Reconstruction of an Agent-Based Simulation Model about Labor Market Policies

Master Thesis

Xi Niu

Abstract

In this master thesis an agent-based macroeconomic model used for economic policy experiments featuring a distinct geographical dimension and heterogeneous workers with respect to skill types is to be introduced and reconstructed with the help of the AOR simulation technology that was developed by the Chair of Internet Technology.

Zusammenfassung

In dieser Masterarbeit wird ein agenten-basiertes makroökonomisches Modell für die wirtschaftspolitischen Experimente mit einem eigenen geographischen Dimension und heterogenen Arbeitnehmern in Bezug auf Skill-Typen vorgestellt und mit Hilfe der am Lehrstuhl Internet-Technologie entwickelten AOR-Simulationstechnologie rekonstruiert.

Table of Contents

Introduction 1
The economic model 1
Background to the model 2
General description 2
Analysis of the model 3

I would like to express my sincere thanks to Prof. Dr. Gerd Wagner for his invaluable guidance and advice throughout the course of this thesis. Without his help this paper would not be possible.

Introduction

So far agent-based modeling (ABM) is a powerful simulation modeling technique that has been extensively developed and well used in a lot of areas, because it can provide many effective methods to facilitate the research into the complex problems of different scientific fields. The model which will be in this paper described aims to use ABM to explore the fields of economics to analyse the effects of different spatial concentrations of economic policy measures depend on spatial frictions in the labor market. The purpose of this paper is to remodel it as a multi-agent based simulation using the Agent-Object-Relationship (AOR) simulation technology that was developed by Prof. Dr. Gerd Wagner and other team members at the Brandenburg University of Technology.

The paper is organized as follows. In Section 2 the economic model will be introduced. Section 3 describes the principles of AOR modeling and simulation in which the model will be implemented. Section 4 provides some simulation results, and Section 5 concludes.

The economic model

This model is an agent-based closed macroeconomic model developed by Herbert Dawid, Simon Gemkow, Philipp Harting and Michael Neugart and it has been implemented in the Flexible Large-

Scale Agent Modeling Environment (FLAME) developed by Simon Coakley, Mike Holcombe and others at the University of Sheffield (see http://www.flame.ac.uk for more information and references).

Background to the model

The model was developed as part of a larger simulation platform for European policymaking known as EURACE. EURACE is a major project aiming at creating a complete agent-based model of the European economy for evaluating European economic policies. The EURACE project proposes an innovative approach to model a macroeconomic system according to the new field of agent-based computational economics (ACE). This project uses the ACE paradigm as an alternative of the rational representative agent model. The EURACE model has a distinct spatial structure simulating the regional statistical units used by Eurostat. It contains various (typically, regional) artificial markets for real commodities (that is, consumption goods, investment goods and labor) and markets for financial assets (such as loans, bonds and stocks). For a general overview of the EURACE model, see http://www.eurace.org.

General description

The model is a simplified model baded on EURACE's labor market module. Two types of active agents and two types of passive agents are present in this model. Active agents can take decisions, whereas passive ones can not. Each type of agent has one or several `roles' corresponding to its activities in the different markets, including an investment (or capital) goods, a consumption goods and a labor market. The following summarizes these roles.

Active Agents:

- Households
  - Comsumption Goods Market: Role of Buyer
  - Labor Market: Role of Worker
- Consumption Goods Producer (CGP)
  - Investment Goods Market: Role of Buyer
  - Consumption Goods Market: Role of Seller
  - Labor Market: Role of Employer

Passive Agents:

- Malls
  - Consumption Goods Market: Information Transfer between Consumption Goods Producers and Households
- Capital Goods Producer (IGP)
  - Investment Goods Market: Role of Seller

Thus, the main actors in the investment goods market are IGP and CGPs. In this market, the investment goods are offered by the unique IGP with infinite supply and there exists only one type of investment goods. The investment goods are sold to CGPs. The quality and price of supplied investment goods increase randomly over time.

CGPs, Households and Malls take part in the consumption goods market. The consumption goods are sold at malls. The malls are simply treated as local market platforms. CGPs store and offer consumption goods at every regional mall and post quantities and prices of goods. Households collect

information about quantities and prices of goods offered at their malls and then purchase goods according to their preferences and available stocks of goods.

CGPs and Households play in the labor market. CGPs open some positions for households. A search-and-matching process is used to represent the interaction between CGPs and Households in this market.

Analysis of the model

Households

The household plays an important role in this model. He follows plausible rules for saving, purchasing, looking for a better job while employed or trying to find a job while unemployed. The Household is characterized by

1. A general skill level
2. Specific skills

The general skill level is heterogeneous within and across regions. The specific skills are acquired on the job to fully exploit the technological potential of the capital used in the production process. The higher the general skill level of a household, the faster it acquires the specific skills associated with a given job.

Overall, a household makes some decisions with different roles affecting the different markets as follows:

1. Allocate budget on consumption and saving
2. Choice of consumption goods
3. Search for a job
4. Acquire specific skills

Allocate budget on consumption and saving

The households who are employed receive wages from their employers, whereas the unemployed get benefits from the government. All households receive dividends distributed by producers. Each household sets once a month the consumption budget which is spent on the consumption goods market based on his income and assets carried over from the previous period and consequently determines the remaining part which is saved.

Table 1. The savings decision

Variable/ Parameter	Symbol	Name (in the sim model)	Description	Value
private saving account	$Ass_{k,t}$	savingAccount	The remaining part of the cash on hand from period t-1 after deducting the consumption budget	*0.0*
personal consumption budget	$B_{k,t}^{cons}$	consumptionBudget	A household k decides about the budget that he will spend in period t	*0.0*
cash on hand	$Liq_{k,t}^{Avail}$	cashOnHand	The cash on hand of a household in period t	*0.0*
current income	$Inc_{k,t}$	currentIncome	In period t a household k receives income	*1.0*

Variable/ Parameter	Symbol	Name (in the sim model)	Description	Value
mean income	$Inc_{k,t}^{Mean}$	meanIncome	The mean individual (labor) income of a household over the last periods	*0.0*
the percentage of mean income	Φ	phi	$\Phi \leq 1$ is the percentage of the mean income such that a household spends all cash on hand below that level	*0.9*
marginal saving propensity	κ	savingPropensity	$0 < \kappa < 1$ the saving propensity	*0.1*

Algorithm: There exists a critical value of cash on hand. When the available liquidity is below this critical value the whole cash on hand will be spent. In the opposite case the household will save a part of his cash on hand. The assets act like a buffer stock which protect consumption against bad income draws.

Formula: The household sets his consumption budget according to the following consumption rule

$$B_{k,t}^{cons} = \begin{cases} Liq_{k,t}^{Avail} - k * \left(Liq_{k,t}^{Avail} - \Phi * Inc_{k,t}^{Mean} \right) & Liq_{k,t}^{Avail} > \Phi * Inc_{k,t}^{Mean} \\ Liq_{k,t}^{Avail} & Liq_{k,t}^{Avail} \leq \Phi * Inc_{k,t}^{Mean} \end{cases} \quad (1)$$

Choice of consumption goods

Once a week the household visits the (regional) mall to purchase consumption goods. When visiting the mall each consumer collects information about the range of goods provided and about the prices and inventories of the different goods. The model does not include any kind of horizontal product differentiation, nor any kind of quality differentiation. Therefore, choice probabilities depend solely on prices.

Consumers make their purchasing decisions based on the posted prices using a stochastic rule as described in a standard logit model. In the Marketing literature it is standard to describe individual consumption decisions. This model represents the stochastic influence of factors not explicitly modeled on consumption decisions, see [Guadagni and Little 1983].

Table 2. Selection of consumption goods

Variable/ Parameter	Symbol	Name (in the sim model)	Description	Value
available stocks of goods	$G_{k,week}$	availableProducts	The set of products consumer k has sampled in week (of period t)	*null*
the intensity of choice by consumer				

Consumption goods producer (CGP)

Consumption goods are produced with labor and physical capital as input factors. The physical capital is purchased on the investment goods market. The Consumption goods producer pays out dividends to all households and the dividends are equally distributed to the households.

In their various roles consumption goods producers have to make decisions:

- Production quantity
- Investment in capital goods
- How much labor to hire
- At which mall to sell
- How much to deliver at a mall
- Which price to set