An Agent-Based Model of Economic Growth in Innovation Ecosystems

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Christopher D. Hollander
Ivan Garibay
Complex Adaptive Systems Laboratory
University of Central Florida
Orlando, FL, USA

In collaboration with:
Thomas O’Neal (Office of Research & Commercialization)
Cameron Ford (College of Business Administration)
University of Central Florida
Orlando, FL, USA
Introduction

• We are in the process of creating an agent-based model of economics that treats economies as ecosystems.
• We are doing this to gain a better understanding of the relationship between innovation and economic growth.
  – Because current growth models oversimplify
Overview

• The Model
  – Foundational concepts
  – Agents
  – Output
    • Network structures
    • Macroeconomic Measures

• The Experiments
FOUNDATIONAL CONCEPTS
Basic Circular Flow Model

Source: google images, “circular flow model” – Original author unknown
Ecological Networks

Source: http://dx.doi.org/10.1016/j.ocecoaman.2012.05.017
Transformation Rules

\{X\} \rightarrow \text{Transformed Into} \rightarrow \{Y\}

Resources --> Resources
Economic Ecosystem
One Source / One Sink (OSOS) System
AGENTS
Implicit Agents

Environment

Spatial Environment

Government
Source Agents

Resources from Environment → $R_{\text{out}}$ → Resources to Agents

Money to Government ← $R_{\text{out}}$ ← Money from Agents

Actions: Trade, Adjust Prices
Adaptive Resource Transformers

Resources to Environment

Resources from Agents \( R_{in} \) \( R_{out} \) Money to Agents

Money to Agents \( $ \) Money from Agents

Money to Government

Actions: Move, Trade, Produce, Adjust Prices, Reproduce, Die
Sink Agents

Resources from Agents → $R_{in}$ → Resources to Environment

Money to Agents ← $R_{in}$ ← Money from Government

Actions: Move, Trade
Economic Ecosystem
One Source / One Sink (OSOS) System
Simulation

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<tr>
<th>Setup</th>
<th>Go</th>
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<th>On/Off births?</th>
<th>On/Off death?</th>
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**Source Controls**

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**Reproduction**

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Network Structures and Macroeconomic Measures

OUTPUT
Interaction Network
Species Network

0 -> 0
0 -> 1
1 -> 2
2 -> 3
3 -> 1
3 -> 3
Transformation Network

Type I Innovation

Type II Innovation
Macroeconomic Measures

- GDP
- Technology Distribution
- Wealth Distribution
- Transformation Network Density
- Production
- Price
- Population
EXPERIMENTS
Experiments

• Replication of experiments done using similar simulations

• Does economic assistance impact economic performance?
  – GDP per Capita
  – Price
  – Production

• Does economic assistance change the density of the transformation network?

• Does economic assistance change the population size?

• 6 experiments at 20 Replications each (using CRN)
• Money and Resources | Young, Old, Random
Results: GDP per Capita

Data > 0 implies GDP per Capita is higher when there is assistance
Results: Price

Data > 0 implies Price is higher when there is assistance
Results: Production

Data > 0 implies Production is higher when there is assistance
Results: Transformation Network

Data > 0 implies Transformation Density is higher when there is assistance.
Results: Population

Data > 0 implies Population is higher when there is assistance
Results Summary

• Economic assistance
  – Has broad and unexpected impacts
  – Results depend on who gets assistance and what type of assistance they get
  – Can have a long lasting impact on the economy

• These results are consistent with earlier versions of our model.
Questions or Feedback?

THANK YOU!