Optimal Mitigation Policies in a Pandemic: Social Distancing and Working from Home

Thomas Philippon

NYU, NBER, CEPR

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SIR Model with Death, Sickness and Congestion

Our model

\[ S_{t+1} = S_t - \gamma e_t l_t \frac{S_t}{N} \]

\[ l_{t+1} = \gamma e_t l_t \frac{S_t}{N} + (1 - \rho) l_t - \delta_t \kappa l_t \]

\[ R_{t+1} = R_t + \rho l_t \]

\[ D_{t+1} = D_t + \delta_t \kappa l_t \]

The number of sick people is \( \kappa l_t \) with \( \kappa = 0.15 \). Health congestion

\[ \delta (\kappa l_t) = \bar{\delta} + \exp (\phi l_t) - 1 \]

CFR 1% in normal time, up to 4% when hospitals overwhelmed (Italy)
Calibrated Exogenous Model: 0.1% shock

- Infected, %
  - plots showing the percentage of infected individuals over time.

- Newly Infected, $\gamma e_t s_i i_t$
  - plots showing the rate of newly infected individuals over time.

- Susceptible (LHS) and Dead (RHS), %
  - plots showing the percentage of susceptible and dead individuals over time.

- Case Mortality, $\frac{\kappa \delta_i}{\rho + \kappa \delta_i}$
  - plots showing the case mortality rate over time.
Our Model

Households

\[ U = \sum_{t=0}^{\infty} \beta^t u(c_t, l_t, it, dt) \]

where

\[ u(c_t, l_t; i_t, d_t) = (1 - d_t - \kappa i_t) \left( \log(c_t) - \frac{\frac{l_t^{1+\eta}}{1+\eta}} \right) \]

\[ + \kappa i_t (\log(c_t) - u_\kappa) - u_d d_t \]

and

\[ e_t = \bar{\epsilon} + e^C_t + e^L_t \]
Calibration

- $\bar{e} = e^c = e^l = \frac{1}{3}$ consistent with Ferguson (2020)
- $u_s = 0.5$ and $u_d = 2$ large non-monetary costs consistent with EPA’s estimates
- Working from home

$$e^H_t = e^l (1 - m_t) l_t (1 - M_t) L_t$$

Dingel and Neiman (2020) estimate that one-third of jobs in the US can be done from home: $\Delta \chi = 0.34$
Decentralized Equilibrium
Planning Solution

- Labor ($\ell$) and Cons ($\hat{\ell}$)
- Learning, $\bar{m}$
- Working From Home, $m_t$
- Exposure, $e_t$
- $\lambda_e$
- $V_s - V_i$

Legend:
- Exogenous
- Macro
- Work from Home
Working from Home

Baisse du PIB par pays (%)

Source: Barrot, Grassi, and Sauvagnat (2020)
Fatalism & Perverse Incentives

$V_{s,t}, V_{i,t}$, Equilibrium, $\phi = 0$

$V_{s,t}, V_{i,t}$, Planner, $\phi = 0$

$V_{s,t}, V_{i,t}$, Equilibrium, $\phi > 0$

$V_{s,t}, V_{i,t}$, Planner, $\phi > 0$
Conclusion

- Working from home has major implications
- Perverse private incentives
- Especially with risk of congestion