Quantifying the Losses from International Trade

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Valorum Data | NYU and NBER

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w.wsj.com/articles/new-life-for-steel-plant-perks-up-depressed-illinois-town-workforce-1520766001

THE WALL STREET JOURNAL.

New Life for Steel Plant Perks Up Depressed Illinois Town, Workforce

U.S. Steel's decision to fire up part of idled Granite City plant has ripple effect through community

Big Picture: The Backlash Against Trade

Hard to deny that the benefits of globalization have been under attack.

A popular narrative. . .

- Large rise in import penetration from China in early/mid 2000's.
- A deteriorating trade deficit, i.e. imports did not arrive with corresponding export opportunities ⇒ negative affects on the US labor market.
- Autor et al.'s (2013) evidence seems supportive. . . Chinese import exposure lead to:
  - Drops in labor earnings,
  - Decreases in labor force participation (and take up of transfer payments),
  - Little out-migration (at least in the short/medium run).

This Paper: How Much Do the Losers Lose From Trade?

This paper: Use theory + data to measure the aggregate and welfare effects of a trade shock.

Two important model elements:

1. Dynamic, Ricardo-Viner trade model. Similar to Kambourov (2009), Artuç et al. (2010), Caliendo et al. (2015).
2. Households face incomplete markets, but can partially self insure as in the standard incomplete market model.

1. allows our model to speak directly to the ADH evidence and then aggregate.
2. makes the normative implications more nuanced...
   - large (or small) welfare losses by the inability to smooth out shocks,
   - appropriate policy interventions, e.g. Lyon and Waugh (2018).

This Paper: How Much Do the Losers Lose From Trade?

Our approach. . .

1. Show that our model lines up with the empirical approach of ADH.

2. Calibrate the model to match ADH evidence.

3. Hit the model with a "China Shock".

- A pure trade shock, i.e. lower the cost to import goods.
- ~~A "global savings glut" shock lowering the interest rate.~~

Ask and answer several questions:

- The aggregate effects of the China **Trade** Shock? labor supply ↑, output ↑, consumption ↗, trade deficit ↓.
- How much did the losers lose from trade? Large losses in labor market 2-3× average; In welfare terms, very few actually lose.

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Ask and answer several questions:

- The aggregate effects of the China **Trade** Shock? labor supply $\uparrow$, output $\uparrow$, consumption $\nearrow$, trade deficit $\downarrow$.
- How much did the losers lose from trade? Large losses in labor market 2-3$\times$ average; In welfare terms, very few actually lose.

Model

Model: Overview

Time: Discrete time, infinite horizon.

- We'll drop time subscripts unless necessary.

Domestic Geography: A continuum of "islands" indexed by $\omega \in [0, 1]$.

On an island ω...

- Competitive producers on an island produce intermediate good ω.
- Households living on ω can work for those producers on the island.

International Trade: Focus on a Small Open Economy, where world prices for an island's intermediate good follow an exogenous, stochastic process.

Model: Production

Island level intermediate good production:

$$q(\omega) = z(\omega)\ell.$$

Productivity z evolves according to:

$$\log z_{t+1} = \phi_z \log z_t + \epsilon_{t+1}$$

where $\epsilon_{t+1} \sim \mathcal{N}(0, \sigma_\epsilon)$. ϵ_{t+1} is independent across time and goods/islands.

Intermediate goods are aggregated according to:

$$Q = \left[\int_0^1 q(\omega)^\rho d\omega\right]^{\frac{1}{\rho}},$$

where $\theta = \frac{1}{1-\rho}$ is the elasticity of substitution.

Model: Trade

Focus on a Small Open Economy (SOE). World prices for intermediate good ω evolve according to:

$$\log p_w(\omega)_{t+1} = \phi_w \log p_w(\omega)_t + \epsilon_{w,t+1}$$

where $\epsilon_{w,t+1} \sim \mathcal{N}(0, \sigma_w)$. $\epsilon_{w,t+1}$ is independent across t, goods, and z shocks.

Trade is subject to iceberg trade cost:

- To ship internationally, produce $\tau > 1$ to deliver one unit.

Intermediate goods can be non-traded, imported, or exported. International arbitrage $\Rightarrow$ domestic prices must lie between

$$\left[\frac{p_w(\omega)_t}{\tau_{ex}} \;, \quad \tau_{im} p_w(\omega)_t \right],$$

and where the domestic price lies must be consistent with the pattern of trade.

Model: Households

Unit mass of households. Individual households **live and work** on islands.

Individual households have preferences:

$$E \sum_{t=0}^{\infty} \beta^t \left\{ \log(c_t) - B \frac{h_t^{1-\gamma}}{1-\gamma} + \nu_t^i \right\}$$

- c_t is consumption of the final good,
- h_t is hours worked.
- ν_t^i is i.i.d. preference shock, where i corresponds with the choice to move or not. Distributed Type 1 extreme value with scale parameter σ_ν.

Model: Households' Choices

Island level state: $\mathbf{s} = \{\ z,\ p_w\ \}$. Households can...

1. Work or not...

- Constrain the choice of labor units to be $h_t \in \{0, \bar{h}\}$.
- If a household works, receive island level wage: $w(\mathbf{s})$.
- If a household does not work, it receives home production: w_h.

2. Stay or move...

- By paying $m > 0$ in units of the final good, households migrate and move to a new island.
- Today — moving households arrive at a random island.

3. Save or borrow...

- Accumulate a non-state contingent asset a that pays gross return R.
- Face a lower bound on asset holding $-\bar{a}$.

Equilibrium: Overview

A Stationary Small Open Economy (SSOE) Equilibrium. Given world prices $\{p_w, R\}$, a stationary Small Open Economy Equilibrium is domestic prices $\{p(\mathbf{s})\}$, policy functions $\{\ g_a(\mathbf{s}, a, \nu), \iota_n(\mathbf{s}, a, \nu), \iota_m(\mathbf{s}, a, \nu)\ \}$, and a probability distribution $\lambda(\mathbf{s}, a, \nu)$ such that

- i Firms maximize profits; policy functions solve the household's problem;
- ii Demand for the final and intermediate goods equals production;
- iii The distribution $\lambda(\mathbf{s}, a, \nu)$ is a stationary distribution.

The basic idea...

1. Households' consumption/savings, work, and moving decisions determine goods demand and labor supply.
2. Bounds on international arbitrage + firm optimization determine goods supply and labor demand.

Need **1.** and **2.** to be consistent.

Model Properties

Island-Level Trade

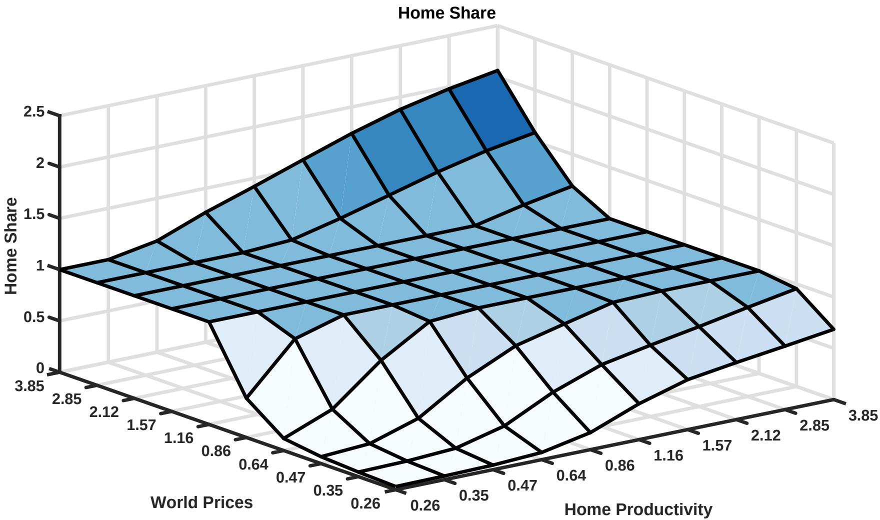
To understand the pattern of trade across islands define the following statistic:

$$\omega(\mathbf{s}) := \frac{p(\mathbf{s}) z \mu(\mathbf{s}) \bar{h}}{p(\mathbf{s}) z \mu(\mathbf{s}) \bar{h} \quad + \quad p(\mathbf{s}) \text{imports}(\mathbf{s}) - p(\mathbf{s}) \text{exports}(\mathbf{s})},$$

- Numerator is national production of an islands variety.
- Denominator is national consumption of that variety.

Essentially, this is the micro-level analog of the "home share" summary statistic emphasized in Arkolakis et al. (2012).

Home Share $\omega(\mathbf{s})^{\frac{1}{\theta}}$ Across Islands



Island-Level Trade and Wages

Trade exposure and wages: Real wages on an island with state $\mathbf{s}$ equal

$$w(\mathbf{s}) = \omega(\mathbf{s})^{\frac{1}{\theta}} \hat{\mu}(\mathbf{s})^{\frac{-1}{\theta}} z^{\frac{\theta-1}{\theta}} C^{\frac{1}{\theta}}.$$

where

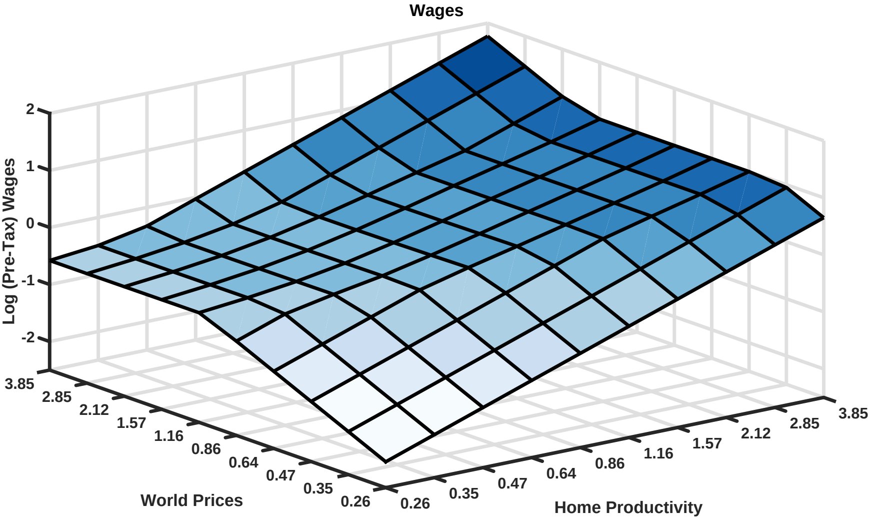
$$\omega(\mathbf{s}) := \frac{p(\mathbf{s}) z \mu(\mathbf{s}) \bar{h}}{p(\mathbf{s}) z \mu(\mathbf{s}) \bar{h} \quad + \quad p(\mathbf{s}) \text{imports}(\mathbf{s}) - p(\mathbf{s}) \text{exports}(\mathbf{s})},$$

which is the "home share" and $\hat{\mu}(\mathbf{s}) = \frac{\mu(\mathbf{s})\bar{h}}{\pi(\mathbf{s})}$ is workers per market.

A smaller home share (**larger import exposure**) implies that wages are **lower** with elasticity $\frac{1}{\theta}$. The economics are easy to understand...

- More imports $\Leftrightarrow$ lower prices; $\Rightarrow$ lower wages
- CES tightly connects the price with the home share and θ.

Real Wages Across Islands



Connecting Our Model with ADH's Empirical Approach

ADH Empirical Approach: Relate changes in labor earnings in a market to changes in import exposure

$$\Delta \log w(\mathbf{s}) = \frac{1}{\theta} \underbrace{\Delta \log \left(\omega(\mathbf{s})/\hat{\mu}(\mathbf{s})\right)}_{\text{trade exposure}} + \underbrace{\frac{1}{\theta} \Delta \log C}_{\gamma_t} + \underbrace{\Delta \log \left(z^{\frac{\theta-1}{\theta}} \right)}_{\epsilon_{s,t}}.$$

Highlights the empirical challenges of ADH:

- Issue #1: Shocks z are unobserved, but correlated with trade.
  - ADH's solution—use another country's imports as an instrument—is a valid IV strategy within our model...
- Issue #2: Aggregate effects, $\Delta \log C$ not observed, absorbed into γ_t.
  - ADH have no solution.

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Motivates our calibration strategy. . .

- ADH are "identifying" the θ which controls the pass through of trade shocks into wages.
- So we will ask our model to match this moment.

Quantitative Results

Calibration Overview

Pre-determined parameters: discount factor, interest rate, persistence of z, p_w.

Remaining parameters picked to match moments in beginning and ending stationary equilibrium and on transition path.

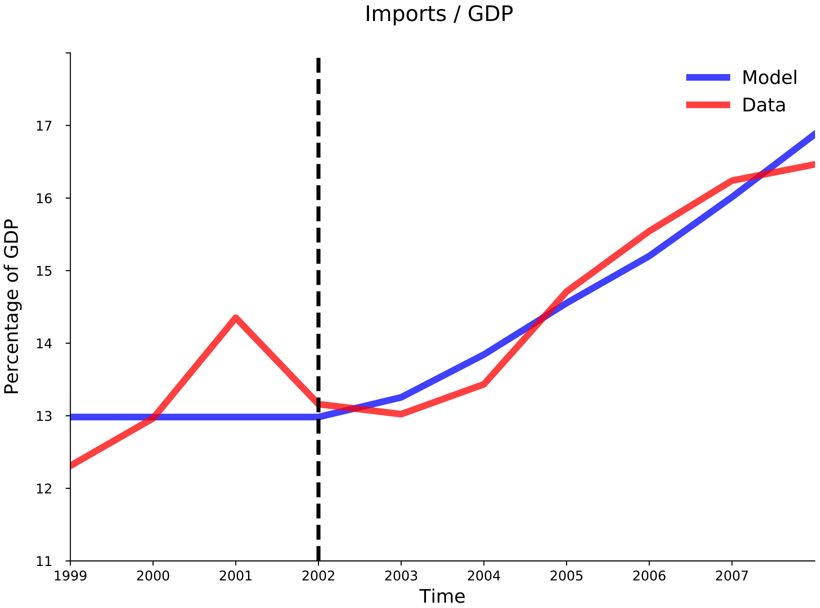
The moments...

- LFP, migration rate, hh with ≤ 0 net worth, std. of wage growth,
- long run trade elasticity,
- **ADH wage and nlfp elasticities, GLM migration elasticity.**

The nature of the shock behind the transition path:

- Unanticipated, new future path of τ_{im}; linear decrease from τ_{im} to τ'_{im} over five years to match rise in import penetration between 2002 and 2007.

The Trade Shock...

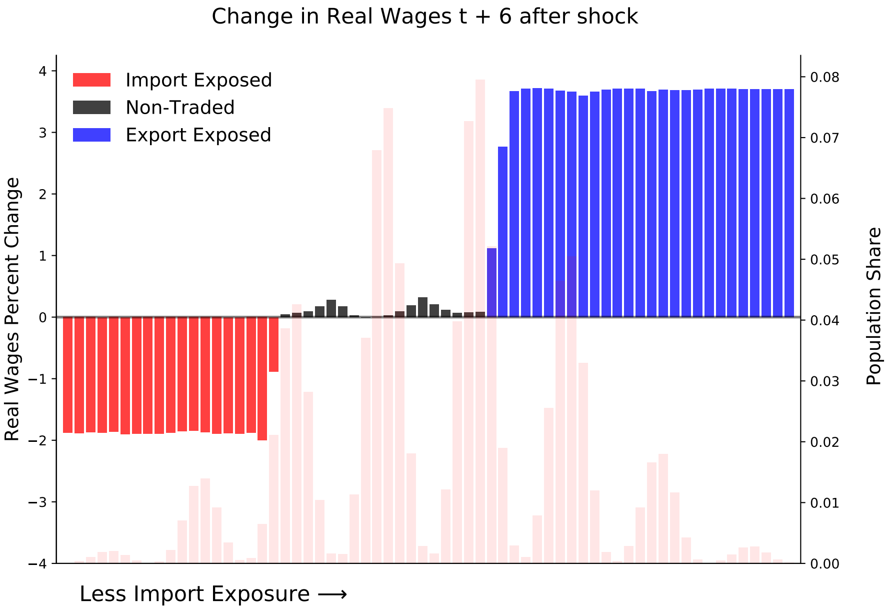


Calibration: ADH Micro Moments and Results

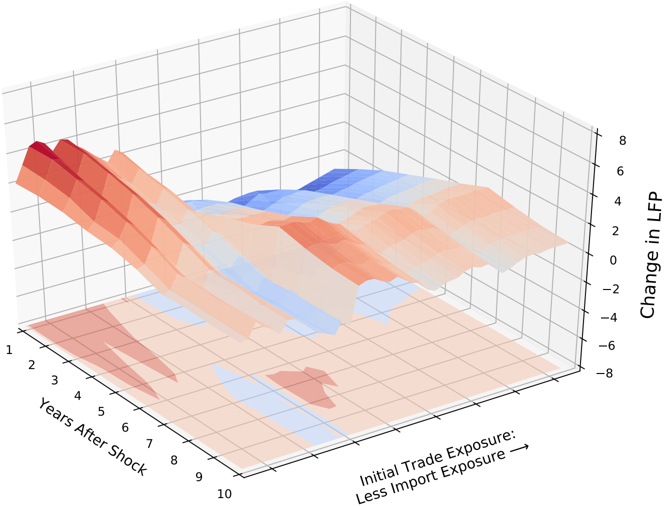
	Δ Labor Earnings	Δ NILF	GLM Δ Population
Data	−4.30 [−6.62, −2.00]	1.11 [0.52, 1.72]	−1.43 [−3.33, 0.48]
Model	−4.10	1.24	−1.92
	Demand elasticity θ	Home production w_h	ν shock σ_ν
Parameter Values	9.53	0.22	0.96

Note: Values in brackets report 95-5 confidence intervals. Greenland et al. (2017) (GLM) replace ADH regional controls with agged population growth at the commute zone level.

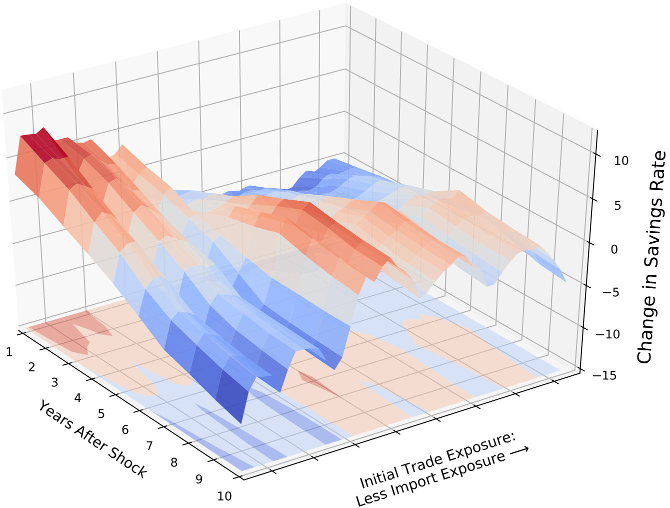
Micro I: Real Wages Across Islands After the Shock



Micro II: Labor Supply, Across Islands, Overtime

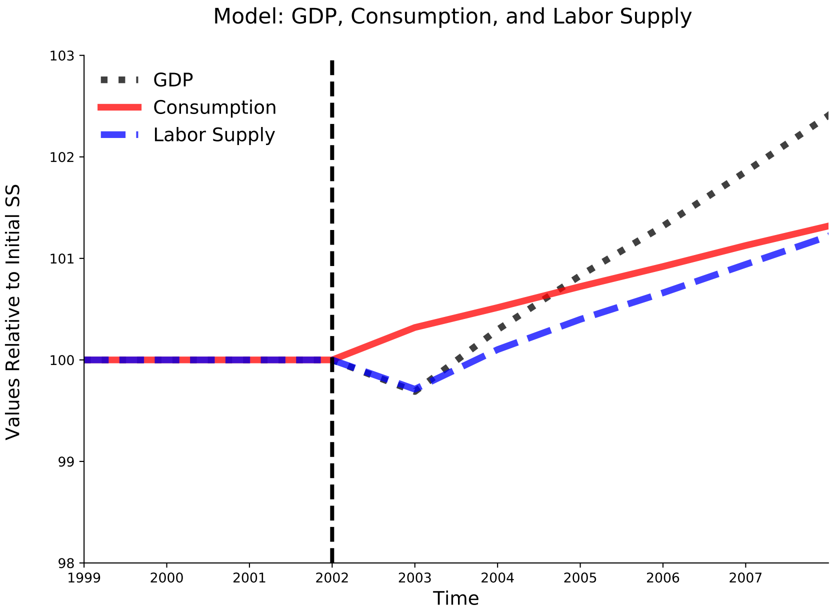


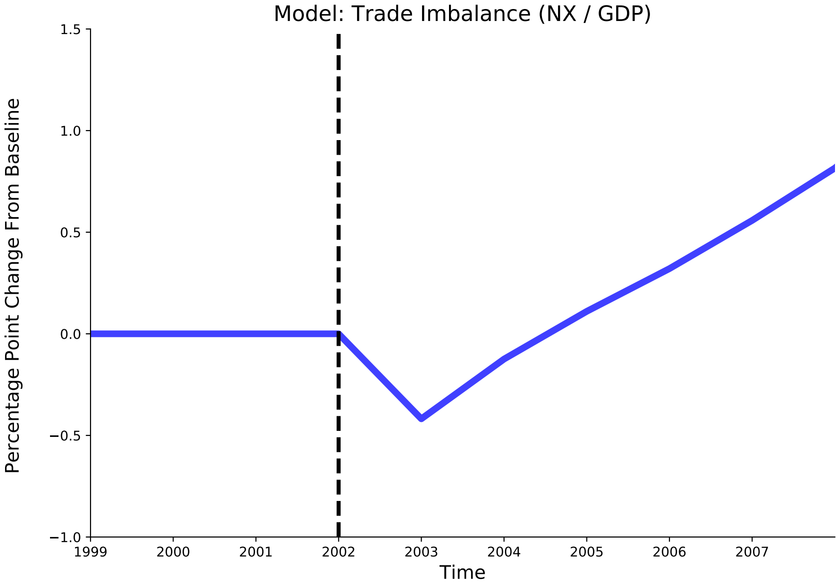
Micro III: Savings Rates, Across Islands, Overtime



Looks like evidence in Barrot et al. (2018).

Macro I: Aggregate Consumption, Labor Supply, Output



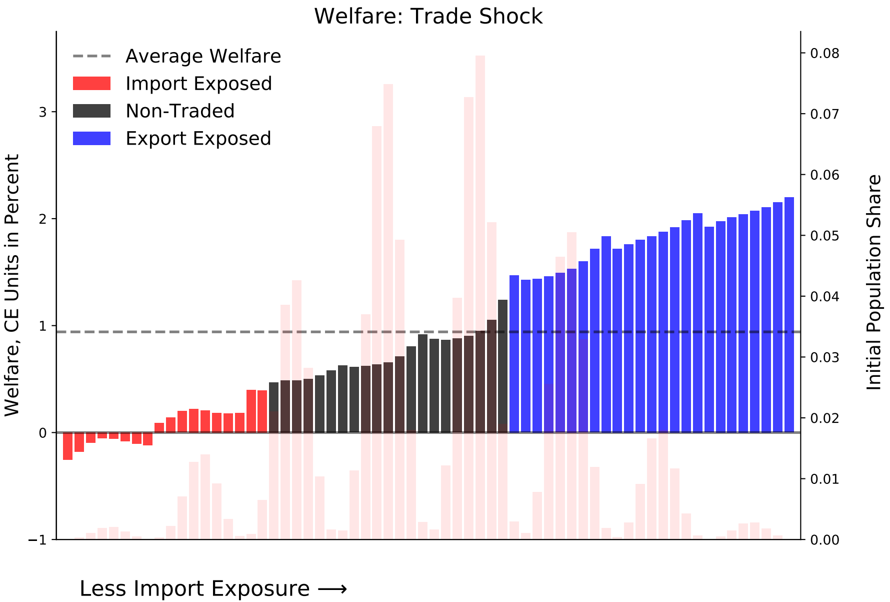

Model: Trade Imbalance (NX / GDP)
Percentage Point Change From Baseline
1.5
1.0
0.5
0.0
−0.5
−1.0
1999
2000
2001
2002
2003
2004
2005
2006
2007
Time

Welfare and Real Wages

		Welfare	Δ Log Wages
Initial Exposure	Import Exposed	0.19 [0.09]	-2.19 [0.09]
	Non-Traded	0.75 [0.68]	0.34 [0.68]
	Export Exposed	1.64 [0.25]	3.99 [0.25]
	Average	0.94	1.06

Note: Welfare values are lifetime consumption equivalents; values in brackets report the share of the population in that category.

Welfare



Welfare: Trade Shock
Average Welfare
Import Exposed
Non-Traded
Export Exposed
Welfare, CE Units in Percent
Initial Population Share
3
2
1
0
−1
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
Less Import Exposure ⟶

Role of the ADH Evidence...

		2×ADH Cal. (-8.60, 4.74)		Baseline (-4.30, 9.53)	
		Welfare	Δ Log Wages	Welfare	Δ Log Wages
Initial Exposure	Import Exposed	−.06	−3.00	0.19	−2.19
		[0.21]	[0.21]	[0.09]	[0.09]
	Non-Traded	0.73	0.00	0.75	0.34
		[0.33]	[0.33]	[0.68]	[0.68]
	Export Exposed	1.71	3.50	1.64	3.99
		[0.46]	[0.46]	[0.25]	[0.25]
	Average	0.91	1.01	0.94	1.06

Note: Welfare values are lifetime consumption equivalents; values in brackets report the share of the population in that category. First two columns are from a calibration targeting a ADH wage elasticity of -8.60.

Final Thoughts

Much more work todo! At the top of our todo list

- Tax system, social insurance, government spending. Build on our companion work in Lyon and Waugh (2018) to evaluate it's importance.
- Variations on extent of insurance, e.g. no insurance, no borrowing, natural borrowing limit, etc.
- Put old people in the model?

References I

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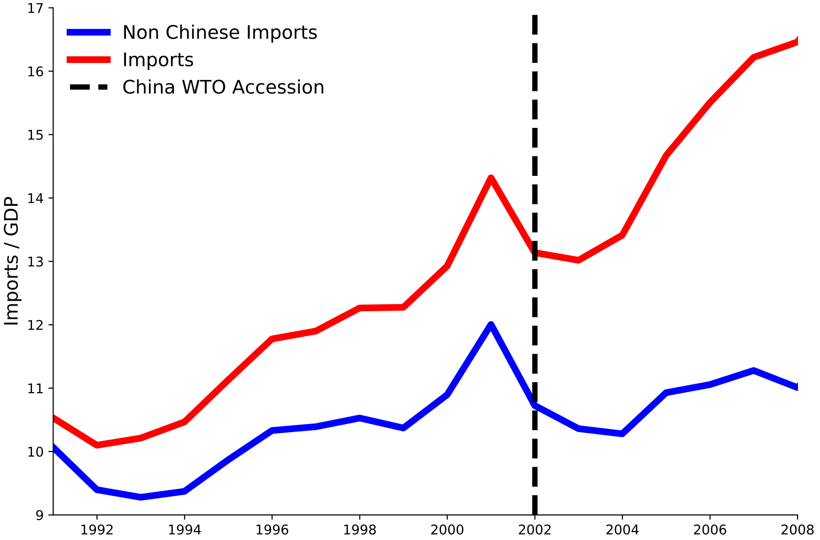
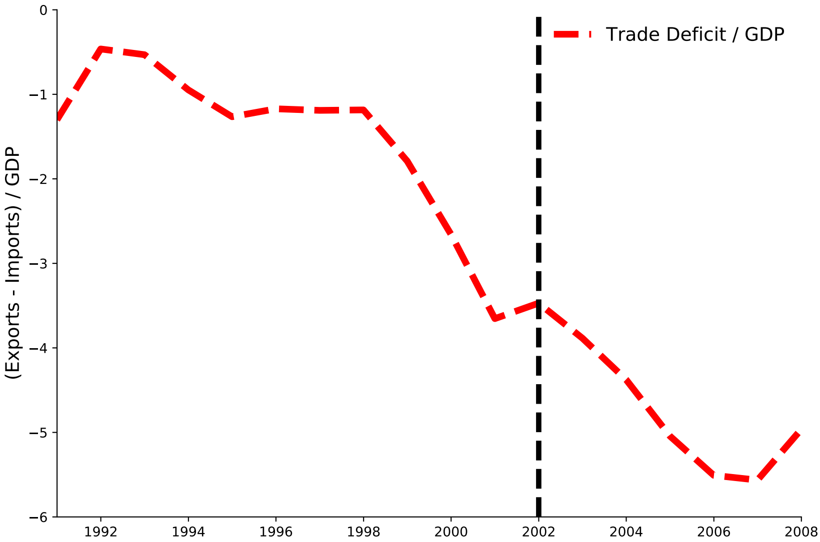
Motivating Evidence

US Data: Rising Import Penetration. . . Almost all from China



US Data: The Trade Deficit



ADH Evidence: Labor Market Outcomes and Trade Exposure

Labor Market Outcomes and Trade Exposure

	Δ Labor Earnings	Δ NILF
Standardized Δ IPW	-4.30 $[-6.62, \ -2.00]$	1.11 $[0.52, \ 1.72]$

Note: Values in brackets report 95-5 confidence intervals. Δ Labor Earnings is average household "wage and salary" income per adult; units are in decadal, percent changes. Δ NILF corresponds to the change in the not in labor force share. Δ IPW is standardized by neting out the mean and dividing by the standard deviation.

Migration and Trade Exposure

	ADH Δ Population	GLM, Δ Population
Standardized Δ IPW	−0.05 [−1.51, 1.41]	−1.43 [−3.33, 0.48]

Note: Values in brackets report 95-5 confidence intervals. Greenland et al. (2017) (GLM) replace ADH regional controls with agged population growth at the commute zone level.

Autor et al. (2013), background. . .

Basic idea: Relate changes in labor-market outcomes across US local labor markets to changes in exposure to Chinese imports.

Mechanically, construct the following:

$$\Delta IPW_{uit} = \sum_j \left(\frac{L_{ijt}}{L_{it}}\right)\left(\frac{\Delta M_{ucjt}}{L_{ijt}}\right)$$

And project labor-market outcomes on ΔIPW_{uit}.

Lots of notation here:

- $uc = US$, $j =$ industry, $i =$ commute zone
- $M_{ucjt} =$ US imports in industry j at time t.
- $L_{ijt} =$ Labor in commute zone i, industry j, at time t.

Calibration: Pre-determined Parameters

Pre-determined parameters. . .

Parameter	Value
Discount Factor, β	0.95
World Interest Rate, R	1.02
Persistence of z and p_w process	0.95

The nature of the shock(s):

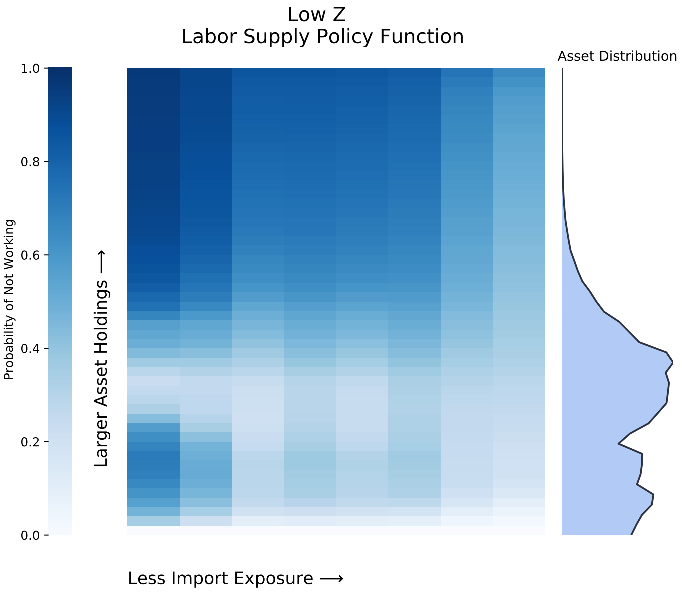
- Unanticipated, future path of trade costs is changed.
- Linearly decrease from τ_{im} to τ'_{im} over five years.

Calibrated Parameters: Results

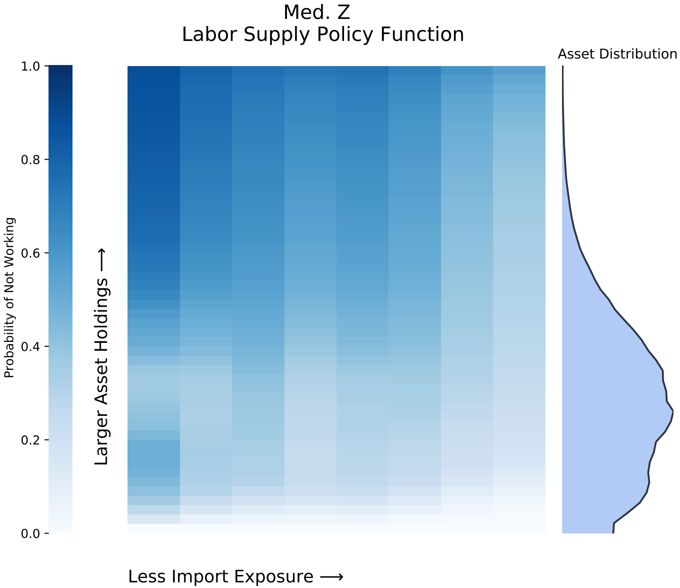
Parameter	Value	Target	Data	Model
Disutility of work, B	1.05	Aggregate participation rate	66	66
Migration Cost, m	1.75	CMZ. migration rate	3	3
Borrowing Limit, $-\bar{a}$	0.84	% Households with ≤ 0 net worth	40	40
Pre-China Trade Cost (τ_{ex}, τ_{im})	1.16	1990s Imports/GDP	13	13
Post-China Trade Cost (τ'_{im})	1.37	2007 Imports/GDP	16.2	15.4
Std. Dv. of z (σ_z)	0.032	Std. Dev. in CMZ earnings	7	9
Std. Dv. of p_w (σ_w)	$1.64 \times \sigma_z$	Predicted ACR Gains	1.6	1.8

Note: All moments are reported in percent. Migration cost and borrowing limit parameters are reported as a fraction of output per worker.

Labor Supply by z, Assets and Trade Exposure



Labor Supply by z, Assets and Trade Exposure



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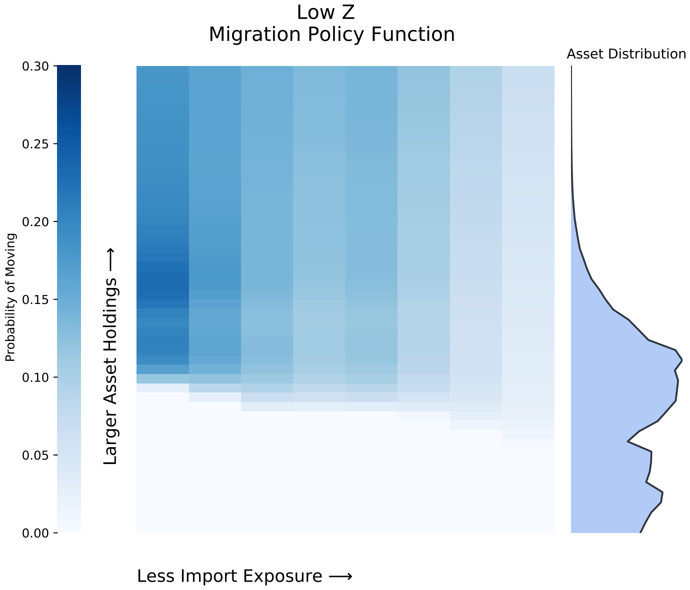
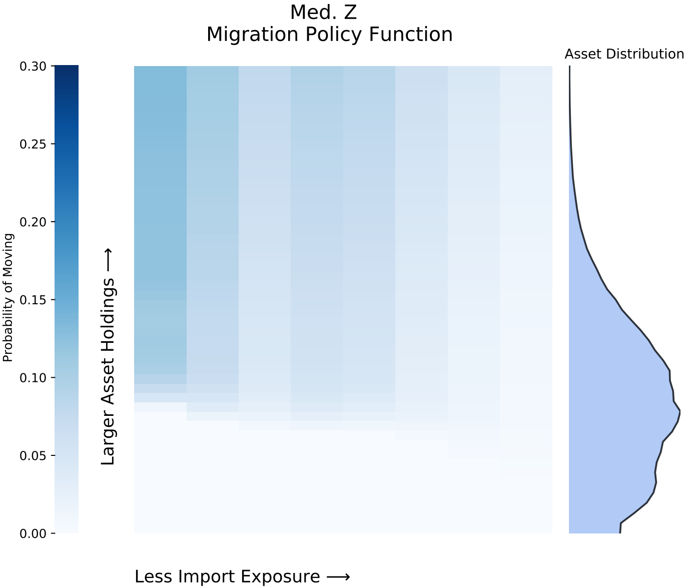


Migration by z, Assets, and Trade Exposure



Value Functions

The value functions for different options

$$V^{s,w}(a,\ \mathbf{s},\ \nu) = \max_{a' \geq -\bar{a}} \left[u(Ra + w(\mathbf{s}) - a') - B + \nu^s + \beta EV(a', \mathbf{s'}, \nu') \right],$$

$$V^{s,nw}(a,\ \mathbf{s},\ \nu) = \max_{a' \geq -\bar{a}} \left[u(w_h + |Ra - a'|^+) + \nu^s + \beta EV(a', \mathbf{s'}, \nu') \right]$$

$$V^{m,w}(a,\ \mathbf{s},\ \nu) = \max_{a' \geq -\bar{a}} \left[u(Ra + w(\mathbf{s}) - a' - m) - B + \nu^m + \beta V^m(a') \right]$$

$$V^{m,nw}(a,\ \mathbf{s},\ \nu) = \max_{a' \geq -\bar{a}} \left[u(w_h + |Ra - a' - m|^+) + \nu^m + \beta V^m(a') \right]$$

Putting everything together. . .

$$V(a,\ \mathbf{s},\ \nu) = \max \left[V^{s,w},\ V^{s,nw},\ V^{m,w},\ V^{m,nw} \right].$$

Equilibrium: A Little Bit of Detail... Non-Traded Goods

Non-Traded Case: An islands with state $\mathbf{s}$ where the good is non traded...

- Because it's non-traded: $\frac{p_w}{\tau_{ex}} < p(\mathbf{s}) < \tau_{im} p_w$.
- Real wages on the island are:

$$w(\mathbf{s}) = \frac{p(\mathbf{s})z}{P}.$$

- Goods market clearing:

$$\left(\frac{p(\mathbf{s})}{P}\right)^{-\theta} Q = z\left(\mu(\mathbf{s})/\pi(\mathbf{s})\right)$$

Note: Household decisions matter in two places: (i) labor supply $\mu(\mathbf{s})$ on the island and (ii) aggregate consumption, Q.

Imported Case: An islands with state $\mathbf{s}$ where the good is **imported**. . .

- Because it's imported: $p(\mathbf{s}) = \tau_{im} p_w$.
- Real wages on the island are:

$$w(\mathbf{s}) = \frac{\tau_{im} p_w z}{P}.$$

- Goods market clearing:

$$\underbrace{\left(\left(\frac{\tau_{im} p_w}{P} \right)^{-\theta} Q \right) - z\left(\mu(\mathbf{s})/\pi(\mathbf{s})\right)}_{\text{imports}} \quad > \quad 0.$$

Equilibrium: A Little Bit of Detail. . . Exported Goods

Exported Case: An islands with state $\mathbf{s}$ where the good is **exported**. . .

- Because it's exported: $p(\mathbf{s})\tau_{ex} = p_w$.
- Real wages on the island are:

$$w(\mathbf{s}) = \frac{p_w z}{\tau_{ex} P}.$$

- Goods market clearing:

$$\underbrace{\left(\frac{p_w/\tau_{ex}}{P}\right)^{-\theta} Q - z\left(\mu(\mathbf{s})/\pi(\mathbf{s})\right)}_{-\text{ exports}} \quad < \quad 0$$

Connection with National Accounts...Income Side

Labor supply is:

$$\mu(\mathbf{s}) = \int_{\nu} \int_{a} \iota_n(\mathbf{s}, a, \nu)\lambda(\mathbf{s}, a, \nu) da\ d\nu.$$

Aggregate income must equal all payments to labor...

$$Y = \int_{\mathbf{s}} w(\mathbf{s})\mu(\mathbf{s})$$

Combining this with households budget constraints and then aggregating connects aggregate income with consumption

$$Y = C - R\mathcal{A} + \mathcal{A}' + \int_a \int_{\mathbf{s}} \int_{\nu} m\iota_m(\mathbf{s}, a, \nu)\lambda(\mathbf{s}, a, \nu) d\nu\ d\mathbf{s}\ da$$

In words, income equals consumption plus government spending minus (i) returns on assets (ii) new purchases of assets and (iii) plus moving costs.

Connection with National Accounts. . . Production Side

Aggregate production equals the value of all island level output. . .

$$Y = \int_{\mathbf{s}} p(\mathbf{s}) z \mu(\mathbf{s})$$

which then working with the island level market clearing conditions gives

$$Y = C + \int_{\mathbf{s}} p(\mathbf{s})\text{exports}(\mathbf{s}) - \int_{\mathbf{s}} p(\mathbf{s})\text{imports}(\mathbf{s}).$$

Savings, Trade Imbalances, and Capital Flows

Then combining the previous results allows us to connect savings with trade imbalances...

$$Y - C = \int_{\mathbf{s}} p(\mathbf{s})\text{exports}(\mathbf{s}) - \int_{\mathbf{s}} p(\mathbf{s})\text{imports}(\mathbf{s}),$$

$$= - r\mathcal{A} + (\mathcal{A}' - \mathcal{A}) + \int_a \int_{\mathbf{s}} \int_{\nu} m\iota_m(\mathbf{s}, a, \nu)\lambda(\mathbf{s}, a, \nu) d\nu \, d\mathbf{s} \, da),$$

Special case with no moving:

$$Y - C = \int_{\mathbf{s}} p(\mathbf{s})\text{exports}(\mathbf{s}) - \int_{\mathbf{s}} p(\mathbf{s})\text{imports}(\mathbf{s}) = -r\mathcal{A} + (\mathcal{A}' - \mathcal{A}).$$