Jan Žemlička

PERSONAL DATA

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EDUCATION

CERGE-EI, Prague *2019 - present*
Ph.D. in Economics and Econometrics
Dissertation topic: Optimal Policies in Heterogeneous Agent Economies with Aggregate Risk
Chair: Marek Kapička
Committee members: Ctirad Slavík, Filip Matějka

Macro courses:

- Core macro sequence (Macro I/II/III)
  - Dynamic programming (including numerical implementation)
  - Neoclassical growth
  - Incomplete market models (including numerical implementation)
  - New Keynesian models
- Public Finance (syllabus)
  - Ramsey problems
  - Mirrlees problems
- Macro Topics II
  - Bayesian estimation of dynamic stochastic equilibrium economies
  - Additional numerical methods (including formal introduction to perturbation and projection methods and key approaches to optimization and numerical differentiation/integration)

CERGE-EI, Prague *2019 - 2021*
MA in Economic Research
Thesis: Macro-Epidemic Modelling: A Deep Learning Approach

Prague University of Economics and Business *2016 - 2019*
BA in Economics
Thesis: Does Risk Matter For Monetary Policy? An Evidence from Small Open Economy Model

EXPERIENCE

Visiting Scholar, University of Pennsylvania *8/2022 - 12/2022*
Sponsor: Jesús Fernandéz-Villaverde

Research Assistant to Professor Filip Matějka, CERGE-EI *2020 - present*
Research assistant work on Filip Matějka's ERC grants Behavioral and Policy Implications of Rational Inattention (INATTENTION) and Economics of Inattention (ATTENTION).

Teaching Assistant to Professor Marek Kapička, CERGE-EI *9/2020 - 10/2020 and 9/2021 - 10/2021*
Teaching assistant for the first-part of the core Ph.D. macro sequence. Covered topics included

- Fixed-point theory and its connection with dynamic programming
- Economic applications of dynamic programming (e.g. growth model)
- Numerical dynamic programming and basic numerical methods (optimization and functional approximation) in Julia

GRANTS AND FELLOWSHIPS

Advanced Neural Networks Architectures for Solving Heterogeneous Agent Models , The Charles University Grant Agency , *Principal Investigator* *2022-2024*
This project aims to develop specialized neural network architectures tailored for approximating value functions and providing compact representation of cross-sectional distributions of agents in Bewley models with aggregate uncertainty.

WORK IN PROGRESS

Average Inflation Targeting in a Behavioral Heterogeneous Agent New Keynesian Model
with František Mašek

Winner of the Karel Englis Prize for the best paper on the Czech economic policy awarded by the Czech Economic Society within the Young Economist of 2022 Award.

We analyze the optimal window length in average inflation targeting rule within a Behavioral THANK model of Pfäuti and Seyrich (2022). The central bank faces an occasionally binding effective lower bound (ELB) or persistent supply shocks and can also use quantitative easing when we merge Pfäuti and Seyrich (2022) with Sims et al. (2020). We show that the optimal averaging period is infinitely long in the case of a conventional degree of myopia. However, for a higher cognitive discounting finite window length dominates. The optimal length of the averaging period depends on the definition of the average inflation process. Optimal period is substantially lower when the target is defined as an arithmetic moving average while the welfare loss is monotonically decreasing in the history-dependence for an exponential moving average process. We solve the model locally and globally to disentangle the effects of uncertainty about hitting the ELB in the future, which may lead to a downward inflation bias in the case of the global solution. The welfare loss difference given the solution technique is considerably decreasing in the degree of history dependence.

SSRN Link

Economics-Inspired Neural Networks with Stabilizing Homotopies
with Marlon Azinović

Contemporary deep learning based solution methods used to compute approximate equilibria of high-dimensional dynamic stochastic economic models are often faced with two pain points. The first problem is that the loss function typically encodes a diverse set of equilibrium conditions, such as market clearing and households' or firms' optimality conditions. Hence the training algorithm trades off errors between those — potentially very different — equilibrium conditions. This renders the interpretation of the remaining errors challenging. The second problem is that portfolio choice in models with multiple assets is only pinned down for low errors in the corresponding equilibrium conditions. In the beginning of training, this can lead to fluctuating policies for different assets, which hampers the training process. To alleviate these issues, we propose two complementary innovations. First, we introduce *Market Clearing Layers*, a neural network architecture that automatically enforces all the market clearing conditions and borrowing constraints in the economy. Encoding economic constraints into the neural network architecture reduces the number of terms in the loss function and enhances the interpretability of the remaining equilibrium errors. Furthermore, we present a homotopy algorithm for solving portfolio choice problems with multiple assets, which ameliorates numerical instabilities arising in the context of deep learning. To illustrate our method we solve an overlapping generations model with two permanent risk aversion types, three distinct assets, and aggregate shocks.

Link

Stabilizing Ergodic Set Simulation in Deep Equilibrium Nets Training

I propose a new approach for approximating the ergodic set of dynamic macroeconomic models in deep learning solution methods: the Convergent Cloud Method. Instead of tracking a small number of state particles for a very large number of periods, my method obtains training data by simulating the transition of a large cloud of states toward the ergodic set of the model. The key advantage of my procedure is stability gain: empirically, I show that my procedure is substantially less likely to diverge relative to long simulation procedures. Beyond that, my method bypasses the need for a sophisticated initial guess and features a massively parallel structure, which allows for more than 60 percent speed-up on modern deep learning hardware.

Link

Functional Programming in Economics
with Jesús Fernandéz-Villaverde

This paper shows how to use *functional programming* to simplify coding of solution algorithms used in economic dynamics. First, we provide a step-by-step guide for functionalization of standard imperative algorithms which illustrates key concepts of functional programming by solving a simple real business cycle model (RBC) with value function iteration. Our RBC example shows that even in simple cases, functional programming often allows for simpler, *yet* more performant code. Finally, we provide more advanced use-cases of functional programming, namely automatic parallelization of value iteration algorithm code on GPUs, and efficient automatic differentiation in deep equilibrium nets solution method.

WORKSHOPS AND CONFERENCES

Midwest Macroeconomics Meeting Fall 2022 2022
SMU, Dallas

NON-ACADEMIC EXPERIENCE

Assistant Analyst, Česká Spořitelna, a.s. *2017-2019*
Part-time in the Department of Economic and Strategic Analysis. My main tasks consisted of economic and financial data acquisition and writing regular internal client reports about domestic and global economic developments in both Czech and English language

AWARDS

The Karel Engliš Prize for the Best Policy Paper , The Czech Economic Society *2021*
My master thesis *Macro-Epidemic Modelling: A Deep Learning Approach* applied recently developed deep learning approximation methods to the issue of solving macro-epidemic models featuring aggregate uncertainty. Beyond solving the model equilibrium for some fixed government policy, my thesis shows how deep learning methods could be used to simultaneously solve the model for a large number of different government policy rules to facilitate optimal policy computations. Link

RSJ Second-Year Research Fellowship - 2nd prize , CERGE-EI *2021*
My dissertation proposal *Optimal Policies in Heterogeneous Agent Economies with Aggregate Risk* propose a novel approach for computing optimal policy systems in rich heterogeneous agent economies with aggregate risk. Compared to the existing literature which focuses on linear policy system, my method aims to allow for nonlinear and time-varying policy instruments (e.g. progressive taxes). Link

Dean's Prize for the Best Undergraduate Thesis , Faculty of Economics and Public Administration, Prague University of Economics and Business *2019*
My thesis *Does Risk Matter For Monetary Policy? An Evidence from Small Open Economy Model* focused on the issue of how approximating method used to solve New Keynesian models could influence policy advise provided by those models. Link

2nd prize in the 38th round of national high school competition "Students' Professional Activities" in Economic , The Ministry of Education, Youth and Sports *2016*
The paper *"Problems and Possible Reform of the Economic and Monetary Union* focused on the issue of asymmetric bank credit flows within the euro area generated by a single interest rate policy applied to heterogeneous economies. Available in Czech Language

SKILLS

Languages
Czech-native proficiency, English-full professional proficiency

Programming Languages and Frameworks
Julia, Python (JAX/TensorFlow), Matlab, R, basics of C++ and Java

REFERENCES

Doc. Marek Kapička, Ph.D. marek.kapicka@cerge-ei.CZ
CERGE-EI

Doc. RNDr. Filip Matějka, Ph.D. filip.matejka@cerge-ei.CZ
CERGE-EI

Jesús Fernandéz-Villaverde Ph.D. jesusfv@econ.upenn.edu
University of Pennsylvania

Dirk Krueger, Ph.D. dkrueger@econ.upenn.edu
University of Pennsylvania

Statement

Dear Sir or Madam,

I apply to the NBER Graduate Student Workshop on Heterogeneous Agents Macroeconomics. My motivation to apply is threefold. First, I would like to learn more about the sequence-space approach to dynamic macroeconomic models and especially its extension which allows for discrete choices. While so far, I worked predominantly with the state-space formulation, I would like to expand my toolbox with the sequence-space alternative, since for many economies, it provides non-trivial tractability gains.

Second, I hope to obtain some comments/feedback on my working paper *Economics-Inspired Neural Networks with Stabilizing Homotopies* coauthored with Marlon Azinović. In this paper, we develop a new method for solving heterogeneous agent economies featuring multiple assets, non-trivial market clearing conditions, and significant aggregate risk. Currently, we are thinking about the economic application of our algorithm, so I hope I can obtain some feedback on our preliminary ideas. Third, I am really curious to hear about the practical application of HANK models in the FRBNY.

Thank you for considering my application.

Sincerely,
Jan Žemlička