



**Open Source
Economics Bonn**

– A platform for transdisciplinary collaboration –

Computational economic models specify an individual's objective and the institutional and informational constraints of their economic environment. They are used to quantify the importance of competing economic mechanisms in determining economic outcomes and forecast the effects of alternative policies before their implementation.

Open Source Economics is a platform for economists and computational scientists to facilitate the transdisciplinary collaboration in the development, analysis, and application of computational economic models. Together, we expand the set of possible economic questions that we can address and improve the quality of our answers. We organize our collaborations around an ensemble of versatile research codes that allow for the analysis of different classes of economic models. These codes are systematically developed, thoroughly tested, well documented, and actively used. Their architecture allows focusing on selected mathematical and computational challenges within a deliberately simplified model while offering the immediate ability to scale up to a full-fledged research project. Please visit our website (<https://open-econ.org>) or contact me directly for additional information.

In support of our agenda, we kindly request funding for the following three items.

OSE scientific computing (for economists)

Transdisciplinary research requires training and preparation. We create a new Master and Ph.D. course in the upcoming winter term for scientific computing. The course is tailored to economists but open to junior researchers across the whole transdisciplinary research area. The goal is to establish a common methodological toolkit and discuss its use-cases in computational economic models. To that end, we initially review standard numerical challenges such as optimization, function approximation and integration, and uncertainty

quantification. We move on to presentations on our group's research codes that enable the flexible specification of micro- and macroeconomic models. We conclude by presenting the core packages of our analysis pipeline for (robust) optimization and uncertainty quantification. All packages are open source and under constant development, and the presentations have the explicit goal to recruit future collaborators and contributors. We invite the Life & Medical Sciences Institute (LIMES) and the Institute for Numerical Simulation (INS) for guest lectures. In the near future, we hope to administer this course in equal partnership with the LIMES and INS in support of the transdisciplinary research profile of the University of Bonn as a whole.

Teaching and research infrastructure

We build the course on the Nuvolos.cloud (<https://nuvolos.cloud>) as an integrated research and teaching platform. The platform provides a simple, browser-based environment in the cloud that gives instructors complete control over students' computational environment and simplifies the dissemination of teaching material. This service is particularly useful during remote teaching as the debugging of any hardware or software issues faced by individual students is particularly challenging. High-performance computing resources in support of our ongoing transdisciplinary research projects are available.

- **estimated cost** $\approx 20,000 \text{ €}$ (2020)

During the summer term, we employ this infrastructure in support of the existing Master class *Microeconometrics*. We exploit our new capabilities to expose students to more computer-intensive methods of data analysis.

Student support

We hire a pre-doc for one year. Mrs. Gehlen has already worked with our group for several years. Her task is to polish the lecture material, provide technical assistance to students, and offer exercise sessions.

- **estimated cost** $\approx 16,000 \text{ €}$ (2020) + 32,000 € (2021)

respy - code as research

Transdisciplinary research involves international collaboration across scientific domains. Our group's flagship research code **respy** provides an extensible framework for specifying, solving, and simulating a broad class of economic models set up as discrete (or discretized)

finite-horizon Markov decision processes. Our codebase is now so mature that we need expert support to further improve its numerical components and unlock the potential for large-scale parallelism. We join forces with computational scientists from the HEC Lausanne to integrate sparse grids (TASMANIAN Sparse Grid Library) and machine learning (TensorFlow Library) methods that enable us to solve much richer economic models and quantify the uncertainties involved in the analysis.

- **estimated cost** $\approx 20,000$ € (2020)

We already cooperate with the group around Prof. Scheidegger on the development of **respy** for joint research projects on the very same issues. However, we require the funds to move our prototypes to production-grade code that we can share with the border research community. One of Prof. Scheidegger's doctoral students (Mr. Mikushin) offers professional scientific software development services, and we use the funds to pay his fee. We host an event in Bonn with the two of them to share their work with interested members of our transdisciplinary research area. Please visit our online documentation (<https://respy.readthedocs.io>) for more details about **respy**.

OSE retreat

Transdisciplinary research demands opportunities for personal interaction and public outreach. We host an international three-day conference (including a one-day networking event) centered around computational methods and models relevant for economists. We recruit senior and junior researchers from our transdisciplinary research area as participants and presenters. Thus, we will set up presentations at the beginning of each day that provide the background motivation for the application of the models within economics. But then focus on the challenges arising from their mathematical formulation and computational implementation for the rest of the day. We showcase our efforts to quantify the inherent uncertainties in the analysis of computational economic models and to explore ways to communicate them to the broader public.

- **estimated cost** $\approx 20,000$ € (2021)

Funding overview

Topic	2020	2021
OSE scientific computing	36,000 €	32,000 €
- teaching infrastructure	20,000 €	—
- student support	16,000 €	32,000 €
respy - code as research	20,000 €	—
OSE retreat	—	20,000 €
Total	56,000 €	52,000 €