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# **Uncertainty quantification and robust decision-making**

Initiating a transdisciplinary research program

Eisenhauer & al. (2020)

April 20, 2021



# Uncertainty quantification and robust decision-making

The slide features a central white rectangular area containing logos of four partner institutions. At the top left is the logo for the Institute for Applied Microeconomics at UNI BONN, which includes a grey square with 'UNI' and a yellow square with 'BONN', followed by the text 'Institute for Applied Microeconomics'. To its right is the LIMES logo, featuring a stylized bar chart graphic above the word 'LIMES' in large letters, with 'Life & Medical Sciences Institute' written below it. In the center is a blue circular logo with a white crosshair and three nested ellipses. To the right is the Fraunhofer SCAI logo, which includes a green square with a diagonal line, the word 'Fraunhofer' in bold, 'SCAI' in a smaller font, and 'Institute of Finance & Statistics' to the right. Below these logos are eight oval-shaped portrait photos of individuals arranged in two rows of four. The top row contains three men and one woman, while the bottom row contains one woman and three men. The entire central area is enclosed in a light blue border, with a dark blue vertical bar on the right side.

The slide displays eight individual portraits of researchers, each enclosed in a white oval. They are arranged in two rows: four in the top row and four in the bottom row. The individuals include both men and women of diverse backgrounds. The portraits are set against a white background, which is itself centered within a larger light blue rectangular frame.

## Computational models

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- **Epidemiologists** guide public mitigation efforts in the current pandemic by predicting the effect of social distancing rules on the disease's spread.
- Economists evaluate alternative welfare programs and forecast their impact on inequality in a variety of economic outcomes.
- Financial institutions manage their capital requirements by conducting stress tests about their business viability under adverse market conditions.

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⇒ **Uncertainty pervades**

## Uncertainty quantification and robust decision-making

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- **Uncertainty quantification** is a systematic attempt to characterize, manage, and reduce uncertainty.
- Robust decision-making seeks to identify potential robust strategies in light of uncertainty, characterize the vulnerabilities of such strategies, and evaluate trade-offs among them.

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## Analysis pipeline

- **Robust optimization**      determine robust decisions in frequentist setting  
use of specialized algorithms
- Copula modeling
- Surrogate modeling

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## Analysis pipeline

- Robust optimization
- **Copula modeling** enable sensitivity analysis in Bayesian setting  
approximate posterior distribution in high dimensions
- Surrogate modeling

## Uncertainty quantification and robust decision-making

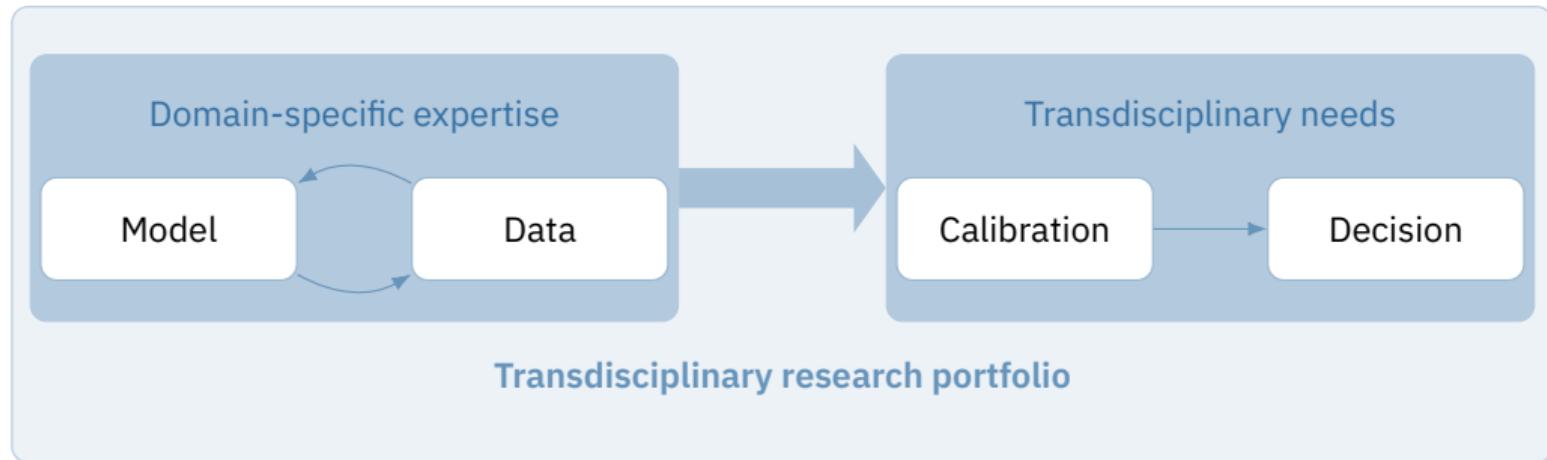
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### Analysis pipeline

- Robust optimization
- Copula modeling
- **Surrogate modeling** address computational challenges  
apply techniques from machine learning

## Transdisciplinary research approach



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# Economics

## Contributions

- interesting questions
- administrative data sources
- research codes
- decision theory

## Contributions

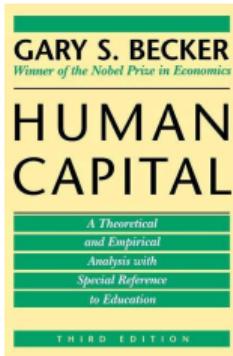
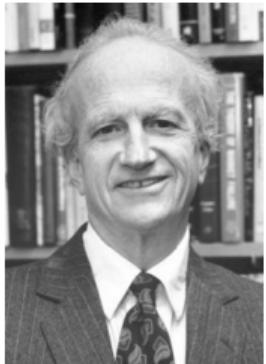
- interesting questions
- administrative data sources
- research codes
- decision theory

## Example

- **Eisenhauer, Gabler, Janys (2020).** *Structural econometric models for policy-making: Coping with parametric uncertainty.* in preparation for submission.

# Human capital formation

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Human capital comprises the knowledge, skills, competencies and attributes embodied in individuals that facilitate the creation of personal, social, and economic well-being.

- OECD

### Understanding individual decisions

- Human capital investment
- Consumption–savings decision

### Predicting effects of policies

- Educational policy
- Welfare programs

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## Mathematical framework and implementation

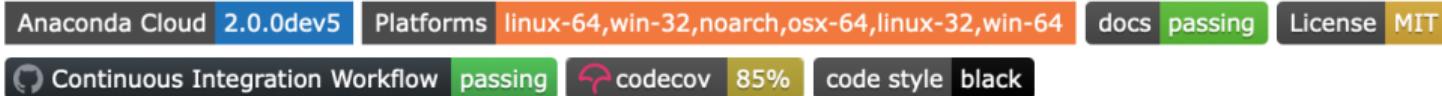
- Finite-horizon discrete Markov decision problem
- Backward induction algorithm

## Community code

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A research code for the flexible specification, simulation, and estimation of Eckstein–Keane–Wolpin models.

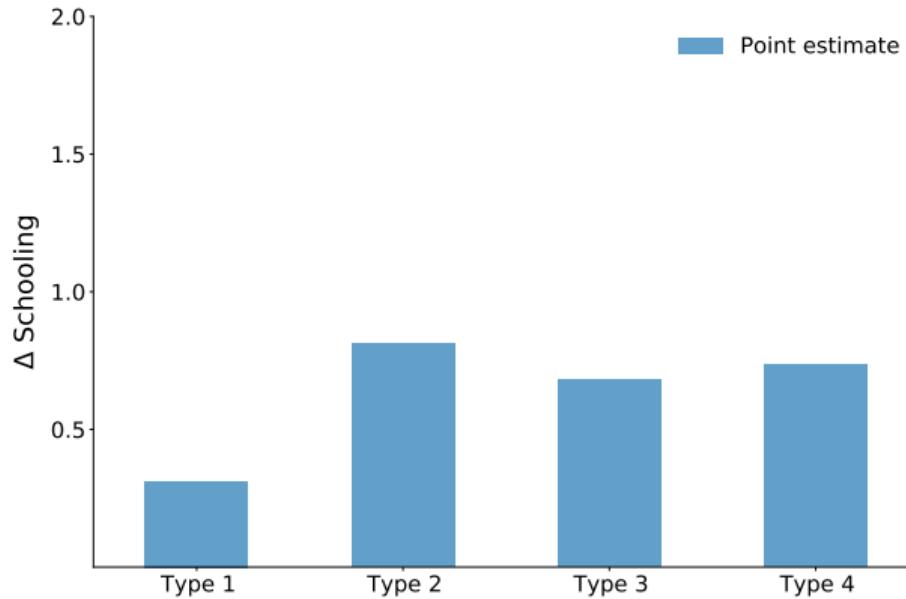


**Core devs** Tobias Raabe, Janos Gabler

**Docs** [respy.readthedocs.io](https://respy.readthedocs.io)

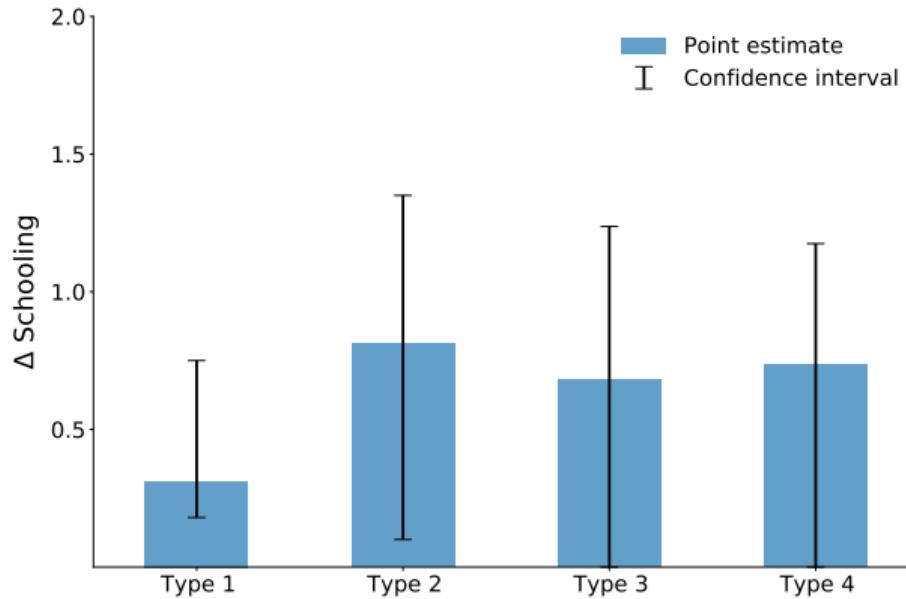
## As-if ranking of policy alternatives

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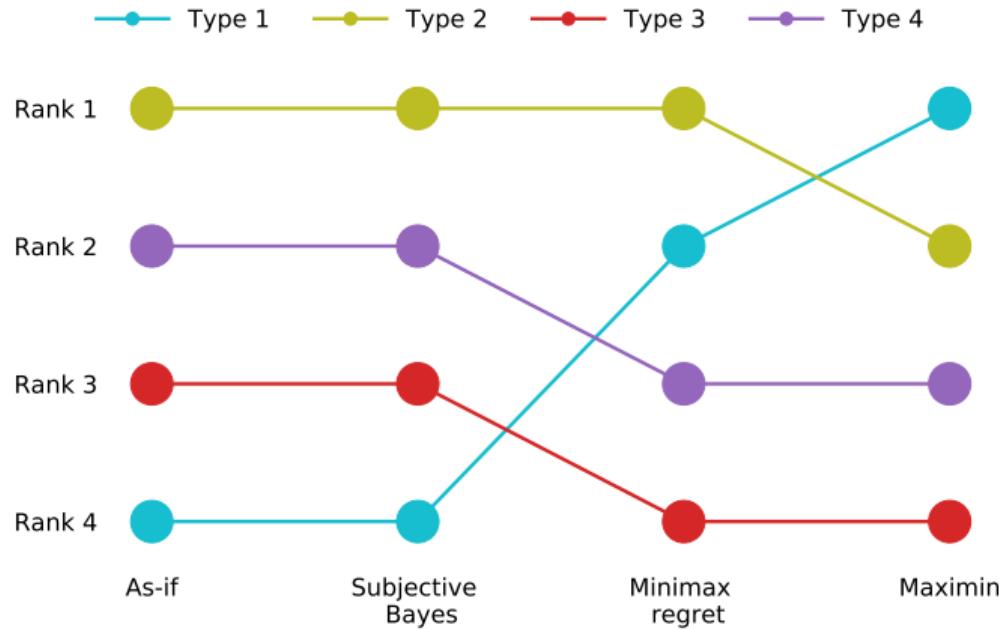
## As-if ranking of policy alternatives

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## Decision-theoretic criteria

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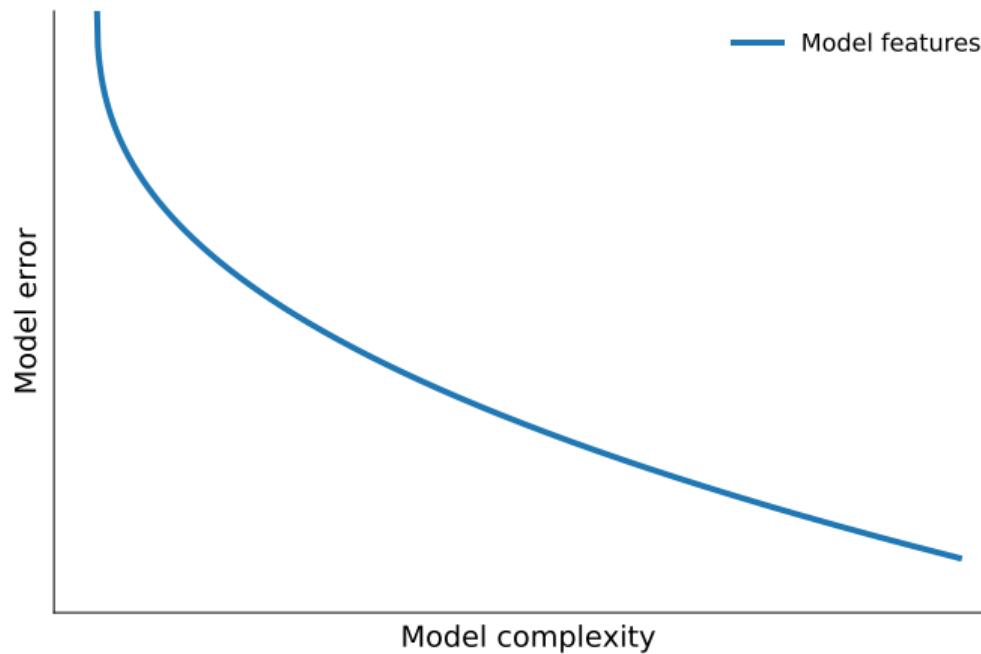


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# Conclusion

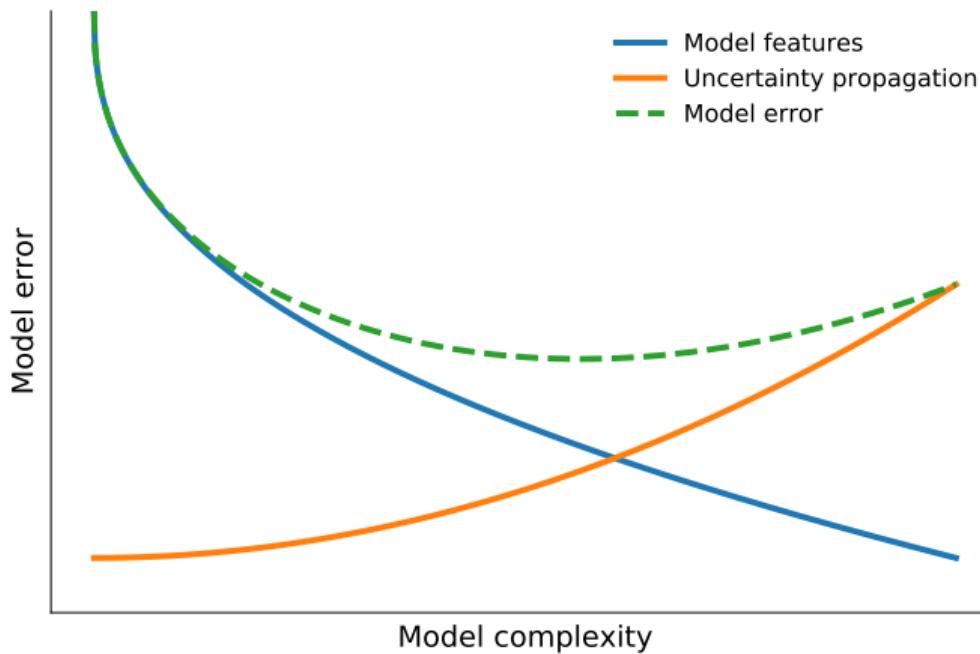
## Price of complexity

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## Price of complexity

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# Appendix

# Data

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**Statistisk sentralbyrå**  
Statistics Norway

National Longitudinal Survey of Youth | 1979  
*NLSY79*



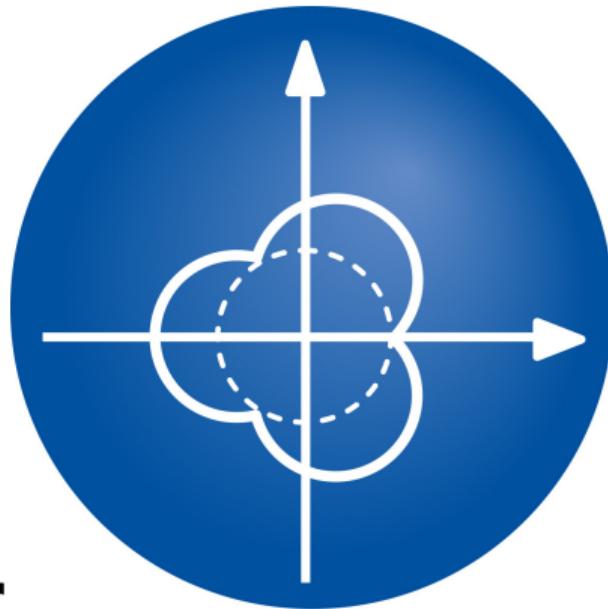
FORSCHUNGSDATENZENTRUM  
der Bundesagentur für Arbeit im Institut für  
Arbeitsmarkt- und Berufsforschung

**NEPS**  
Nationales Bildungspanel

**SOEP** Das Sozio-  
oekonomische  
Panel



Institute for  
Applied  
Microeconomics



Institute of  
Finance &  
Statistics

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## References

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## References

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