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
- \( \beta \) is the rate at which potential interactions lead to a new infection. It is the likelihood each interaction occurs times the likelihood of transmission.
- \( \gamma \) 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 $\beta$ (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