Globalization and Pandemics

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Motivation

• What is the relationship between globalization and pandemics?
  • Does globalization make societies more vulnerable to pandemics?
  • How do pandemics affect globalization (present and future)?
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  - Gravity model of trade
  - $R_0$ and disease dynamics are endogenous to trade
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• We introduce forward-looking endogenous social distancing
Model: Trade

- Welfare of households in country $i$

$$W_i = \left( \sum_{j \in J} \int_0^{n_{ij}} q_{ij}(k) \frac{\sigma - 1}{\sigma} dk \right)^{\frac{\sigma}{\sigma - 1}} - \frac{c}{\phi} \sum_{j \in J} \mu_{ij} (d_{ij})^\rho \times (n_{ij})^\phi,$$
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- Iceberg trade costs $\tau_{ij} = t_{ij} \times (d_{ij})^\delta$

- Human Contacts $n_{ij} = \left( c \left( \frac{\sigma-1}{\phi} \right) \mu_{ij} \left( d_{ij} \right) \right)^{\frac{1}{\phi-1}} - \frac{\sigma}{\phi} (t_{ij})^\rho Z_j P_i - \left( \frac{\sigma}{\phi} \right) \left( w_i P_i \right)^{\frac{1}{\phi-1}}$

- Gravity $\pi_{ij} = \left( \frac{w_j}{Z_j} \right)^{\frac{\sigma}{\phi}} - \phi \left( \frac{\sigma-1}{\phi} \right) \left( \frac{\phi-1}{\phi} \right) (\mu_{ij})^{\frac{1}{\phi-1}} \left( d_{ij} \right)^{\frac{\sigma}{\phi-1}} + \phi \left( \frac{\sigma-1}{\phi} \right) \delta (\phi-1) (t_{ij})^{\rho} Z_j P_i - \left( \frac{\sigma}{\phi} \right) \left( w_i P_i \right)^{\frac{1}{\phi-1}} \left( \frac{\phi-1}{\phi} \right) (\mu_{ij})^{\frac{1}{\phi-1}} \left( d_{ij} \right)^{\frac{\sigma}{\phi-1}}$
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$$W_i = \left( \sum_{j \in \mathcal{J}} \int_0^{n_{ij}} q_{ij}(k) \frac{\sigma-1}{\sigma} \, dk \right)^{\frac{\sigma}{\sigma-1}} - \frac{c}{\phi} \sum_{j \in \mathcal{J}} \mu_{ij} (d_{ij})^{\rho} \times (n_{ij})^{\phi},$$

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$$n_{ij} = \left( c \,(\sigma - 1) \, \mu_{ij} \right)^{-1/(\phi-1)} \,(d_{ij})^{-\frac{\rho+(\sigma-1)\delta}{\phi-1}} \left( \frac{t_{ij} w_j}{Z_j P_i} \right)^{-\frac{\sigma-1}{\phi-1}} \left( \frac{w_i}{P_i} \right)^{1/(\phi-1)}$$
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\[ n_{ij} = (c (\sigma - 1) \mu_{ij})^{-1/(\phi - 1)} (d_{ij})^{-\frac{\rho + (\sigma - 1)\delta}{\phi - 1}} \left( \frac{t_{ij} w_j}{Z_j P_i} \right)^{-\frac{\sigma - 1}{\phi - 1}} \left( \frac{w_i}{P_i} \right)^{1/(\phi - 1)} \]

- Gravity

\[ \pi_{ij} = \left( \frac{w_j}{Z_j} \right)^{-\frac{\phi(\sigma - 1)}{\phi - 1}} \times (\mu_{ij})^{-\frac{1}{\phi - 1}} (d_{ij})^{-\frac{\rho + \phi(\sigma - 1)\delta}{\phi - 1}} (t_{ij})^{-\frac{\phi(\sigma - 1)}{\phi - 1}} \sum_{\ell \in J} \left( \frac{w_\ell}{Z_\ell} \right)^{-\frac{(\sigma - 1)\phi}{\phi - 1}} \times (\Gamma_{i\ell})^{-\varepsilon} \]
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- Welfare gains from trade (at household level)
  \[ W_i = \frac{\phi (\sigma - 1) - 1}{\phi (\sigma - 1)} \times (\pi_{ii})^{-\frac{(\phi - 1)}{\phi (\sigma - 1) - 1}} \times \left( \frac{(Z_i)^{\phi (\sigma - 1)}}{c (\sigma - 1)} (\Gamma_{ii})^{-\varepsilon (\phi - 1)} \right)^{\frac{1}{\phi (\sigma - 1) - 1}} \]
Model: Pandemic

- Dynamics of infection in two-country SIR model

\[
\begin{bmatrix}
\dot{I}_1 \\
\dot{I}_2 \\
\end{bmatrix} =
\begin{bmatrix}
2\alpha_1 n_{11} S_i \\
(\alpha_2 n_{12} + \alpha_1 n_{21}) S_2 \\
\end{bmatrix}
\begin{bmatrix}
I_1 \\
I_2 \\
\end{bmatrix} -
\begin{bmatrix}
\gamma_1 & 0 \\
0 & \gamma_2 \\
\end{bmatrix}
\begin{bmatrix}
I_1 \\
I_2 \\
\end{bmatrix}
\]

- Disease can only be contained (stable pandemic-free equilibrium) if both countries' disease reproduction under autarky is less than one:

\[
R_0 \geq R_0 \bigg|_{n_{12} = n_{21} = 0} = \max \left\{ \frac{2\alpha_1 n_{11}}{\gamma_1}, \frac{2\alpha_2 n_{22}}{\gamma_2} \right\}
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- \( R_0 \) determined by spectral radius of next generation matrix \( FV^{-1} \)

\[
R_0 = \frac{1}{2} \left( \frac{2\alpha_1 n_{11}}{\gamma_1} + \frac{2\alpha_2 n_{22}}{\gamma_2} \right) + \frac{1}{2} \sqrt{\left( \frac{2\alpha_1 n_{11}}{\gamma_1} - \frac{2\alpha_2 n_{22}}{\gamma_2} \right)^2 + 4 \left( \frac{\alpha_2 n_{12} + \alpha_1 n_{21}}{\gamma_1 \gamma_2} \right)^2}.
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- Gradually increase $\alpha_2$ while holding $\alpha_1 = 0.04$ constant

\[\alpha_1 = 0.04, \alpha_2 \in [0.04, 0.10].\]
Proposition

Suppose that countries are symmetric, in the sense that $L_i = L$, $Z_i = Z$, $\Gamma_{ij} = \Gamma$, $\alpha_i = \alpha$, and $\gamma_i = \gamma$ for all $i$. Then, a decline in any (symmetric) international trade friction:

(i) decreases the likelihood of a pandemic-free equilibrium being stable
(ii) increases the share of steady-state infected in both countries
Asymmetries in Contagion and Recovery

Proposition

When the contagion rate $\alpha_i$ and the recovery rate $\gamma_i$ vary sufficiently across countries, a decline in any international trade friction increases the likelihood of a pandemic-free equilibrium being stable.
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When the contagion rate $\alpha_i$ and the recovery rate $\gamma_i$ vary sufficiently across countries, a decline in any international trade friction increases the likelihood of a pandemic-free equilibrium being stable.
Other Results (Stay Tuned)

- Other results from our analysis
  - Multiple waves of infection in open economy without lock-downs
  - Characterize globalization and steady-state share of susceptibles
  - Incorporate terms of trade effects through endogenous labor supply
  - Dynamic forward-looking model of endogenous social distancing
  - Add adjustment costs - fear of future pandemics leads to slow recovery
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\[ R_1 = 1.08, \quad R_2 = 1.66, \quad R_0 = 1.66 \]