Northwestern University

Aggregating Individual Decisions to Represent a Macro Economy

Ethan Sterling
EECS 372

Background

The Circular Economy Dynamics Model explores **how individual decisions aggregate to influence the macro economy**, simulating interactions between households and firms within a circular economy. **Based on the 3-Equation New Keynesian Model**, the agent-based model captures the essential dynamics of inflation, output, and interest rates.

This model aims to provide insights into **how economic policies and shocks affect these key indicators** by simulating the flow of goods, services, and money between households and firms.

Motivation

Creating an agent-based model can establish **macro-micro linkages** that are harder to achieve with traditional equation-based models. The model aims to provide insights into the complex interactions between households, firms, and macroeconomic variables like **inflation and output**. By simulating these dynamics, researchers and policymakers can better **understand how different policy interventions and economic shocks impact the overall economy.**

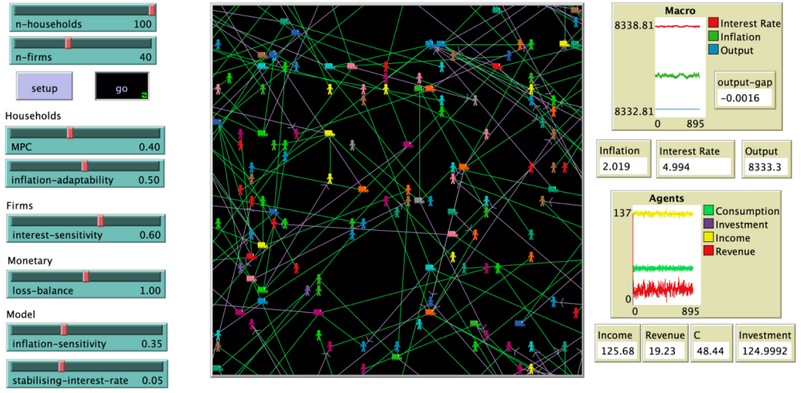
Model

Agents

The model simulates a circular economy with **households** and **firms**.

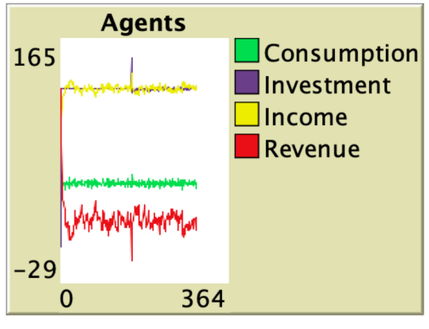
Rules

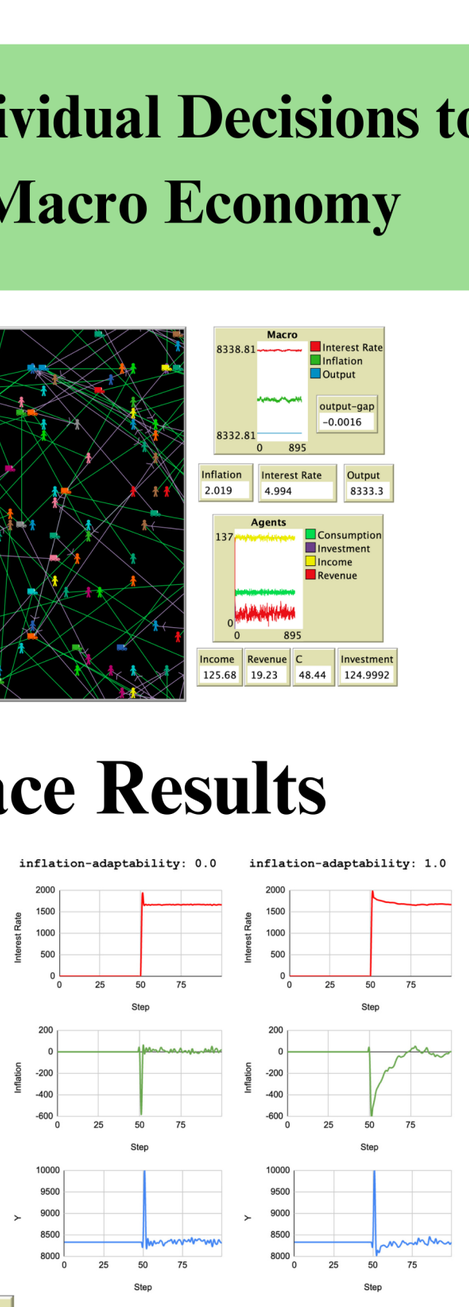
Households decide their consumption based on their **marginal propensity to consume** (MPC) and update their **inflation expectations adaptively**. Firms determine investment levels based on **interest sensitivity** and use these investments to pay wages to households. The model dynamically updates macroeconomic variables, including **inflation** and **output**, while adjusting **interest rates according to a policy rule** designed to stabilize the economy.



BehaviorSpace Results

Using BehaviorSpace, the experiment creates a **demand shock under different levels of household inflation-adaptability** [0, 0.25, 0.5, 0.75, 1] with base conditions such as a stabilizing interest rate of 0.05, inflation sensitivity of 0.35, MPC of 0.4, interest sensitivity of 0.6, 40 firms, 100 households, and a loss balance parameter of 1.

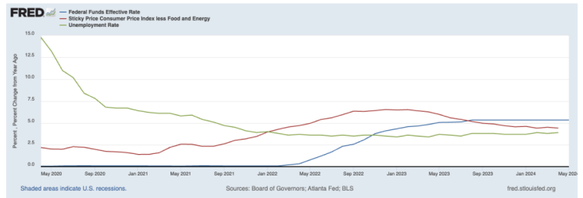




The results show that **higher inflation-adaptability leads to more responsive inflation adjustments and smoother economic stabilization but introduces greater volatility in output**. Visualizations include graphs depicting the behavior of key indicators like interest rates, inflation, and output across different levels of inflation-adaptability, along with agent behavior.

Analysis

Empirical validation using **data from the St. Louis Federal Reserve** supports the model's findings. The data shows the interest rate, inflation, and unemployment rate from May 2020 to May 2024, reflecting a demand shock during the COVID relief acts. The gradual increase in the interest rate, rising inflation and declining unemployment **align with the model's projections** following a demand shock.



In the experiment, **fully grounded inflation expectations led to a sharp spike in interest rates due to the central bank's aggressive stabilization efforts**. Inflation-adjusted slowly, resulting in significant drops and oscillations. **As inflation-adaptability increased households adjusted their expectations more moderately, leading to faster inflation stabilization and less aggressive interest rate adjustments.** Output fluctuated more due to significant interest rate adjustments by the central bank. These results **highlight the importance of managing inflation expectations in economic policy**, as different adaptability levels significantly influence the economy's resilience and response to demand shocks.

Future Work

Future enhancements to the model could include **utility optimization** behaviors for households, capturing a wider range of responses to economic incentives. For firms, **incorporating game theory** and more sophisticated investment and production functions could provide a deeper understanding of market dynamics. Additionally, **incorporating behavioral aspects** like bounded rationality and heterogeneous expectations would enhance the model's ability to simulate real-world economic complexities.