Trade with Nominal Rigidities: Understanding the Unemployment and Welfare Effects of the China Shock

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The views expressed in this paper do not necessarily reflect the views of the FRBSF or the Fed System
Motivation

- Autor, Dorn, and Hanson (2013) results

Table: Effects of Exposure to China

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Unemployment</td>
<td>0.221**</td>
</tr>
<tr>
<td>Not In Labor Force (NILF)</td>
<td>0.553**</td>
</tr>
<tr>
<td>Population</td>
<td>-0.050</td>
</tr>
<tr>
<td>Manufacturing Employment</td>
<td>-0.596**</td>
</tr>
<tr>
<td>Non-Manufacturing Employment</td>
<td>-0.178</td>
</tr>
<tr>
<td>Manufacturing Wage</td>
<td>0.150</td>
</tr>
<tr>
<td>Non-Manufacturing Wage</td>
<td>-0.761**</td>
</tr>
</tbody>
</table>
Motivation

- Standard model: Full employment $\rightarrow$ all effects on wages

- Add upward sloping labor supply $\rightarrow$ employment effects
  - Need labor supply to be extremely elastic
  - No unemployment; different welfare implications

- **Our approach**: Add downward-nominal wage rigidity (DNWR)
This paper

- CDP + nest (EoS $1/\nu$ across sectors and $1/\kappa$ across regions)
- Add DNWR as in Schmitt-Grohe and Uribe (2016)
  - Wage can fall by no more than $100(1-\delta)$% per year
- Dynamic exact hat algebra for counterfactual analysis
- Data: WIOD + 50 U.S. states (with migration), 2000-2007
- Calibrate China shock to match predicted change in US imports from China
- Pick $\nu$, $\kappa$, $\delta$ to match ADH on unemployment, participation, population
- Study implications for employment and welfare
Preview of Findings

- DNWR has important effects at state level:
  - No DNWR $\rightarrow$ 1 state loses and suffers declines in $L$
  - DNWR $\rightarrow$ 8 states lose, and 31 suffer declines in $L$

- Aggregate: 1.5 pp $\uparrow$ in unemployment in 2007

- Decent fit to non-targeted moments

- DNWR reduces avg U.S. welfare gain by 1/4 to 1/3
Literature

- Aggregate and dist. effects of China Shock: ADH’13, CDP’19, GRY’21, AAE’21

- Trade + Search and matching frictions: Dix-Carneiro et al.’20, Kim & Vogel’20

- Trade + Wage rigidities: EK + Neiman’14, Costinot et al’22

- Nominal rigidities in macro: NS’18, Shimer’04, Schmitt-Grohe & Uribe’16

- Microeconomic evidence for DNWR: Dickens et al.’07, Hazell-Taska’20
Outline

- Model
- Data and Calibration
- Results
Basic Assumptions

- $I$ regions ($M$ inside US), $S$ market sectors plus home production

- Cobb-Douglas preferences ($\alpha_{i,s}$) across market sectors. Armington assumption within sectors with EoS $\sigma_s > 1$. All income devoted to consumption

- Cobb-Douglas production using labor ($\phi_{i,s}$) and intermediate inputs ($\phi_{i,ks}$)

- Perfect competition with iceberg trade costs $\tau_{ij,s,t} \geq 1$

$$P_{i,t} = \prod_{s=1}^{S} P_{i,s,t}^{\alpha_{i,s}}, \quad P_{j,k,t}^{1-\sigma_k} = \sum_{i=1}^{I} P_{ij,k,t}^{1-\sigma_k}$$

where $p_{ij,k,t} = \tau_{ij,k,t} A_{i,k,t}^{-1} W_{i,k,t} \prod_{s=1}^{S} P_{i,s,t}^{\phi_{i,sk}}$
Market Clearing

- Exogenous trade imbalances: \( P_{i,t} C_{i,t} = \sum_{s=1}^{S} W_{i,s,t} L_{i,s,t} + D_{i,t} \)

- Equilibrium in sector \( s \), region \( i \), at time \( t \):

\[
R_{i,s,t} = \sum_{j=1}^{l} \lambda_{ij,s,t} \left( \alpha_{j,s} P_{j,t} C_{j,t} + \sum_{k=1}^{S} \phi_{j,sk} R_{j,k,t} \right)
\]

with trade shares \( \lambda_{ij,k,t} = \frac{p_{ij,k,t}^{1-\sigma_k}}{\sum_{r=1}^{l} p_{rj,k,t}^{1-\sigma_k}} \)

- Labor market clearing: \( W_{i,k,t} L_{i,k,t} = \phi_{i,k} R_{i,k,t} \)

- Standard model: free mobility and \( \sum_{k=1}^{S} L_{i,k,t} = \bar{L}_{i,t} \)
Labor Supply

- As in CDP:
  - Agents can move across sectors and regions within U.S., only across sectors in other countries
  - Forward-looking agents (with perfect foresight) move subject to relocation costs
  - In region $i$, time $t$, home production yields $\mu_i$ and sector $s$ yields $\omega_{i,s,t}$

- Different elasticities across sectors ($\frac{1}{\nu}$) and regions ($\frac{1}{\kappa}$)
  - Nested Gumbel for amenity shocks across regions and sectors

- In CDP: $\omega_{i,s,t} \equiv \frac{W_{i,s,t}}{P_{i,t}}$. With DNWR: $\omega_{i,s,t} \equiv \frac{W_{i,s,t} L_{i,s,t}}{P_{i,t} \ell_{i,s,t}}$

- This block determines labor supply $\ell_{i,s,t}$
Nominal Wage Rigidity

- DNWR: $W_{i,s,t}^{LCU} \geq \delta_s W_{i,s,t-1}^{LCU}$

- Maximum employment: $L_{i,s,t} \leq \ell_{i,s,t}$

- Complementary slackness:

$$\left(\ell_{i,s,t} - L_{i,s,t}\right)\left(W_{i,s,t}^{LCU} - \delta_s W_{i,s,t-1}^{LCU}\right) = 0$$

- For regions outside of the U.S., with exchange rate $E_{i,t}$ given in dollars per LCU, DNWR implies

$$W_{i,s,t} \geq \frac{E_{i,t}}{E_{i,t-1}} \delta_s W_{i,s,t-1}$$
Exchange Rate and Nominal Anchor

**Exchange rate** (options for third countries):

1. ER flexibility: \( E_{i,t} \) can adjust enough so that DNWR never binds
   - Implies \( L_{i,s,t} = \ell_{i,s,t} \quad \forall i > M \), unemployment only in US states
   - This will be our baseline

2. Fixed exchange rate: \( E_{i,t} = E_{i,t-1} \)
   - Implies that DNWR takes same form in other countries as in US

**Nominal anchor:** World aggregate demand in $ grows at \( \gamma \)

\[
\sum_{i=1}^{I} \sum_{s=1}^{S} W_{i,s,t} L_{i,s,t} = \gamma \sum_{i=1}^{I} \sum_{s=1}^{S} W_{i,s,t-1} L_{i,s,t-1}
\]
Assume agents did not expect China shock but then in 2001 know how it will unfold with perfect foresight

Match 2000 data \((t = 0)\) assuming this year is at steady state (no unemployment)

Denote \(\hat{x}_t \equiv x_t / x_{t-1}\) and \(\hat{\dot{x}}_t \equiv \dot{x}_t / \dot{x}_t\)

Goal is to compute relative changes \(\hat{x}_t\) only due to the China shock modeled as a sequence of shocks starting in 2001.
Outline

- Model
- Data and Calibration
- Results
87 regions: 50 U.S. states, 36 other countries, aggregate RoW

15 sectors: home production, 12 manufacturing sectors, services, agriculture

- WIOD: 35 sectors for 40 countries for 2000
- 2002 CFS: trade flows across U.S. States for 43 commodities
- 2008 U.S. Census: trade between U.S. states and other countries
- BEA: state-level production and consumption in serv. and agric. for 2000
- BLS and OECD: labor force participation for 2000
- CPS + ACS: sector-level bilateral migration flows between U.S. states for 2000
Exposure to China

\[
\text{Exposure}_i \equiv \sum_{s=1}^{S} \frac{L_{i,s,2000}}{L_{i,2000}} \frac{\Delta X_{C,US,s}^{2007-2000}}{R_{US,s,2000}},
\]

- \( L_{i,s,2000} \equiv \) employment in \((i, s)\) in 2000

- \( R_{US,s,2000} = \) U.S. sales in \(s\) in 2000

- \( \Delta X_{C,US,s}^{2007-2000} = \) predicted change in exports from China to the US from 2000 to 2007 in \(s\)

- Re-normalize to have the same mean as the measure in ADH
Chinese Technology Changes

- Need $\hat{A}_{\text{China},s,t}$ for $s = 1, \ldots, 12$ and $t = 2001, \ldots, 2007$

- Set $\hat{A}_{\text{China},s,t} = \hat{A}_{\text{China},t}^1 \hat{A}_{\text{China},s}^2$ (19 parameters instead of 84)

- Predict $\Delta X$ in USA using $\Delta X$ from other countries:

  $\Delta X^{2007-2000}_{C,US,s} = b_2 \Delta X^{2007-2000}_{C,OC,s} + \varepsilon_s$

  $\Delta X_{C,US,t} = a + b_1 \Delta X_{C,OC,t} + \varepsilon_t$

- $\{\hat{A}_{\text{China},t}^1\}, \{\hat{A}_{\text{China},s}^2\}$ to match $\{\Delta X^{2007-2000}_{C,US,s}\}, \{\Delta X_{C,US,t}\}$
Parameters

- $\sigma_s = \sigma = 6$ (trade elasticity of 5 in all sectors)
- Set $\gamma = 1$, put burden on $\delta$
- Match ADH on unemployment, participation, and population:
  - 0.22↑ in unemp., 0.55↓ in LFP, and 0.05% fall in population for each $1000$ of exposure to China shock
- Result is $\delta \approx 0.98$, $\nu \approx 0.55$, and $\kappa \approx 12$
  - Wages can fall $\approx 2\%/year \approx$ Schmitt-Grohe and Uribe
  - $\nu \neq \kappa$ key to match NiLF and population effects: CDP’s $\nu = \kappa = 2.02$ implies too little NiLF and too large population effects
Outline

▶ Model

▶ Data and Calibration

▶ Results
Some Intuition, Flexibility

\[ W_0 = \delta \]

\[ W_1 = \delta W_0 \]

\[ W_2 = \delta^2 W_0 \]

\[ W_3 = \delta^3 W_0 \]

\[ L_0^S \]

\[ L_0^D \]

\[ L_0 \]

\[ W_0 \]
Some Intuition, Flexibility

\[ W_0 = \delta W_0 \]

\[ W^* = \delta W^* \]

\[ L_0^S \]

\[ L_3^S \]

\[ L^D \]

\[ L^{D'} \]

\[ L_0 \]

\[ L^* \]
Some Intuition, DNWR

\[ W_0 \]

\[ L^D \]

\[ L^S \]

\[ W = \delta W_0 \]

\[ L = L_0 \]
Some Intuition, DNWR

\[ W_1 = \delta W_0 \]

\[ W_0 \]

\[ L^S_0 \]

\[ L^S_1 \]

\[ L^S_3 \]

\[ L^D \]

\[ L^{D'} \]

\[ L_1 \]
Some Intuition, DNWR

\[ W_1 = \delta W_0 \]
\[ W_2 = \delta^2 W_0 \]
Some Intuition, DNWR

\[ W_1 = \delta W_0 \]

\[ W_2 = \delta^2 W_0 \]

\[ W^* = \frac{W_0}{1+\delta} \]

\[ W^* = \frac{W_0}{1+\delta^2} \]
Average Unemployment

Cumulative change in US unemployment.

US change in unemployment, in %

Year


0 0.5 1 1.5
### Effects Across States

<table>
<thead>
<tr>
<th></th>
<th>Number of States</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>ToT &amp; L in S.S.</td>
<td>↓</td>
</tr>
<tr>
<td>Welfare</td>
<td>↓</td>
</tr>
<tr>
<td>L in transition</td>
<td>↓</td>
</tr>
</tbody>
</table>
Higher Exposure Decreases Welfare

The diagram shows a scatter plot with the exposure to China on the x-axis and the welfare change in percent on the y-axis. The points are scattered with a downward trend indicating a negative correlation between exposure to China and welfare change. States such as AK, WA, LA, NV, CA, IN, NV, NH, SC, WA are marked on the graph.
## Net Exports Exposure vs. ADH Exposure

Table: “Horse race” between exp. measures with and without DNWR

<table>
<thead>
<tr>
<th></th>
<th>(1) Welf. Flex</th>
<th>(2) Welf. DNWR</th>
<th>(3) Emp. Flex</th>
<th>(4) Emp. DNWR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>0.513**</td>
<td>0.522**</td>
<td>3.204**</td>
<td>4.732**</td>
</tr>
<tr>
<td>ADH Exp.</td>
<td>-0.016</td>
<td>-0.031*</td>
<td>-0.168</td>
<td>-0.944**</td>
</tr>
<tr>
<td>NX Exp.</td>
<td>-0.076**</td>
<td>-0.092**</td>
<td>-0.537**</td>
<td>-1.168**</td>
</tr>
<tr>
<td>N</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>R squared</td>
<td>0.491</td>
<td>0.554</td>
<td>0.460</td>
<td>0.503</td>
</tr>
<tr>
<td>Mean d.v.</td>
<td>0.269</td>
<td>0.198</td>
<td>1.351</td>
<td>-0.821</td>
</tr>
</tbody>
</table>
## Baseline and Extensions

<table>
<thead>
<tr>
<th></th>
<th>ADH (1)</th>
<th>Base. (2)</th>
<th>NoMo (3)</th>
<th>DNWRM (4)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Change in Population Shares</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unemployment <em>(targeted)</em></td>
<td>0.221**</td>
<td>0.221</td>
<td>0.221</td>
<td>0.221</td>
</tr>
<tr>
<td>NILF <em>(targeted)</em></td>
<td>0.553**</td>
<td>0.553</td>
<td>0.553</td>
<td>0.553</td>
</tr>
<tr>
<td>Mfg Employment</td>
<td>-0.596**</td>
<td>-0.331</td>
<td>-0.337</td>
<td>-0.543</td>
</tr>
<tr>
<td>Non-mfg Employment</td>
<td>-0.178</td>
<td>-0.442</td>
<td>-0.437</td>
<td>-0.230</td>
</tr>
<tr>
<td><strong>Percentage Changes</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Population <em>(targeted)</em></td>
<td>-0.050</td>
<td>-0.050</td>
<td>0.000</td>
<td>-0.050</td>
</tr>
<tr>
<td>Mfg. Wage</td>
<td>0.150</td>
<td>-0.214</td>
<td>-0.182</td>
<td>0.152</td>
</tr>
<tr>
<td>Non-mfg. Wage</td>
<td>-0.761**</td>
<td>-0.689</td>
<td>-0.717</td>
<td>-1.065</td>
</tr>
<tr>
<td><strong>Welfare</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean welfare change</td>
<td>0.229</td>
<td>0.235</td>
<td>0.197</td>
<td></td>
</tr>
<tr>
<td>Mean welfare change no DNWR</td>
<td>0.310</td>
<td>0.313</td>
<td>0.298</td>
<td></td>
</tr>
<tr>
<td>$\nu$</td>
<td>0.551</td>
<td>0.594</td>
<td>0.496</td>
<td></td>
</tr>
<tr>
<td>$\kappa$</td>
<td>12.30</td>
<td>11.21</td>
<td></td>
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<tr>
<td>$\delta$</td>
<td>0.980</td>
<td>0.980</td>
<td>0.987</td>
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</tr>
</tbody>
</table>
Dispersion in Employment and Income Effects

- ADH 2021 and AAE 2021 show that standard quantitative models deliver too little dispersion in employment or income effects of China shock.

- For example, CDP or Galle et al. (2021) struggle to match the spatial het. of the employment and income effects in ADH.

- Model with DNWR leads to much larger declines in employment in the most exposed regions:
  - S.D. for effects on employment/pop = 1.35 (vs 1.18 in ADH)
  - S.D. for effects on income/pop = 2.5 (vs 1.9 in ADH)
Conclusion

- DNWR can explain \( \uparrow \) in unemployment, and larger \( \uparrow \) in NiLF

- Model leads to realistic dispersion and rationalizes importance of ADH exposure

- Relevant implications for welfare

- Caveats: macro rules, risk sharing
Additional Slides
<table>
<thead>
<tr>
<th></th>
<th>ADH (1)</th>
<th>Base. (2)</th>
<th>Def. Low (5)</th>
<th>Def. High (6)</th>
<th>Fixed ER (7)</th>
</tr>
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<td><strong>Change in Population Shares</strong></td>
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<td>Non-mfg. Wage</td>
<td>-0.761**</td>
<td>-0.689</td>
<td>-0.661</td>
<td>-0.541</td>
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<td><strong>Welfare</strong></td>
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<td></td>
<td></td>
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<tr>
<td>Mean welfare change</td>
<td>0.229</td>
<td>0.232</td>
<td>0.221</td>
<td>0.185</td>
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<td>Mean welfare change no DNWR</td>
<td>0.310</td>
<td>0.323</td>
<td>0.386</td>
<td>0.284</td>
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<tr>
<td>(\nu)</td>
<td>0.551</td>
<td>0.548</td>
<td>0.571</td>
<td>0.521</td>
<td></td>
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<tr>
<td>(\kappa)</td>
<td>12.30</td>
<td>11.87</td>
<td>10.38</td>
<td>10.37</td>
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<tr>
<td>(\delta)</td>
<td>0.980</td>
<td>0.981</td>
<td>0.986</td>
<td>0.987</td>
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### Welfare and Discounting

**Table:** Welfare gains for different discount factors

<table>
<thead>
<tr>
<th>$\beta$</th>
<th>$\delta = 0$</th>
<th>cal. $\delta$</th>
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Welfare and Discounting

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## Welfare and Discounting

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Dispersion in Sector-State Welfare
Job Losses and the “Missing Intercept” Problem

- ADH: a $1k/worker ↑ exposure ⇒ emp/pop ↓ 77 bp (22 from unemp + 55 LFP)
- These effects are relative (more exposure vs less exposure)
- A naive calculation that assumes zero exposure → zero effect
  - Cross-sectional regression with zero intercept
  - Job losses = 0.77 × 2.63 × 220 mill = 4.4 million jobs, where 2.63 is mean exposure
- Model implies an intercept = -1.75
  - Back-of-the-envelope comp. ⇒ (−1.75 + 0.77 × 2.63) × 220 = 0.55 mill jobs lost
  - Full GE model implies 0.47 million jobs lost
- We stop counting job losses in 2007. Long-term effect are net gains