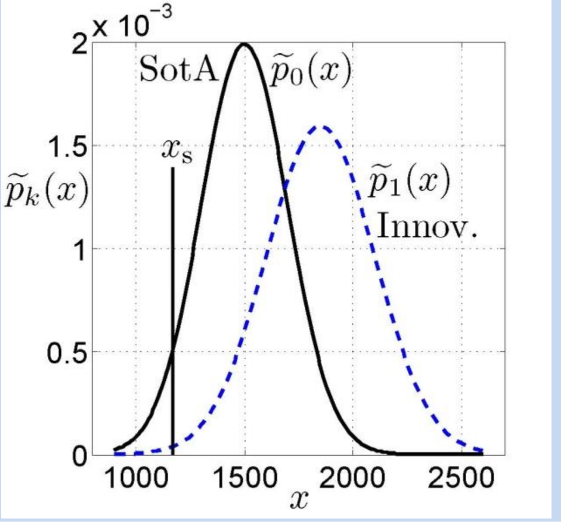
Field study of traditional State of the Art:

- Survival requirement: 1171 kg wheat/ha.
- Probability dist. of productivity **well known**.
- Survival probability: **0.95 (known).**
- Survival catastrophe return-time: **20 years (known).**



Knowledge about innovative option:

- Probability distribution of productivity **estimated, uncertain**.
- Survival probability: **0.9967 (estimate).**
- Survival catastrophe return-time: **303 years (estimate).**

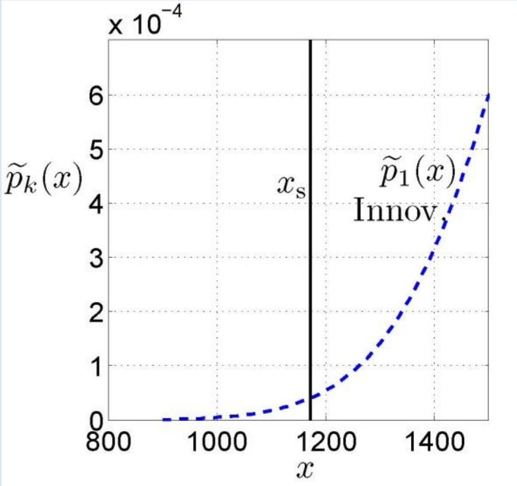


The choice is clear?

Poverty dilemma: quantitative

Uncertainty of innovative option:

- Prob. distribution of productivity: estimated.
- True tail (rare but bad): highly uncertain.
- Survival probability & catastrophe return-time may be **much worse than for SotA**.



Robustness of an option: How much error can we tolerate?

Greatest **uncertainty** at which current **knowledge** satisfies the survival **requirement**.

Robust prioritization: Innovation or SotA?

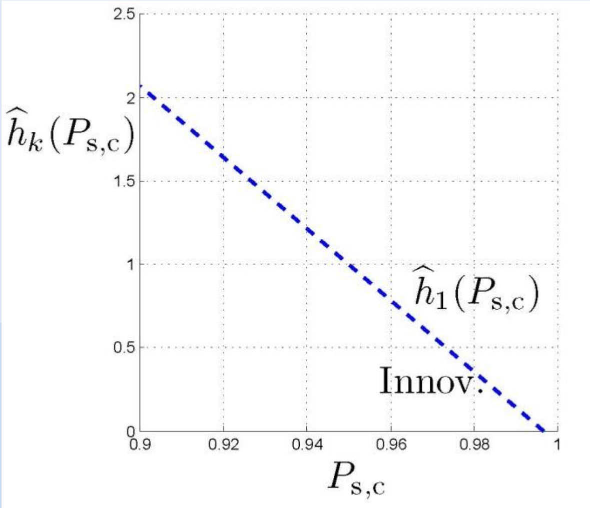
- Maximize robustness, satisfice outcome.
- Don't try to optimize the outcome.

Poverty dilemma: quantitative

Robustness of innovative option:

Pessimist's thm. Trade off:

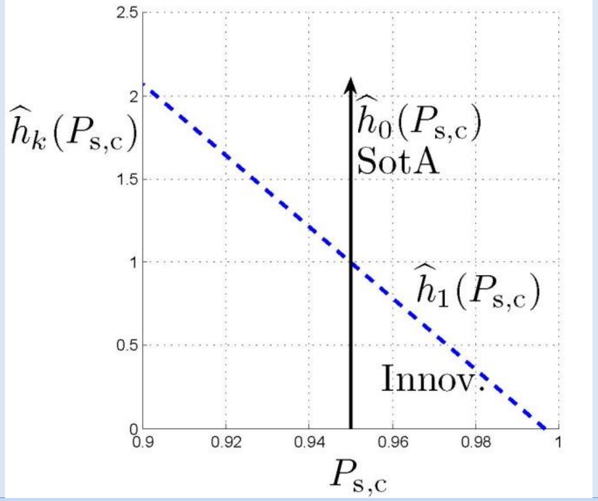
Higher survival prob ⟺ lower robustness



Zeroing: No robustness at estimated survival probability.

Robustness of SotA:

- **Unbounded** for survival probability up to 0.95.
- **Zero** for survival probability above 0.95.

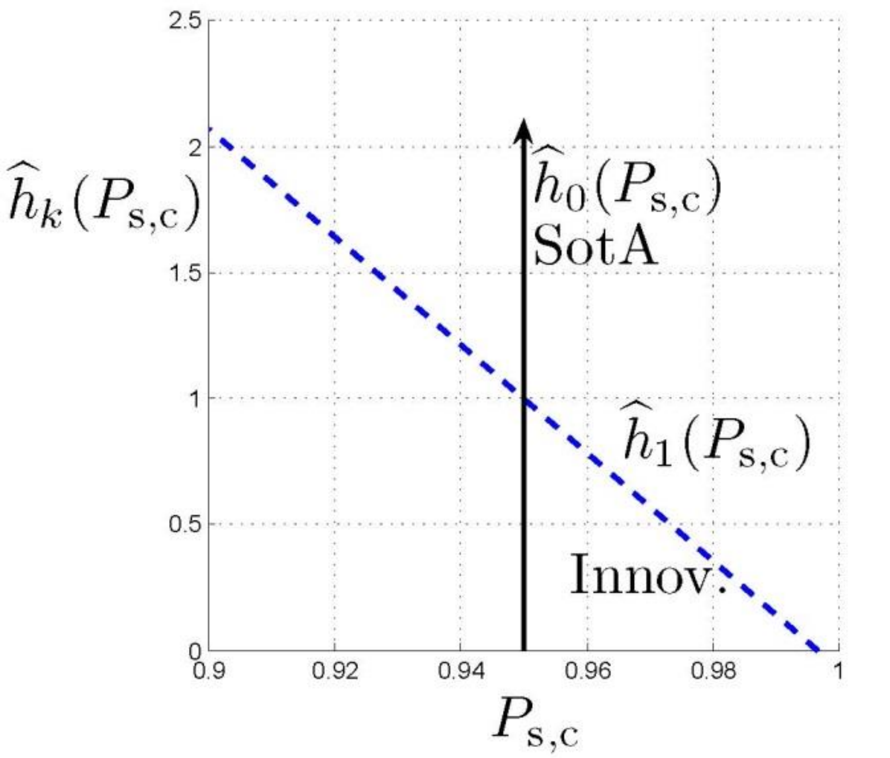


Decision: Choose by robustly satisfying the requirement.

Poverty dilemma: quantitative

Summary of quantitative analysis of innov. dilemma:

- **Zeroing:** no robustness at estimated survival prob.
- **Optimizer's fallacy:** Prioritize by estimates.
- **Trade off:** robustness vs survival probability.
- **Preference reversal:** Resolution of dilemma.



Poverty dilemma: qualitative

Now for the hard part:

Qualitative analysis of robustness.

Robustness:

- We can't evaluate it quantitatively.
- Assess it qualitatively with **proxies for robustness**:
  - **Resilience**: rapid recovery of critical functions.
  - **Redundancy**: multiple alternative solutions.
  - **Flexibility**: rapid modification of tools and methods.
  - **Adaptiveness**: adjust goals and methods online.
  - **Comprehensiveness**: interdisciplinary system-wide coherence.

Poverty dilemma: qualitative

Basic questions:

- What are the **goals**?
- What is our **knowledge**?
- What are the **uncertainties**?

Bernard Amadei: girl water carriers.

- **Goal**: more potable water.
- **Knowledge**: Abundant fuel. Pump tech. Local culture.
- **Uncertainties:**
  - Long-term maintenance? Catastrophe if not.
  - Stable fuel supply?
  - Social response: what happens to the girls?

Poverty dilemma: qualitative

Robust solution:

- **Satisfice** the goal. Don't try to maximize. (Exploit trade off)
- **Co-design**: local involvement in all stages (comprehensive).
- **Train** locals in pump maintenance (resilience, flexibility).
- **Transition period** of dual supply (redundancy).
- **Long-term contact** for emergency support (adaptiveness).
- **Education** for girls (and boys) (comprehensiveness).
- **Quantitative** analysis where possible.

Poverty dilemma: qualitative

Methodological re-cap:

- **Trade off:** higher ambition = lower robustness.

  Ambitions: Yes. Wishful thinking: No.
- **Zeroing:** Best-estimated outcomes have no robustness.
- **Satisfice** your goals. **Optimize** your robustness.

  Don't try to maximize the outcome.
- **Preference reversal:** sub-optimal may be more robust.

  Wood burning steam pump more robust to uncertainty than solar electric technology.

Last words

Innovation dilemma: New is promising but more uncertain.

Severe uncertainty:

- The idea of an info-gap.
- Shackle-Popper indeterminism.

Info-gap robust satisficing:

Satisfice the goals, optimize the robustness.

Example: Monetary policy selection.

Example: The innovation dilemma of rural poverty.

Questions?