Labor Mobility and Geography of Pandemics

Erhan Artuc
Caglar Ozden
He Wang

Development Research Group
World Bank
Motivation

• COVID-19 Pandemic is the ultimate economic externality...
  • People spreading it are least likely to be impacted

• Epidemiology (SIR) models are good at capturing this
  • Pandemic is spread through mobility of people – both within and across cities

• Two shortcomings:
  • Mobility of people is endogenous
  • Policy interventions have spillovers and distributional impacts

• Need to merge endogenous labor mobility model with SIR model
Questions

• How mobility impacts spread of outbreak? (and vice versa)

• How different policies impact spread of outbreak, labor mobility and welfare?

• How policy responses in one city spill over to other cities?

• (Why) do we need policy coordination?
Additional points

• Different risk levels across individuals
  • Low-risk: Mild or no symptoms, usually young and no pre-existing conditions
  • High-risk: Severe symptoms, possibly fatal, old and pre-existing conditions

• Low-risk people put high-risk individuals in danger → First externality

• Different risk levels across cities (or countries)
  • Heterogeneity of optimal response based on stage of outbreak
  • Spillovers across cities → Second externality

• Bring some concepts from trade and migration literatures
  • Need dynamics and high frequency, cannot use the most standard models
Mobility

Stay home or go out in own city

City 1

Pay moving cost

City 2

City 3
Discrete choice

Agent in city 1

Choose business to interact, pay moving cost, visit, and return

Produce at home

Interact with a local business

City 1
- Business 5
- Business 6
- Stay home

City 2
- Business 3
- Business 4

City 3
- Business 1
- Business 2
Health transition (SIR)

Susceptible

Number of infected in visited city impacts probability (staying home reduces)

Infected

Recovered

Deceased

Two agent types: high-risk and low-risk

Probability depends on risk level + congestion in healthcare system
Bellman equation (w/ expectation)

\[ V_{i,t}^{s,h} = \omega_{t}^{s,h} + \sum_{j} m_{i,j,t}^{s,h} \left( -\nu \log m_{i,j,t}^{s,h} + \nu \log N_{j,t}^{s,h} - C_{i,j,t}^{s,h} + \sum_{h'} \pi_{j,t}^{s} (h,h') \beta E_{t} V_{i,t}^{s,h'} \right) \]
Simulations

- Time unit = 1 week, discount factor $\beta=0.998$
- Three cities:
  - Each city has 4 businesses plus an option to stay home for locals
  - 50% high-risk population, 50% low-risk population
  - City 1 has 5% infected initially, otherwise identical
- Marginal weekly infection rate is 0.9 (but 0.3 while at home)
- Recovery takes approximately 3 weeks
- Death probability
  - for low-risk: 0.5%
  - for high risk: 5% (+ increasing)

→ We consider city-isolation and social distancing scenarios
Mobility before COVID-19
Infection & cumulative death dynamics

Infection dynamics in city 2

Cumulative deaths in city 2
Mobility dynamics

Low-risk, from city 2

High-risk, from city 2
Policy I - Isolate city 1

Infection dynamics (high risk)

Cumulative deaths (high risk)
Policy I - Isolate city 1

% Death (high-risk)

%Annual output loss (compared with pre-COVID19)
Policy I - Isolate city 1

Values (average discounted present)
Policy I - Isolate city 1

Death vs. average value
(Duration changing from 8 weeks to 50 weeks)
Policy II - Isolate all cities

Infection dynamics (high-risk)

Cumulative deaths (high-risk)
Policy II - Isolate all cities

%Death (high-risk)

%Annual Output loss (compared with pre-COVID19)
Policy III - Social distancing in city 3

Infection dynamics (high-risk)

Cumulative deaths (high-risk)
Policy III - Social distancing in city 3

%Death (high-risk)

% Loss in annual output (compared with pre-COVID19)
Policy III - Social distancing in city 3

Values (average discounted present)
Conclusion

• Labor mobility and spread of outbreak impact each other

• There are strong externalities across individual decisions as well as local policies

• Policy coordination at federal and global level is crucial

• Future work: Calibrate model using data
Thank you.

eartuc@worldbank.org

cozden@worldbank.org

hwang21@worldbank.org