Uncertainty quantification and robust decision-making

Initiating a transdisciplinary research program

Eisenhauer & al. (2020)

March 2, 2021

Open Source Economics

Uncertainty quantification and robust decision-making

Computational models

- **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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$\Rightarrow$ **Uncertainty pervades**

Uncertainty quantification and robust decision-making

- **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

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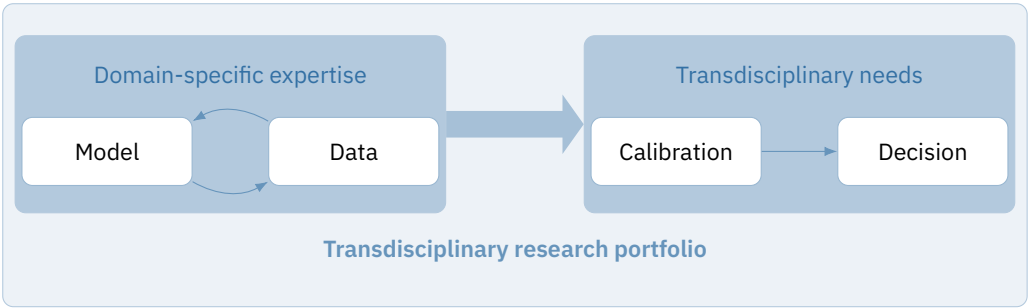
Analysis pipeline

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

Transdisciplinary research approach



Economics

Contributions

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

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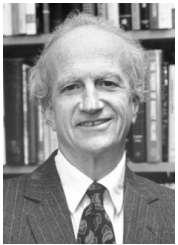
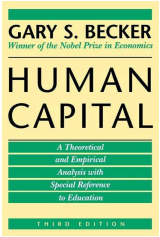
Example

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

Human capital formation





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

- OECD

Eckstein–Keane–Wolpin models

Understanding individual decisions

- Human capital investment
- Consumption–savings decision

Predicting effects of policies

- Educational policy
- Welfare programs

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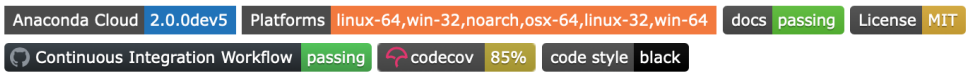
Mathematical framework and implementation

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

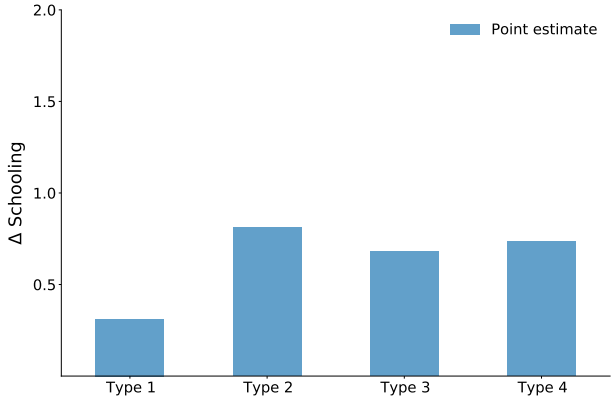
respy

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

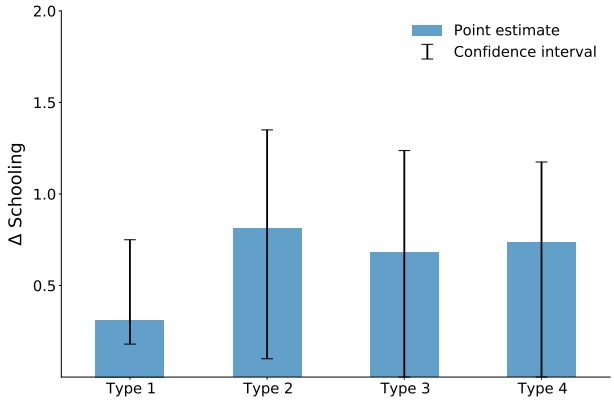


Core devs Tobias Raabe, Janos Gabler
Docs respy.readthedocs.io

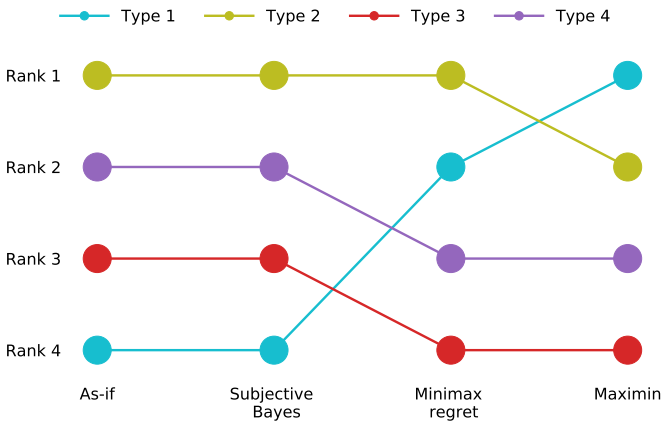
As-if ranking of policy alternatives



As-if ranking of policy alternatives

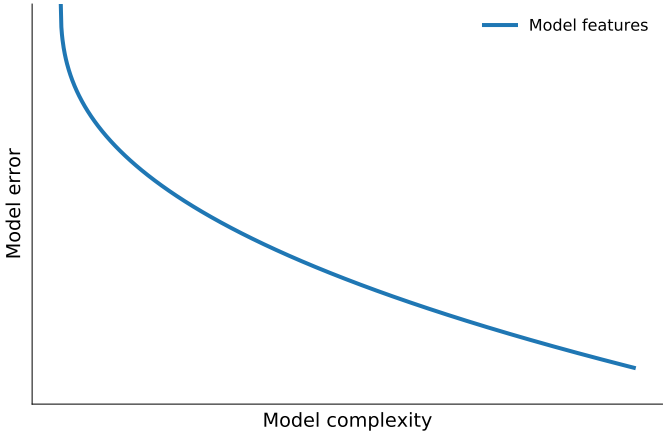


Decision-theoretic criteria

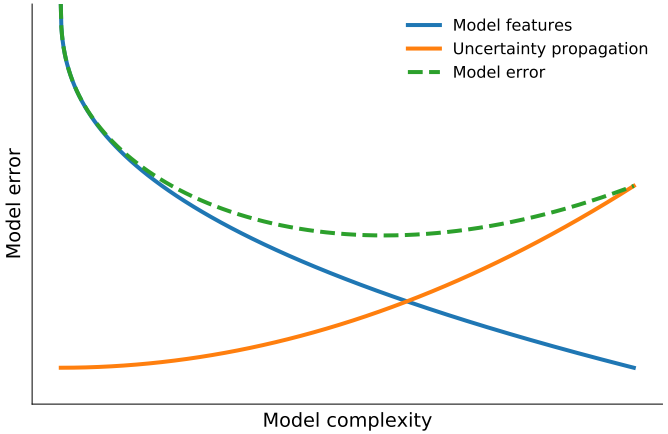


Conclusion

Price of complexity



Price of complexity



Appendix

Data


Statistisk sentralbyrå
Statistics Norway


National Longitudinal Survey of Youth 1979

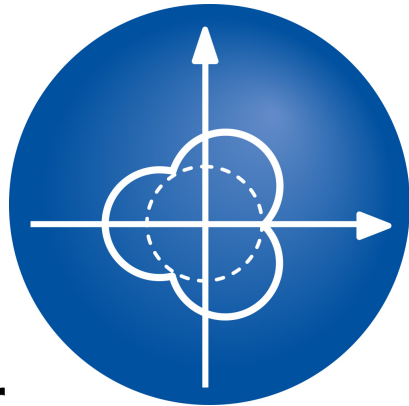

IAB
FDZ
FORSCHUNGSDATENZENTRUM
der Bundesagentur für Arbeit im Institut für Arbeitsmarkt- und Berufsforschung


NEPS
Nationales Bildungspanel


SOEP
Das Sozio-oekonomische Panel

UNIVERSITÄT BONN Institute for Applied Microeconomics

LIMES Life & Medical Sciences Institute



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