Why Markets Fail? The Economics of Covid-19

Part 4: The SIR Model

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How Epidemiologists (Social Scientists) Model Infection/Transmission Rates

The SIR Model:

$$\Delta \text{ Infection} = \beta \text{ Susceptible Population} \times \text{Infected Population} - \gamma \text{ Infected Population}$$

- Susceptible Population $\times$ Infected Population is the number of potential interactions
- β is the rate at which potential interactions lead to a new infection. It is the likelihood each interaction occurs times the likelihood of transmission.
- γ is the recovery rate from the infection

Lockdown, Testing, Social Distancing, Travel

- Lockdown reduces infection by removing a fraction $1 - \theta$ of the susceptible and infection populations

  $$\Delta \text{ Infection} = \beta\ (\theta \text{ Susceptible Pop.}) \times (\theta \text{ Infected Pop.}) \\ -\gamma \text{ Infected Population}$$

  So a lockdown has a quadratic effect on infection rate

  $$\Delta \text{ Infection} = \beta\ \theta^2 \text{ Susceptible Pop.} \times \text{Infected Pop.} \\ -\gamma \text{ Infected Population}$$

- Testing helps because it leads to more lockdowns of the Infected Population.
- Social distancing reduces β (the likelihood of transmission).
- Travel equalizes the Infected Population across regions.

Lessons

- The value of testing, contact tracing, vaccines, and treatment is complex
- Models, particularly ones that carefully anticipate economic behavior, are essential in the social sciences
- Even when models are simple and hard to calibrate, they help us link policy to outcomes