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Shlok Goyal

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EDUCATION

Harvard University, Cambridge, MA **May 2027**
PhD in Business Economics
Supported by the *National Science Foundation Graduate Research Fellowship*

Carnegie Mellon University, Pittsburgh, PA **May 2020**
B.S. in Economics Cumulative GPA: 3.95/4.0
B.S. in Statistics and Machine Learning
Minor: Computer Science

PhD COURSEWORK (Macroeconomics)

- **Economic Theory** (ECON 2010C) – *Harvard University* Aug – Dec 2022
- **Economic Theory** (ECON 2010D) – *Harvard University* Jan – May 2023
- **Macroeconomics I** (ECON 47-803) – *Carnegie Mellon University* Oct – Dec 2019

EXPERIENCE

Senior Research Analyst, Federal Reserve Bank of New York – New York, NY **Jul 2020 – Jul 2022**
Worked for the Dynamic Stochastic General Equilibrium (DSGE) Team

- Improved computation of the stationary equilibrium in the Heterogeneous Agent New Keynesian model of "Shocks, Frictions, and Inequality in US Business Cycles" to enable fast estimation.
- Adapted the DSGE model for the pandemic by adding regime switching into the equilibrium conditions, parameter estimation, filter, smoother, and shock and forecast decomposition.
- Incorporated the shift in monetary policy to average inflation targeting. Agents have time-varying uncertainty about policy, taking weighted averages over multiple scenarios.
- Estimated Bayesian vector autoregression models with change points via a Gibbs sampler to brief the NY Fed President on debt sustainability.
- Extended the results of "Online Estimation of DSGE Models" to use the weighted average of multiple existing estimations as the starting point for a new Sequential Monte Carlo estimation.
- Devised a method to fully parallelize the tempered particle filter with time variation.
- Implemented an efficient algorithm to endogenously determine the zero lower bound's duration.
- Developed the Fed's open-source Julia packages: DSGE.jl, StateSpaceRoutines.jl, SMC.jl.
- Constructed a database of past forecasts using SQLite to evaluate historical forecast accuracy.
- Produced forecasts and quantitatively assessed economic risks to aid internal discussions.

Previously ***Summer Analyst*** **June – Aug 2019**

- Implemented a projection-based nonlinear solution method in Julia with anisotropic Smolyak grids and Anderson acceleration.

Recitation Leader, Carnegie Mellon University – Pittsburgh, PA **Jan – May 2020**

- Intermediate Microeconomics (Economics 230)

Research Assistant, Carnegie Mellon University
Antitrust Enforcement Actions Database. Supervisor: Martin Gaynor *Aug 2018 – May 2019*

- Wrote a web crawler in Python to create a dataset cataloging enforcement actions over 40 years.

Redistributive Politics with Target-Specific Beliefs. Supervisor: Christina Fong *Feb – Aug 2018*

- Solved under various conditions a model to understand preferences for income redistribution.

Research Analyst, Antitrust Division, U.S. Department of Justice – Washington, D.C. **May – Aug 2018**

- Helped develop a statistical package for simulating mergers in R to enable merger effect estimates.
- Calculated upward pricing pressure and diversion ratios to ascertain the effects of large mergers.
- Created mapping visualizations in R, used in identifying collusion and as exhibits in court cases.

Economics Intern, Office of Monetary Affairs, U.S. Department of State **Aug 2017 – May 2018**

- Constructed fixed effects and additive models in R to assess effects of debt relief on GDP growth and government expenditures, exploiting variation in when countries received the relief.
- Presented findings to the Assistant Secretary of State for Economic and Business Affairs.

RESEARCH PROJECTS

Abstracts provided at the end of the CV. Projects are solo authored unless stated otherwise.

Costs to Migration and Occupational Switching across Time (thesis advisor: Laurence Ales) **May 2020**

- Used Poisson Pseudo-Maximum Likelihood estimation and generalized additive models while exploiting spatial discontinuities to verify the state border effect in trade and migration.
- Used a migration model to estimate migration and occupational switching costs and intergenerational occupational mobility since the Industrial Revolution.

Generation and Style Transfer of Lyrics using GANs **May 2019**

Investigating Speech Adaptation with CNN (advisors: Peter Freeman and Charles Wu) **May 2020**
(with Esther Ahn, Yuk Yeung Lam, Lesley Lyu)

PRESENTATION / ARTICLES

"**Modeling the Economy During the Pandemic**" – *JuliaCon 2021* (with Alissa Johnson) July 2021
"**Does Lineup Balance Matter?**" (2018). *By the Numbers*, 28(1), 3-6. April 2018
"**New York Fed DSGE Model Forecast**" – *Federal Reserve Bank of New York Liberty Street Economics*
8 articles (with W. Chen, M. Del Negro, A. Gleich, A. Johnson et al.) Sep 2020 – Jun 2022
Media Coverage: Wall Street Journal | Telegraph | Bloomberg | Fortune | Financial Review

HONORS AND AWARDS

Best Tepper Senior Honors Thesis in Economics **2020**
Omicron Delta Epsilon Charles Phillips Outstanding Student Leadership Award **2020**
Distinguished Service to the Undergraduate Economics Program (sole recipient) **2020**
Andrew Carnegie Scholar (awarded by the college deans) **2020**
Presidential Scholarship (merit-based 4-year scholarship) **2016 – 2020**
Quantitative Social Sciences Scholar **2016 – 2020**
Phi Beta Kappa (early inductee; 1% of class selected) **2019**
1st Place, Global Challenges (Carnegie Mellon economics competition on climate policy) **2019**
Daniel L. Shaw Scholarship (sole recipient; received for Department of Justice internship) **2018**

EXTRACURRICULAR ACTIVITIES

Founder, Economics Research Club **Nov 2018 – Dec 2019**

- Led group of 30 students discussing economics research among themselves and with professors.
- Gave presentations on the methods underlying DSGE models and real-time forecasting.

Chair, Finance Committee, Student Senate **May – Dec 2017**

- Managed a $166,000 budget for capital improvements and student initiatives. Built a framework to improve consistency and communication in allocation decisions and reduced turnover by 60%.

Student Consultant, Allegheny Land Trust **May – Aug 2017**

- Analyzed data and created interactive visualizations for a non-profit to measure the effectiveness of the water treatment system at an abandoned mine site.

SKILLS

Programming and Software: Julia, R, Python, Excel (Advanced); C, C++, Java, SML (Intermediate)
Languages: English, Hindi (Fluent), Spanish (Conversational)

RESEARCH PROJECT ABSTRACTS

Costs to Migration and Occupational Switching across Time **May 2020**

This paper finds substantial negative effects of state borders on migrant and trade flows within the United States by exploiting spatial discontinuities. Existing explanations for the border effect like demographics or double-counting intrastate trade due to rural-rural trade going through urban centers are ruled out. Migrants are shown to modify the trade network of the place they move to, but migration rates are small enough that trade networks aren't substantially altered.

The paper also finds that the polarization of the American job market over the past 50 years contrasts with prior periods in US history. Costs to switching occupations are also measured. Historically, there were significant costs to switching out of agriculture and as a result, the shift from agriculture to manufacturing was slow. Intergenerational occupational mobility has increased for the median occupation over the past 170 years while declining recently for service workers.

Generation and Style Transfer of Lyrics using GANs **May 2019**

Song lyrics are generated from a Generative Adversarial Network (GAN). To get around the inability to pass the gradient update from the discriminative to the generative model due to the generator's discrete outputs, the data generator is treated as a stochastic policy in reinforcement learning. Lastly, hip-hop lyrics are transferred into the style of country lyrics and vice-versa using cross-alignment.

Investigating Speech Adaptation with CNN **May 2020**

We use electroencephalogram (EEG) data and a convolutional neural network (CNN) to investigate how the brain adapts when listening to new accents. Even though human subjects had difficulty identifying words spoken in an unfamiliar accent, the neural network using brain data did not. This suggests that people's brains begin noticing patterns to permit understanding unfamiliar accents well before this understanding is reflected in conversation.

Personal Statement

I would like to attend the workshop to better understand the empirical motivations for and implications of existing heterogeneous-agent models. I am also excited to learn about the state-of-the-art techniques for solving HANK models, especially as I spent time working in the field as an RA at the New York Fed. I also hope the workshop will prepare me to conduct research in areas I have great interest but hitherto little experience in, such as optimal monetary policy in open-economy HANK models.

I am particularly interested to learn about the research other participants are conducting in the space and to get feedback on my projects. My research interests broadly are in the transmission of monetary policy and the determinants of business cycles. Specifically, I am interested in how heterogeneity in firms' credit demand can affect the effectiveness and time lag of monetary policy. I also aim to study how heterogeneity in households' attention can affect coordination and the implications for the amplification of aggregate shocks.