# Review: The Hammer and the Scalpel: On the Economics of Indiscriminate versus Targeted Isolation Policies during Pandemics

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# Overview

- The paper talks about a simple dynamic economic model of epidemic transmission consistent with SIR Model of transmission of epidemics.
- There is a trade-off between the losses to economic activity associated with limiting contact and the gains from reduced transmission of the virus arising from reduced healthcare cost, lower strains on hospitals, and fewer deaths.
- The final goal is to maximise the welfare in such situation using various intervention policies, like testing and isolation

# Models

Three main models are considered in the paper

- Baseline Model with no Intervention
- Model with Testing
- Model with Isolation and no Testing

# Baseline Model

- In this model, dynamics of the system are formulated where there is no intervention from government.
- 4 types of people considered in system : S, I , I’, R
- N activities are considered with each having pi associated which tells the probability that susceptible person who meets an infected person gets infected.
- For each time period t, Mi meetings considered for each activity i.
- The probability of being infected in Mi meetings is:

$$1-\left(1-p_i\frac{\lambda_{it}\tilde{I}_t}{L_{it}}\right)^{M_i},$$

$$L_{it}=\lambda_{it}(S_t+\tilde{I}_t)+\mu_{it}R_t.$$

# Laws of Motion

$$S_{t+1} = S_t - \sum_i \lambda_{it} S_t \left(1 - \left(1 - p_i \frac{\lambda_{it} \tilde{I}_t}{L_{it}}\right)^{M_i}\right).$$

$$S_{t+1} = \left[1 - \sum_i \left(\lambda_{it} \pi_i \frac{\lambda_{it} \tilde{I}_t}{L_{it}}\right)\right] S_t$$

$$\tilde{I}_{t+1} = (1-\gamma)(1-\tilde{\tau})\tilde{I}_t + S_t \sum_i \left(\lambda_{it} \pi_i \frac{\lambda_{it} \tilde{I}_t}{L_{it}}\right),$$

$$R_{t+1} = R_t + \gamma (1 - S_t - R_t).$$

# Model with testing

- At the beginning of each period, each person whose type is not known (S or I) is associated with a public signal that he is infected
- The mass of agents receiving a signal of infection is θs*S + θi*I. The planner chooses the fraction τ of these individuals to test.
- Testing is considered accurate and once tested positive, they are removed from system, until they recover
- Law of motion becomes: $\tilde{I}_{t+1} = (1-\tau\theta_I)\left[(1-\gamma)(1-\tilde{\tau})\tilde{I}_t + S_t \sum_i \left(\lambda_{it}\pi_i \frac{\lambda_{it}\tilde{I}_t}{L_{it}}\right)\right].$ $L_{it} = \lambda_{it}\left(S_t + (1-\tau\theta_I)\,\tilde{I}_t\right) + \mu_{it}R_t$
- The output is:

$$y_{it} = b_i\left(\lambda_{it}(S_t + (1-\tau\theta_I)\,\xi\tilde{I}_t) + \mu_{it}R_t\right).$$

# Planning Problem

So here we see that there is a cost associated with testing. The planning problem is to choose a testing policy τt, labor allocation policies λit and μit to solve:

$$\max \sum_{t=0}^{\infty} \beta^{t} \left[ U\left(Y_t - C\left(\tau_t\left(\theta_S S_t + \theta_I I_t\right)\right)\right) - Z_t\left(I_t\right) - D_t\left(\gamma \delta I_t\right) \right]$$

# Model with Isolation and no Testing

- The planner does not test but simply isolates some fraction of the agents who have received signals in the current period
- One advantage of this policy is that it does not require the use of testing resources.
- A disadvantage of this policy is that some fraction of susceptible people are also removed from productive economic activity

# Laws of motion

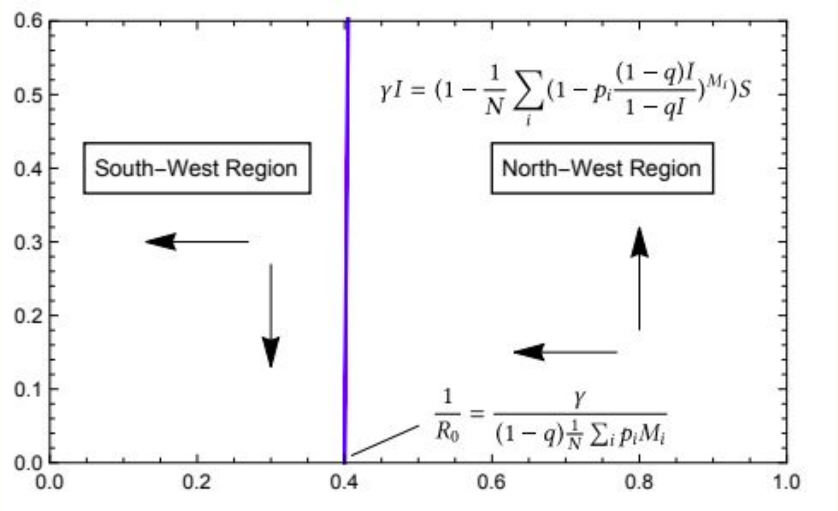
$$\tilde{I}_{t+1} = (1-\gamma)(1-\tilde{\tau})\tilde{I}_t + (1-\tau\theta_S) S_t \sum_i \left(\lambda_{it}\pi_i \frac{\lambda_{it}(1-\tau\theta_I)\tilde{I}_t}{L_{it}}\right).$$

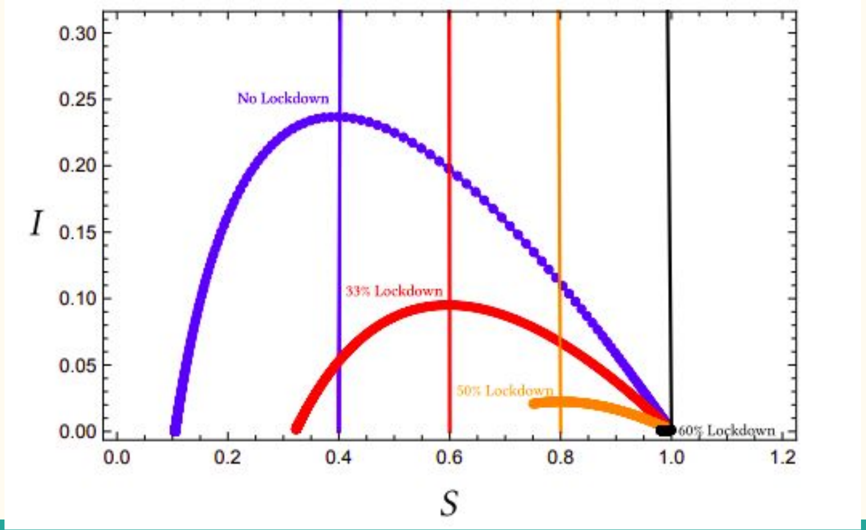
$$L_{it} = \lambda_{it}\left((1-\tau\theta_S) S_t + (1-\tau\theta_I)\tilde{I}_t\right) + \mu_{it} R_t$$

$$y_{it} = b_i\left(\lambda_{it}\left((1-\tau\theta_S) S_t + (1-\tau\theta_I)\xi\tilde{I}_t\right) + \mu_{it} R_t\right).$$

# Analysis: Simpler Case of Dynamics

Fraction of agents who are known to be infected relative to the mass of infected agents is constant = q. The system converges to a steady state where at most 1/R0 agents avoid infection. As R0 → ∞, the fraction of individuals who never get infected goes to zero



# Analysis: Comparison of various models

Table 2: Results on welfare, deaths, and output loss

| Experiment | Welfare gain relative to no-intervention | Cumulative deaths | Output loss |
|---|---|---|---|
| No intervention | 0 | .48% | 1.3% |
| Opt policy: no testing | .59% | .35% | 1.94% |
| Opt policy: untargeted testing | .71% | .3% | 2.06% |
| Targ Test ($\theta_s = .0044, \theta_I = .38$) | 3.07% | .15% | 1.28% |
| Targ Isolation ($\theta_s = .0044, \theta_I = .38$) | 2.12% | .26% | 1.66% |

Table 3: Sensitivity analysis with respect to signal parameters

| Experiment | Welfare gain relative to no-intervention | Cumulative deaths | Output loss |
|---|---|---|---|
| Targeted Test ($\theta_s = .03, \theta_I = .4$) | 3.39% | .14% | 1.10% |
| Targeted Isolation ($\theta_s = .03, \theta_I = .4$) | 1.75% | .28% | 1.79% |
| Targeted Test ($\theta_s = .03, \theta_I = .6$) | 5.7% | .04% | .19% |
| Targeted Isolation ($\theta_s = .03, \theta_I = .6$) | 3.99% | .09% | 1.56% |
| Targeted Test ($\theta_s = .03, \theta_I = .15$) | .78% | .3% | 2.03% |
| Targeted Isolation ($\theta_s = .03, \theta_I = .15$) | .71% | .34% | 1.99% |