Long Tail Economic Recovery from an Epidemic

By Kevin McCabe and Sarah Sylvester

Abstract

We use an agent-based model of decentralized economic exchange to demonstrate the potential problems to economic recovery after a large-scale epidemic. Our model shows convergence to highly efficient market exchange pre-epidemic, a significant drop in efficiency during the epidemic, and a post-epidemic recovery to higher market efficiency. However, the recovery from the epidemic shows a long tail efficiency loss during the recovery process. This long-term loss is due to greater market fragmentation resulting in less gains from exchange. The policy implication of this model is to pursue top-down policies and bottom-up incentives to that make markets more resilient to fragmentation.

Economic Environment

Agents are either buyers with reservation values or sellers with unit costs. Agents live and move on a square grid.

Economic Institutions

Agents interact with institutions by sending and receiving messages. We explicitly model three institutions:

1. Travel Institution
2. Matching Institution
3. Negotiation Institution

Agent Strategies

Agents negotiate as zero-intelligence traders.

We consider three types of travel strategies:

1. Random Movement: No stopping
2. Random Movement: Stop at first contract
3. Random Movement: Stop at first contract but leave if n > m. Set m = 2, 3, 4.

Market Timing

A simulation consists of trials t = 1, …, T.

At the beginning of each trial t, agent’s reservation prices and unit costs are initialized, and each agent is randomly assigned a grid point.

A trial consists of weeks w = 1, …, W.

At the beginning of each week, agents current working unit is reset to zero.

A week consists of days, d = 1, …, D.

At the beginning of each day, agents can decide to move in any valid unit direction from their current location.

A day consists of bargaining rounds, r = 1, …, R.

Only buyers and sellers at the same location on the grid can bargain with one another.

Each round r consists of an offer stage and an acceptance stage.

In the offer stage agents place WTP for one unit or WTA for one unit in the order book.

In the acceptance stage agents take turns, in random order, accepting zero or one order in the order book. An acceptance becomes a contract that is immediately fulfilled.

Data is collected by the time tuple an offer, acceptance, or contract is indexed by (t, w, d, r), travel decisions are indexed by (t, w, d), market performance is indexed by (t, w), and simulation performance is indexed by (t).

Simulations

1. Calibration
   1. Result 1: Choose parameters to hit 90% efficiency
2. Compare strategies 1 and 2: Efficiency
   1. Result 2: Strategy 2 outperforms 1
   2. Reason: Amount of Market Fragmentation
3. Compare strategies 1, 2, and 3 (varying m): Efficiency
   1. Result 3: Strategy 3 varies between strategy 1 and strategy 2 depending on m (I think)
   2. Reason: Amount of Market Fragmentation
4. Run strategy 2 for a while, inject strategy 3-m for some number of weeks, return to strategy 2.
   1. Result 4: Recovery does not reach pre-epidemic levels
   2. Reason: Pandemic introduces new market fragmentation

Conclusions

1. Model strengths and weaknesses.
2. Importance of reducing new market fragmentation in pandemics.