Recessionary Shocks, Economic Resilience, and International Trade

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Two recessions with a large trade collapse and yet different recoveries

(a) Great Recession

(b) Covid-19 recession
A stronger resilience in 2020

(a) Great Recession

(b) Covid-19 recession

- Measuring resilience: cumulative deviation from pre-recession trend
- Trade-to-GDP ratio is twice as resilient during the Covid-19 recession: Why?
This paper

What determines the resilience of international trade to macroeconomic shocks?

- Develop a multi-country, multi-sector GE model of trade, production, and investment
- Investigate the differences between the two recessions in terms of 6 sets of shocks

How does international trade affect the resilience of the macroeconomy?

- Estimate counterfactual macroeconomic resilience in autarky

Today: Understanding the differential behavior of trade during the two recessions

- Apply the model to 16 countries and 7 sectors
- Investigate model-based micro-shocks to the economy in the two recessions
Preview of the Results

The Covid-19 recession was deeper, broader yet shorter than the Great Recession

- Deeper: aggregate productivity and labor shock much larger in 2020 than in 2009
- Broader: output collapse concentrated in fewer sectors during the Great recession
- Shorter: V-shape recovery in 2020 driven by sharp temporary exogenous shocks

Trade resilience is driven by shocks targeting tradable goods

- Supply side shocks: opposite investment efficiency shocks
- Demand side shocks: consumption re-allocation in favor of tradable goods in 2020
- Trade cost shocks: larger during the Great Recession
• **Great Trade Collapse**
  Baldwin (2009), Levchencko, Lewis, and Tesar (2010), Bricongne et al. (2012), Behrens, Corcos and Mion (2013), Bems, Johnson, and Yi (2010, 2013), Eaton et al. (2016)

• **Covid-19 recession**

• **Measuring resilience**
Outline

1. Model

2. Application and results
   - Data and procedure
   - Estimated shocks
Model
Setup

- Multiple countries: $n = 1, \ldots, N$
- Seven sectors: $j \in \Omega$
  - Producer goods: durable manufactures ($DM$), nondurable manufactures ($NM$)
  - Consumer goods: nondurable goods ($NC$), durable goods ($DC$) and Covid goods ($M$)
  - Services: tradable services ($T$) and in-person services ($S$)
- Country $n$ may import goods $j \in \Omega_T = \Omega \setminus S$ from country $i$, subject to iceberg trade cost $d_{ni,t}$
- Country $n$ is endowed with labor $L_{n,t}$ and capital stock of durables $K_{n,t}^k$, $k \in \Omega_K = \{DC, DM\}$
- Complete markets, no uncertainty, perfect competition
Building blocks

- Cobb-Douglas production function:

\[
y^j_{n,t} = A^j_{n,t} \left( \frac{L^j_{n,t}}{\beta^L_{n,j}} \right)^{\beta^L_{n,j}} \left( \frac{K^j_{n,t}}{\beta^K_{n,j}} \right)^{\beta^K_{n,j}} \Pi_{j' \in \{DM, M, NM, T\}} \left( \frac{M^j_{n,t}}{\beta^M_{n,j'}} \right)^{\beta^M_{n,j'}}
\]

- Armington model of trade:

\[
\pi^j_{n,i,t} = \left( \frac{c^j_{i,t} d^j_{n,i,t}}{A^j_{i,t} p^j_{n,t}} \right)^{1-\eta_j}
\]

- Utility combining consumption of consumer nondurables and "non-essential goods":

\[
U_n = \sum_{t=0}^{\infty} \rho^t \phi^t_{n,t} \left[ \psi^NC_n \ln(C^NC_{n,t}) + \psi^H_n \ln \left( \sum_{h \in \{DC, NM, M, S, T\}} (a^h_{n,t})^{\frac{1}{\sigma}} (C^h_{n,t})^{\frac{\sigma-1}{\sigma}} \right) \right]
\]

- Capital accumulation for \( k \in \Omega_K \):

\[
K^k_{n,t+1} = \chi^k_{n,t} \left( I^k_{n,t} \right)^{\alpha^k} \left( K^k_{n,t} \right)^{(1-\alpha^k)} + (1 - \delta^k) K^k_{n,t}
\]
Summarizing micro-shocks

- The set of exogenous shocks to the equilibrium is defined by:

\[ \Psi_t = \left[ L_{n,t}, A_{n,t}^j, d_{ni,t}^j, \phi_{n,t}, a_{n,t}^h, \chi_{n,t}^k \right] \]

- Labor shock \( L_{n,t} \)
- Productivity shocks \( A_{n,t}^j \)
- Trade costs shocks \( d_{ni,t}^j \)
- Aggregate demand shock \( \phi_{n,t} \)
- Preference shocks \( a_{n,t}^h \)
- Capital investment efficiency shocks \( \chi_{n,t}^k \)
Application and results
Data and procedure
From the model to the data

Data:

- 16 countries: Belgium, Canada, China, Czech Republic, Denmark, Finland, Germany, Greece, Italy, Mexico, Netherlands, Spain, Sweden, UK, USA, ROW
- 63 quarters: 2005-Q1 to 2020-Q3
  - Key challenge: Data availability in 2020

Two-steps procedure:

1. Solve for the path of capital stocks
   - For now: Use estimates of capital stocks from the IMF
2. Use equilibrium in changes to back out shocks in changes
Two recessions of different nature

(a) Great Recession

(b) Covid-19 recession
Estimated shocks
A collapse of labor supply and productivity

(a) Great Recession

(b) Covid-19 recession

By sectors
Opposite investment efficiency shocks

(a) Great Recession

(b) Covid-19 recession
A demand reallocation in favor of consumer durable goods

(a) Great Recession

(b) Covid-19 recession
Lower and staggered trade costs shocks

(a) Great Recession

(b) Covid-19 recession
A special role for Covid goods?
Conclusion - Summary

• Two recessions with a large trade collapse and yet different recoveries
  ▶ Resilience of trade-to-GDP was twice as large in 2020

• Two recessions different in nature
  ▶ Covid-19 recession deeper, broader and shorter
  ▶ Different micro-shocks at play

• Trade resilience in 2020 compared to 2009 explained by:
  ▶ Positive shocks to investment efficiency
  ▶ Positive demand re-allocation shock in favor of tradable goods
  ▶ Lower increase in trade costs
Conclusion - Next steps

• Estimate each individual shock’s contribution to both recessions:
  ▶ Solve for model-implied capital path
  ▶ Run counterfactual models with only one shock at a time
  ▶ Estimate model-based measure of resilience: deviation from equilibrium with no shock

• How does international trade affect the resilience of the macroeconomy?
  ▶ Counterfactual resilience in autarky economy
Appendix
Key equations of the model
We solve the Planner’s problem using country-weights $\omega_n$:

$$ W = \sum_{n=1}^{N} \omega_n U_n $$

Restriction on demand parameters: demand has no global component:

$$ \sum_{n=1}^{N} \omega_n \phi_{n,t} = 1 $$

Interpret shadow prices as competitive prices

Planner’s Lagrangian
• Trade share of country $n$ absorption of sector $j$ imported from country $i$:

$$\pi_{ni,t}^j = \left( \frac{c_{i,t}^j d_{ni,t}^j}{A_{i,t}^j p_{n,t}^j} \right)^{1-\eta_j}$$

• Price index for sector $j$ in country $n$ combining production in each country:

$$p_{n,t}^j = \left[ \sum_{i=1}^{N} \left( \frac{c_{i,t}^j d_{ni,t}^j}{A_{i,t}^j} \right)^{1-\eta_j} \right]^\frac{1}{1-\eta_j}$$
• Household spending on consumer nondurable goods:

\[ p_{n,t}^{NC} C_{n,t}^{NC} = \omega_n \phi_{n,t} \psi_n^{NC} \]

• Household spending on non-essential goods:

\[ p_{n,t}^h C_{n,t}^h = a_{n,t}^h \left( \frac{p_{n,t}^h}{p_{n,t}^H} \right)^{1-\sigma} \omega_n \phi_{n,t} \psi_n^H \quad \forall h \in \Omega_N \setminus \{DC\} \]

\[ r_{n,t}^{DC} C_{n,t}^{DC} = a_{n,t}^h \left( \frac{r_{n,t}^{DC}}{p_{n,t}^H} \right)^{1-\sigma} \omega_n \phi_{n,t} \psi_n^H \]
Euler equation for capital stocks $k \in \Omega_K$:

$$
\frac{p_{n,t}^k}{\chi_n^k} \left( \frac{I_{n,t}^k}{K_{n,t}^k} \right)^{1-\alpha^k} = \rho \alpha^k \left[ r_{n,t+1}^k + \frac{(1 - \alpha^k)}{\alpha^k} \left( \frac{p_{n,t+1}^k I_{n,t+1}^k}{K_{n,t+1}^k} \right) + \frac{p_{n,t+1}^k (1 - \delta^k)}{\alpha^k \chi_n^{k,t+1}} \left( \frac{I_{n,t+1}^k}{K_{n,t+1}^k} \right)^{1-\alpha^k} \right]
$$

- Factor prices
- Market clearing conditions
Prices

- Labor cost:
  \[
  w_{n,t} = \beta_n^{L,j} \left( \frac{c_{n,t}^j}{A_{n,t}^j} \right) \frac{y_{n,t}^j}{L_{n,t}^j}
  \]

- Cost of capital of durable manufactures:
  \[
  r_{n,t}^{DM} = \beta_n^{DM,j} \left( \frac{c_{n,t}^j}{A_{n,t}^j} \right) \frac{y_{n,t}^j}{K_{n,t}^{DM,j}}
  \]

- Cost of producing sector \(j\) in country \(n\):
  \[
  c_{n,t}^j = (w_{n,t})^{\beta_n^{L,j}} (r_{n,t}^{DM})^{\beta_n^{DM,j}} \Pi_{j' \in \Omega_P} (p_{n,t}^{j'})^{\beta_n^{M,j'}}
  \]

- Price index of non-essential goods:
  \[
  p_{n,t}^H = \left[ \sum_{j \in \Omega_N \setminus \{DC\}} a_{n,t}^j \left( p_{n,t}^j \right)^{1-\sigma} + a_{n,t}^{DC} \left( r_{n,t}^{DC} \right)^{1-\sigma} \right]^{\frac{1}{1-\sigma}}
  \]
Market clearing conditions

- Denote $X_{n,t}^j = p_{n,t}^j x_{n,t}^j$, $Y_{n,t}^j = \left( \frac{c_{n,t}^j}{A_{n,t}^j} \right) y_{n,t}^j$, $X_{n,t}^{F,h} = p_{n,t}^h C_{n,t}^h$ for $h \in \Omega - K$ and $X_{n,t}^{F,k} = p_{n,t}^k l_{n,t}^k$ for $k \in \Omega_K$

- World goods-market clearing implies:

$$Y_{n,t}^j = \sum_{i=1}^{N^j} \pi_{i,n,t}^j x_{i,t}^j$$

- Total spending on sector $j$:

$$X_{n,t}^j = X_{n,t}^{F,j} + \sum_{j' \in \Omega} \beta_{n}^{M,J,j} Y_{n,t}^{j'}$$
Market clearing conditions

- Labor income:
  \[ w_{n,t} L_{n,t} = \sum_{j \in \Omega} \beta_{n,j} Y_{n,t} \]

- Capital stock market clearing implies:
  \[ r_{n,t}^{DM} K_{n,t}^{DM} = \sum_{j \in \Omega} \beta_{n,j}^{DM} Y_{n,t} \]
  \[ r_{n,t}^{DC} K_{n,t}^{DC} = \frac{\psi_n^H}{(1 - \psi_n^H)} X_{n,t}^{F,NC} - \sum_{h \in \Omega_n \setminus \{DC\}} X_{n,t}^{F,h} \]

- Implied numéraire is world consumption expenditure
Equilibrium in changes
• Trade shares:

\[
\hat{\pi}_{ni,t+1}^j = \left( \frac{\hat{c}_{i,t+1}^j \hat{d}_{ni,t+1}^j}{\hat{A}_{i,t+1}^j \hat{p}_{n,t+1}^j} \right)^{1-\eta_j}
\]

• Price index for sector \( j \) in country \( n \):

\[
\hat{p}_{n,t+1}^j = \left[ \sum_{i \in N} \pi_{ni,t}^j \left( \frac{\hat{c}_{i,t+1}^j \hat{d}_{ni,t+1}^j}{\hat{A}_{i,t+1}^j} \right)^{1-\eta_j} \right]^{\frac{1}{1-\eta_j}}
\]
Demand system

- Household spending on consumer nondurable goods:
  \[ \hat{X}_{n,t+1}^{NC} = \hat{\phi}_{n,t} \]

- Household spending on non-essential goods:
  \[ \hat{X}_{n,t+1}^{F,h} = \hat{a}_{n,t+1}^h \left( \frac{\hat{\rho}_{n,t+1}^h}{\hat{\rho}_{n,t+1}^H} \right)^{1-\sigma} \hat{\phi}_{n,t+1} \quad \forall h \in \Omega_N \setminus \{DC\} \]
  \[ \hat{r}_{n,t+1}^{DC} \hat{K}_{n,t+1}^{DC} = \hat{a}_{n,t+1}^{DC} \left( \frac{\hat{\rho}_{n,t+1}^{DC}}{\hat{\rho}_{n,t+1}^H} \right)^{1-\sigma} \hat{\phi}_{n,t+1} \]

- Price index of non-essential goods:
  \[ \hat{\rho}_{n,t+1}^H = \left[ \sum_{j \in \Omega_P \setminus \{DC\}} \hat{a}_{n,t+1}^j \left( \hat{\rho}_{n,t+1}^j \right)^{1-\sigma} \times \frac{X_{n,t}^{F,j}}{X_{n,t}^{F,H}} + \hat{a}_{n,t}^{DC} \left( \hat{r}_{n,t}^{DC} \right)^{1-\sigma} \frac{r_{n,t}^{DC} C_{n,t}^{DC}}{X_{n,t}^{F,H}} \right]^{\frac{1}{1-\sigma}} \]
Capital stock and investment in changes

- Euler equation for capital stocks $k \in \Omega_K$:

$$
\frac{1}{\rho} \frac{\hat{K}_{n,t+1}^k}{\hat{K}_{n,t+1}^k - (1 - \delta^k)} = \alpha_k \frac{r_{n,t+1}^k K_{n,t+1}^k}{X_{n,t}^F, k} \\
+ \hat{X}_{n,t+1}^F, k \left[ (1 - \alpha^k) + \frac{1 - \delta^k}{\hat{K}_{n,t+1}^k - (1 - \delta^k)} \frac{1}{\hat{X}_{n,t+1}^k} \left( \frac{\hat{p}_{n,t+1}^k \hat{K}_{n,t+1}^k}{\hat{X}_{n,t+1}^F, k} \right)^{\alpha^k} \right]
$$

- Updating capital stock:

$$
\hat{K}_{n,t+2}^k - (1 - \delta^k) = \hat{X}_{n,t+1}^k \left( \frac{\hat{X}_{n,t+1}^F, k}{\hat{p}_{n,t+1}^k \hat{K}_{n,t+1}^k} \right)^{\alpha^k} \left( \hat{K}_{n,t+1}^k - (1 + \delta^k) \right)
$$
Shocks
1. Trade costs:

\[ \hat{d}_{ni,t+1} = \left( \frac{\pi_{ni,t+1}}{\pi_{ii,t+1}} \right)^{\frac{1}{1-\eta_j}} \frac{\hat{p}_{n,t+1}}{\hat{p}_{i,t+1}} \]

2. Productivity shocks:

\[ \hat{A}_{n,t+1} = (\hat{\pi}_{nn,t+1})^{-\frac{1}{1-\eta_j}} \frac{\hat{c}_{n,t+1}}{\hat{p}_{n,t+1}} \]

3. Investment efficiency shocks:

\[ \hat{\chi}_{n,t+1}^{k} = \frac{\hat{K}_{n,t+2} - (1 - \delta^{k})}{\hat{K}_{n,t+1} - (1 - \delta^{k})} \left( \frac{\hat{p}_{n,t+1} \hat{K}_{n,t+1}}{\hat{X}_{n,t+1}^{F,k}} \right)^{\alpha^{k}} \]
Estimating shocks

4. Aggregate demand shocks:
\[ \hat{\phi}_{n,t+1} = \hat{X}_{n,t+1}^{NC} \]

5. Preference shifters shocks:
\[ \hat{a}_{n,t+1}^j = \frac{\hat{X}_{n,t+1}^{F,j}}{\hat{\phi}_{n,t+1}} \left( \frac{\hat{\rho}_{n,t+1}^j}{\hat{\rho}_{n,t+1}^H} \right)^{\sigma-1} \]
\[ \hat{a}_{n,t+1}^{DC} = \frac{\hat{X}_{n,t+1}^{F,DC}}{\hat{\phi}_{n,t+1}} \left( \frac{\hat{\rho}_{n,t+1}^{DC}}{\hat{\rho}_{n,t+1}^H} \right)^{\sigma-1} \]

6. Labor shocks: directly from the data
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\rho$</td>
<td>0.975</td>
<td>Quarterly interest rate of 2.6%</td>
</tr>
<tr>
<td>$\eta_j$</td>
<td>[3.1, 11.8]</td>
<td>Fontagné et al. (2021)</td>
</tr>
<tr>
<td>$\sigma$</td>
<td>2</td>
<td></td>
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<tr>
<td>$\beta_{nLj}$</td>
<td>[0.0028, 0.42]</td>
<td>KLEMS</td>
</tr>
<tr>
<td>$\beta_{nMjDj'}$</td>
<td>[0.0005, 0.5]</td>
<td>WIOT 2011 release</td>
</tr>
<tr>
<td>$\psi_{nNC}$</td>
<td>[0.03, 0.23]</td>
<td>OECD</td>
</tr>
<tr>
<td>$\alpha^{DC}$</td>
<td>0.34</td>
<td>EKNR (2016)</td>
</tr>
<tr>
<td>$\alpha^{DM}$</td>
<td>0.55</td>
<td>EKNR (2016)</td>
</tr>
<tr>
<td>$\delta^{DC}$</td>
<td>0.18</td>
<td>Fraumeni (1997)</td>
</tr>
<tr>
<td>$\delta^{DM}$</td>
<td>0.026</td>
<td>EKNR (2016)</td>
</tr>
</tbody>
</table>
Local v.s. global recession

(a) Great Recession

(b) Covid-19 recession
Global trade collapse in both cases

(a) Great Recession

(b) Covid-19 recession
Productivity collapse during the Covid-19 recession
\[
\mathcal{L} = \sum_{n=1}^{N} \sum_{t=0}^{\infty} \rho^t \left[ \omega_n \phi_{n,t} \left( \psi_{n}^{NC} \ln(C_{n,t}^{NC}) + \psi_{n}^{DM} \ln(C_{n,t}^{DM}) + \psi_{n}^{H} \ln(C_{n,t}^{H}) \right) \right. \\
+ \left. \lambda_{n,t}^{C} \left( \left( \sum_{j \in \Omega_N} \beta_{n}^{L,j} \frac{1}{\beta_{n}^{L,j}} C_{n,t}^{j} \frac{\sigma-1}{\sigma} \right) \right) \right) \\
+ \left. \lambda_{n,t}^{L} \left( L_{n,t} - \sum_{j \in \Omega} L_{n,t}^{j} \right) + \sum_{k \in \Omega_K} \lambda_{n,t}^{K,k} \left( K_{n,t}^{k} - \sum_{j \in \Omega} K_{n,t}^{k,j} - C_{n,t}^{k} \right) \right) \\
+ \sum_{j \in \Omega} \lambda_{n,t}^{i} \left( A_{n,t}^{j} \left( \frac{L_{n,t}^{j}}{\beta_{n}^{L,j}} \right) \beta_{n}^{DM,j} \left( \frac{K_{n,t}^{DM,j}}{\beta_{n}^{DM,j}} \right) \Pi_{j' \in \Omega_P} \left( \frac{M_{n,t}^{jj'}}{\beta_{n}^{M,jj'}} \right) \right) \\
+ \sum_{j \in \Omega_T} \lambda_{n,t}^{X_j} \left( y_{n,t}^{j} - \sum_{i \in \mathcal{N}} x_{i,n,t}^{j} d_{in,t}^{j} \right) \ldots
\]
\[ \cdots + \sum_{j \in \Omega_T} \lambda_{n,t}^{A,j} \left( \left( \sum_{i \in N} x_{ni,t}^{j} \right)^{\eta_j^{-1}} - x_{n,t}^{j} \right) \]

\[ + \sum_{h \in \Omega \setminus \{DC, DM\}} \lambda_{n,t}^{F,h} \left( x_{n,t}^{h} - \sum_{j \in \Omega} M_{n,t}^{j,h} - C_{n,t}^{h} \right) \]

\[ + \sum_{k \in \Omega_K} \lambda_{n,t}^{F,k} \left( x_{n,t}^{k} - \sum_{j \in \Omega} M_{n,t}^{j,k} - I_{n,t}^{k} \right) \]

\[ + \sum_{k \in \Omega_K} \kappa_{n,t}^{k} \left( \chi_{n,t}^{k}(I_{n,t}^{k})^{\alpha_k} (K_{n,t}^{k})^{(1-\alpha_k)} + (1 - \delta_k)K_{n,t}^{k} - K_{n,t+1}^{k} \right) \]

with non-negativity constraints and transversality condition