The Impact of Trade with China on US Labor Market

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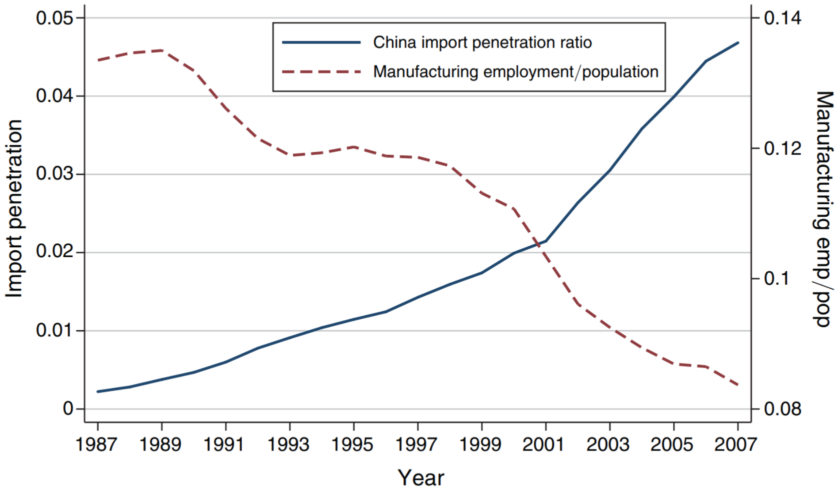

FIGURE 1. IMPORT PENETRATION RATIO FOR US IMPORTS FROM CHINA (*left scale*), AND SHARE OF US WORKING-AGE POPULATION EMPLOYED IN MANUFACTURING (*right scale*)

Motivation

- Since the era of mercantilism, and even earlier, economists have been concerned with the impact of trade on a country's labor market (real wages, employment, and the overall welfare).
- Following China's reform and opening-up, the country's competitiveness in exports has continuously strengthened, leading to a rapid increase in its share of US imports.
- We will begin our introduction by Autor, Dorn, and Hanson (2013), this is a paper with more than 2000 citations.

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Setting

- Treat each commuting zone (CZ) as a small open economy
- Supply of labor in CZ i is L_i, where labor may be employed in traded goods or in non-traded goods
- Assume there is no migration between CZs
- Demand for goods is given by C-D utility function, with share γ of expenditure going to traded goods
- The single non-traded good is manufactured with $X_{Ni} = L_{Ni}^{\eta}$
- Profit maximization yields $W_i = \eta P_{Ni} L_{Ni}^{\eta-1}$
- Market clearing condition for non-traded good

$$P_{Ni} X_{Ni} = (1-\gamma)\left(W_i L_i + B_i\right)$$

where B_i is the difference between expenditure and income

Setting (Continued)

- Traded goods are produced by firms in a monopolistically competitive sector. There are two traded-good sectors indexed by j
- Demand for labor is given by $l_{ij} = \alpha_{ij} + \beta_{ij} x_{ij}$
- Demand for product varieties is given by

$$x_{ij} = \sum_k x_{ijk} = \sum_k \frac{P_{ijk}^{-\sigma_j}}{\Phi_{jk}^{1-\sigma_j}} \frac{\gamma E_k}{2}$$

  where E_k is the total expenditure in market k
- Firms M_{ij} set prices as a constant markup over marginal cost

$$P_{ijk} = \frac{\sigma_j}{\sigma_j - 1} \beta_{ij} W_i \tau_{ijk}$$

  where τ_{ijk} is the iceberg transport cost
- A detailed derivation of Dixit-Stiglitz Model can be seen here

Setting (Continued)

- Free entry in each sector drives profits to zero $x_{ij} = \alpha_{ij}(\sigma_j - 1)/\beta_{ij}$
- Labor market clearing $L_i = L_{Ni} + L_{Ti}$, where $L_{Ti} = \sum_j M_{ij} l_{ij}$
- Price index is given through

$$\Phi_{jk} = \left[\sum_h M_{hj} P_{hjk}^{1-\sigma_j} \right]^{\frac{1}{1-\sigma_j}}$$

- Log differentiating yields ($\hat{x} \equiv \Delta \log x$)

$$\hat{\Phi}_{jk} = -\frac{1}{\sigma_j - 1} \sum_h \phi_{hjk} \hat{A}_{hjk}$$

  where ϕ_{hjk} is the share of region h in purchases of sector j goods by market k and $\hat{A}_{hjk} \equiv \hat{M}_{hj} - (\sigma_j - 1)\left(\hat{W}_h + \hat{\beta}_{hj} + \hat{\tau}_{hjk}\right)$ is the log change in the "export capability" of region h in market k, determined by changes in the number of varieties region h produces $\left(\hat{M}_{hj}\right)$, its wages $\left(\hat{W}_h\right)$, its labor productivity $\left(\hat{\beta}_{hj}\right)$, and its trade costs $\left(\hat{\tau}_{hjk}\right)$.

Solving the Model

- Five equations in five unknowns $W_i, P_{Ni}, L_{Ni}, M_{ij}$ for $j = 1, 2$.

$$\hat{W}_i = \hat{P}_{Ni} - (1-\eta)\hat{L}_{Ni}$$

$$\eta\hat{L}_{Ni} = \rho_i\left(\hat{W}_i + \hat{L}_i\right) + (1-\rho_i)\,\hat{B}_i - \hat{P}_{Ni}$$

- $$\hat{L}_i = \left(1 - \sum_j \delta_{ij}\right)\hat{L}_{Ni} + \sum_j \delta_{ij}\hat{M}_{ij} \quad (1)$$

$$\sigma\,\hat{W}_i = \sum_k \theta_{ijk}\left[\hat{E}_k + (\sigma_j - 1)\,\hat{\Phi}_{jk}\right] = \sum_k \theta_{ijk}\hat{E}_k - \sum_k \theta_{ijk}\sum_h \phi_{hjk}\hat{A}_{hjk}, j = 1, 2$$

- We can get an analytical solution

$$\hat{W}_i = \sum_j c_{ij}\frac{L_{ij}}{L_{Ni}}\left[\theta_{ijC}\hat{E}_{Cj} - \sum_k \theta_{ijk}\phi_{Cjk}\hat{A}_{Cj}\right]$$

$$\hat{L}_{Ti} = \rho_i\sum_j c_{ij}\frac{L_{ij}}{L_{Ti}}\left[\theta_{ijC}\hat{E}_{Cj} - \sum_k \theta_{ijk}\phi_{Cjk}\hat{A}_{Cj}\right] \quad (2)$$

$$\hat{L}_{Ni} = \rho_i\sum_j c_{ij}\frac{L_{ij}}{L_{Ni}}\left[-\theta_{ijC}\hat{E}_{Cj} + \sum_k \theta_{ijk}\phi_{Cjk}\hat{A}_{Cj}\right]$$

Empirical Approach

- With further assumptions, we have

$$\hat{L}_{Ti} = -\alpha \sum_j \frac{L_{ij}}{L_{Ti}} \frac{X_{ijU}}{X_{ij}} \frac{M_{CjU}}{E_{Uj}} \hat{A}_{Cj} \approx -\tilde{\alpha} \sum_j \frac{L_{ij}}{L_{Uj}} \frac{M_{CjU} \hat{A}_{Cj}}{L_{Ti}}$$

- The change in Chinese import exposure per worker in a region

$$\Delta IPW_{uit} = \sum_j \frac{L_{ijt}}{L_{ujt}} \frac{\Delta M_{ucjt}}{L_{it}}$$

- OLS regression model

$$\Delta L_{it}^m = \Upsilon_t + \beta_1 \Delta IPW_{uit} + X_{it}' \beta_2 + e_{it}$$

Empirical Approach (Continued)

- Endogeneity problem: Realized US imports from China may be correlated with industry import demand shocks
- Using realized imports from China to other high-income markets ΔM_{ocjt} as an IV

$$\Delta IPW_{oit} = \sum_{j} \frac{L_{ijt-1}}{L_{ujt-1}} \frac{\Delta M_{ocjt}}{L_{it-1}}$$

- They provided first-stage results to show the validity of IV
- 2SLS regression model

$$\Delta L_{it}^{m} = \Upsilon_t + \beta_1 \Delta IPW_{oit} + X_{it}' \beta_2 + e_{it}$$

Empirical Results

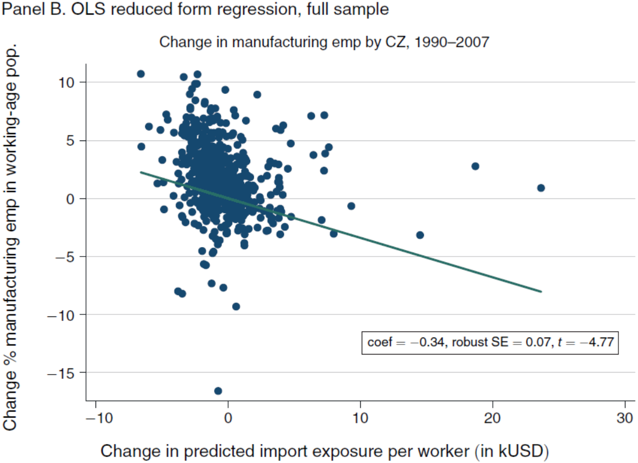

FIGURE 2. CHANGE IN IMPORT EXPOSURE PER WORKER AND DECLINE OF MANUFACTURING EMPLOYMENT: ADDED VARIABLE PLOTS OF FIRST STAGE AND REDUCED FORM ESTIMATES

Notes: $N = 722$. The added variable plots control for the start of period share of employment in manufacturing industries. Regression models are weighted by start of period CZ share of national population.

Empirical Results (Continued)

- 2SLS Estimates

TABLE 2—IMPORTS FROM CHINA AND CHANGE OF MANUFACTURING EMPLOYMENT IN CZS, 1970–2007: 2SLS ESTIMATES

Dependent variable: 10 × annual change in manufacturing emp/working-age pop (in % pts)

	I. 1990–2007			II. 1970–1990 (pre-exposure)		
	1990–2000 (1)	2000–2007 (2)	1990–2007 (3)	1970–1980 (4)	1980–1990 (5)	1970–1990 (6)
(Δ current period imports from China to US)/worker	−0.89*** (0.18)	−0.72*** (0.06)	−0.75*** (0.07)			
(Δ future period imports from China to US)/worker				0.43*** (0.15)	−0.13 (0.13)	0.15 (0.09)

Notes: $N = 722$, except $N = 1{,}444$ in stacked first difference models of columns 3 and 6. The variable "future period imports" is defined as the average of the growth of a CZ's import exposure during the periods 1990–2000 and 2000–2007. All regressions include a constant and the models in columns 3 and 6 include a time dummy. Robust standard errors in parentheses are clustered on state. Models are weighted by start of period CZ share of national population.

***Significant at the 1 percent level.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

Empirical Results (Continued)

- Wage effects

TABLE 6—IMPORTS FROM CHINA AND WAGE CHANGES WITHIN CZs, 1990–2007: 2SLS ESTIMATES

Dependent variable: Ten-year equivalent change in average log weekly wage (in log pts)

	All workers (1)	Males (2)	Females (3)
Panel A. All education levels			
(Δ imports from China to US)/worker	−0.759***	−0.892***	−0.614***
	(0.253)	(0.294)	(0.237)
R^2	0.56	0.44	0.69
Panel B. College education			
(Δ imports from China to US)/worker	−0.757**	−0.991***	−0.525*
	(0.308)	(0.374)	(0.279)
R^2	0.52	0.39	0.63
Panel C. No college education			
(Δ imports from China to US)/worker	−0.814***	−0.703***	−1.116***
	(0.236)	(0.250)	(0.278)
R^2	0.52	0.45	0.59

Notes: $N = 1,444$ (722 CZs × two time periods). All regressions include the full vector of control variables from column 6 of Table 3. Robust standard errors in parentheses are clustered on state. Models are weighted by start of period CZ share of national population.

*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.

Empirical Results (Continued)

- They tried to conduct robustness checks through
  - adding different demographic and labor force measures as control variables
  - dropping various industries to address on the issue of import demand shocks being correlated across countries
  - showing there are little migration due to import from China
- They conducted heterogeneity tests between
  - manufacturing sector and non-manufacturing sector
  - workers with different education background
  - male workers and female workers
  - workers with different demographic characteristics

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Settings

- Caliendo, Dvorkin, and Parro (2019) provided a DSGE version
- N locations and J sectors
- Competitive labor markets and a continuum of perfectly competitive firms producing intermediate goods
- Households are forward looking, perfect foresight, optimal decision, facing mobility cost and an idiosyncratic shock across markets
  - Can be either employed or non-employed
  - An employed household supplies a unit of labor inelastically
  - Preferences are over a C-D aggregator of local goods
  - Time invariant migration costs
- Firms have a C–D production function, demanding labor, structures and materials
  - Intermediate goods production requires labor l_t^{nj}, structures h_t^{nj} and materials M_t, and TFP is composed of a time-varying component A_t^{nj} and a variety-specific component z^{nj}
  - Local sectoral aggregate goods Q_t^{nj} are produced through CES over intermediate goods of varieties
  - Time varying iceberg bilateral trade cost Details

Equilibrium

Endogenous State	L_t	Labor Distribution
Time-varing Fundamentals Θ_t	A_t	Sectoral-regional productivities
	κ_t	Bilateral trade costs
Constant Fundamentals $\bar{\Theta}$	Υ	Labor relocation costs
	H	Stock of structures
	b	Home production
Parameters	γ^{nj}	Value added shares
	$1-\xi^n$	Labor shares in value added
	$\gamma^{nk,nj}$	Input-output coefficients
	ι^n	Portfolio shares
	α^j	Final consumption expenditure shares
	β	Discount factor
	θ	Trade elasticities
	ν	Migration elasticity

Constructing the Counterfactuals

- Dynamic hat algebra as a powerful tool See Here

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  - Step 3: Assume that a set of time varying fundamentals evolves as they did over a given period of time while another subset of time-varying fundamentals changes in a different way relative to their true changes.

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  - Step 4: What would have happened differently across U.S. labor markets if the China shock did not occur?

Constructing the Counterfactuals

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  - Step 4: What would have happened differently across U.S. labor markets if the China shock did not occur?
- What we should do
  - Compute a baseline economy
  - Compute the counterfactual economy
  - Identify the China shock

Taking the Model to the Data

- Baseline Economy: compute the baseline economy with the actual evolution of fundamentals between 2000-2007 and constant fundamentals going forward
- Counterfactuals: compute the counterfactual economy in which all fundamentals evolve as they did over 2000-2007 except for the estimated changes in productivities in China
- Compute: biliteral trade flows $\pi_t^{nj,ij}$, value added $w_t^{nj} L_t^{nj} + r_t^{nj} H_t^{nj}$, distribution of employment L_t, migrations across regions and sectors $\mu_t^{nj,\,ik}$, the share of value added in gross output γ^{nj}, the material shares $\gamma^{nj,\,nk}$, the share of structures in value added ξ^n, the final consumption shares α^j
- Calibrate: the global portfolio shares ι^n, the size of the TFP changes for each of the manufacturing sectors in China
- Estimate: the sectoral trade elasticities θ^j, the migration elasticity ν, and the discount factor β

Employment Effect: Manufacturing Industries

- Increased competition from China reduced the share of manufacturing employment by 0.36 percentage points after 15 years
- Increased import competition from China leads workers to relocate to other sectors See Here
- Industries with higher exposure to import competition from China (computer and electronics, furniture, etc.) lost more employment
- Industries less exposed to import competition from China (food, beverage and tobacco, petroleum, etc.) explain a smaller portion of the decline in manufacturing employment See Here
- States with a comparative advantage in industries more exposed to import competition from China lose more employment in manufacturing See Here
- Although the contribution of larger regions to the aggregate decline in manufacturing is large, the local impact of the China shock could be mitigated compared with smaller and less diversified regions See Here

Employment Effect: Non-manufacturing Industries

- All non-manufacturing industries absorbed workers displaced from manufacturing industries
- U.S. states with a larger service sector contribute more to the increase in non-manufacturing employment, as they were able to absorb more workers displaced from the manufacturing industries See Here
- The unequal regional effects from the China shock in different industries See Here
- China shock reduced the U.S. non-employment rate by 0.22 percentage points in the long run

Welfare Effect

- U.S. aggregate welfare increases by 0.2% due to China's import penetration growth
- There is a very heterogeneous response to the same aggregate shock across labor markets See Here
- In the long run, aggregate welfare increases in all states due to the China shock, ranging from 0.12 to 0.22 See Here
- In all states, the welfare gains in the nonmanufacturing industries are larger than in the manufacturing industries See Here
- Manufacturing industries across U.S. states are worse off in the short run due to increased import competition and relocation costs See Here
- All countries gain from the China shock See Here
- Taking into account the dynamic relocation process after the China shock is crucial to capturing the long-run welfare gains
- On average, transition costs reduce steady-state welfare by about 4.7%. However, the variation across individual labor markets is substantial See Here

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Overview

- New insights by Autor, Dorn, Hanson, and Song (2014), Autor, Dorn, and Hanson (2016) and Acemoglu et al. (2016)
- Critiques on Autor, Dorn, and Hanson (2013)
  - Feenstra, Ma, and Xu (2017) (hereafter FMX), Rothwell (2016a, 2016b, 2017)
  - Wang et al. (2018)
- Examples from other countries
  - Europe: De Ville and Vermeiren (2016)
  - Protuguese: Branstetter et al. (2019)
- After China-US Trade War
  - Fajgelbaum and Khandelwal (2022), Waugh (2019)

New insights

- Autor, Dorn, Hanson, and Song (2014), *QJE*
  - Workers more exposed to trade with China exhibit lower cumulative earnings and employment and higher receipt of SSDI
  - Workers with lower labor force attachment, shorter tenure, and lower earnings incur larger losses in subsequent earnings and employment
  - We find little evidence that geographic mobility is an important mechanism through which trade adjustment operates
- Autor, Dorn, and Hanson (2016), *Annual*
  - Interindustry linkages thus magnify the employment effects of trade shocks, doubling the size of the impact within manufacturing and producing an equally large employment effect outside of manufacturing
- Acemoglu et al. (2016), *JLE*
  - Import competition from China, which surged after 2000, was a major force behind both recent reductions in US manufacturing employment and—through input-output linkages and other general equilibrium channelsweak overall US job growth

Critiques on ADH 2013

- Feenstra, Ma, and Xu (2017), *NBER*
  - The estimation results on the impact of import competition on labor-market outcomes in ADH 2013 are biased by the exclusion of controls for contemporaneous changes in housing prices
- Rothwell (2016a, 2016b, 2017)
  - The empirical results in ADH 2013 on the impact of import competition with China on local labor markets in the United States are subject to specification bias
- ADH's Replies
  - To FMX: The trend component of local housing-price changes on which FMX primarily rely is highly likely to be endogenous to trade shocks, and there is little change in ADH's main empirical results
  - To Rothwell: The main methodological critique provided by Rothwell is unfounded
- Wang et al. (2018), *NBER*
  - The United States imports intermediate inputs from China, helping downstream US firms to expand employment

Examples from other countries

- De Ville and Vermeiren (2016), *Comparative European Politics*
  - An asymmetric shock in the Eurozone: while Germany largely benefited from the rise of China in the global monetary and trading system, the GIPS countries have been much less adapted
- Branstetter et al. (2019), *NBER*
  - In the later period (2000-2007), when more flexible temporary contracts comprise a larger share of employment, we find employment reductions among more exposed firms.

After China-US Trade War

- Fajgelbaum and Khandelwal (2022), *Annual*
  - Lack of data availability has so far prevented an analysis of actual wage changes across regions in response to the trade war, and recent studies have considered other less standard outcomes
- Waugh (2019), *NBER*
  - Chinese retaliation is leading to concentrated welfare losses in the US

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In Conclusion

- Hardly any consensus regarding the impact of China shock on US labor market
  - Real wages and employment probably go down
  - Overall welfare may probably increase
- We have seen the research paradigm in recent years shift from solely utilizing IV regression, to considering upstream and downstream relationships in multi-stage models, and then to the transition to general equilibrium with discrete choices
- This is a promising field, very much worthy of Chinese scholars' dedication

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Thank you!

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Appendix 1: Dixit-Stiglitz Model

- Continuum of firms i on measure N
- Each firm is the monopoly supplier of a differentiated product
- These products enter household utility through the consumption index

$$C = [\int_0^N c_i^{\frac{\phi-1}{\phi}} di]^{\frac{\phi}{\phi-1}}$$

- Household utility is then $U(C, L, \cdots)$
- ϕ is the elasticity of substitution between different c_is
- Suppose the price of good i is p_i, household would like to maximize the amount of C it can purchase for a given amount of spending Z

$$\max_{c_i} [\int_0^N c_i^{\frac{\phi-1}{\phi}} di]^{\frac{\phi}{\phi-1}} \quad \text{subject to} \quad \int_0^N p_i c_i di = Z$$

BACK

Appendix 1: Dixit-Stiglitz Model

- Set a Lagrangian

$$L = [\int_0^N c_i^{\frac{\phi-1}{\phi}} di]^{\frac{\phi}{\phi-1}} - \lambda[\int_0^N p_i c_i di - Z]$$

- Differentiating with respect to c_i yields

$$(\frac{C}{c_i})^{1/\phi} = \lambda p_i$$

- This is true for each i. Rearranging yields

$$c_i = c_i'(\frac{p_i}{p_i'})^{-\phi}$$

- Define the ideal price index P as the minimum expenditure needed to purchase 1 unit of the consumption index. We are going to find P.

Appendix 1: Dixit-Stiglitz Model

- Plugging in c_i into budget constraint

$$Z = \int_0^N p_i c_i' \left(\frac{p_i}{p_i'}\right)^{-\phi} di$$

- Rearranging yields

$$c_i' = \frac{p_i'^{-\phi} Z}{\int_0^N p_i^{1-\phi} di}$$

- Plugging in c_i into the expression of C yields

$$C = \left[\int_0^N \left(\frac{p_i^{-\phi} Z}{\int_0^N p_i'^{1-\phi} di'}\right)^{\frac{\phi-1}{\phi}} di\right]^{\frac{\phi}{\phi-1}}$$

Appendix 1: Dixit-Stiglitz Model

- By definition of P

$$1 = \left[\int_0^N \left(\frac{p_i^{-\phi} P}{\int_0^N p_i'^{1-\phi} di'} \right)^{\frac{\phi-1}{\phi}} di \right]^{\frac{\phi}{\phi-1}}$$

- Rearranging then yields

$$P = \left[\int_0^N p_i^{1-\phi} di \right]^{\frac{1}{1-\phi}}$$

- Since $Z = PC$, we get

$$c_i' = \frac{p_i'^{-\phi} PC}{\int_0^N p_i^{1-\phi} di}$$

- Some rearranging then yields

$$c_i = C \left(\frac{p_i}{P} \right)^{-\phi}$$

Appendix 1: Dixit-Stiglitz Model

- Now let's return to firms. Suppose their marginal cost of production is ψ
- Firm profits are then given by $\Pi_i = p_i c_i - \psi c_i$
- Firms set prices to maximize profits given demand for their products

$$\max_{p_i} C\left(\frac{p_i}{P}\right)^{-\phi}(p_i - \psi)$$

- Profit maximization yields

$$p_i = \frac{\phi}{\phi - 1}\psi$$

- Firm's set prices equal to a markup over marginal cost[1] BACK

[1] This part refers to Jon Steinsson's slides on Expanding Variety Model, which is quoted from his personal website.

Appendix 2: Equilibrium Definition in CDP

- The household problem can be written through

$$\mathrm{v}_t^{nj} = U\left(C_t^{nj}\right) + \max_{\{i,k\}_{i=1,k=0}^{N,J}} \left\{\beta E\left[\mathrm{v}_{t+1}^{ik}\right] - \tau^{nj,ik} + \nu\epsilon_t^{ik}\right\}$$

$$\text{s.t. } C_t^{nj} \equiv \begin{cases} b^n & \text{if } j = 0 \\ w_t^{nj}/P_t^n & \text{otherwise} \end{cases}$$

or equivalently

$$V_t^{nj} = U\left(C_t^{nj}\right) + \nu \log\left(\sum_{i=1}^{N}\sum_{k=0}^{J} \exp\left(\beta V_{t+1}^{ik} - \tau^{nj,ik}\right)^{1/\nu}\right)$$

BACK

Appendix 2: Equilibrium Definition in CDP (Continued)

- The labor market evolves with

$$L_{t+1}^{nj} = \sum_{i=1}^{N} \sum_{k=0}^{J} \mu_t^{ik,nj} L_t^{ik}$$

where

$$\mu_t^{nj,ik} = \frac{\exp\left(\beta V_{t+1}^{ik} - \tau^{nj,ik}\right)^{1/\nu}}{\sum_{m=1}^{N} \sum_{h=0}^{J} \exp\left(\beta V_{t+1}^{mh} - \tau^{nj,mh}\right)^{1/\nu}}$$

- Intermediate goods producing implies

$$x_t^{nj} = B^{nj} \left(\left(r_t^{nj} \right)^{\xi^n} \left(w_t^{nj} \right)^{1-\xi^n} \right)^{\gamma^{nj}} \prod_{k=1}^{J} \left(P_t^{nk} \right)^{\gamma^{nj,nk}}$$

Appendix 2: Equilibrium Definition in CDP (Continued)

- Local sectoral aggregate goods producing implies

$$P_t^{nj} = \Gamma^{nj} \left(\sum_{i=1}^{N} \left(x_t^{ij} \kappa_t^{nj,ij} \right)^{-\theta^j} \left(A_t^{ij} \right)^{\theta^j \gamma^{ij}} \right)^{-1/\theta^j},$$

- Share of total expenditure is given by

$$\pi_t^{nj,ij} = \frac{\left(x_t^{ij} \kappa_t^{nj,ij} \right)^{-\theta^j} \left(A_t^{ij} \right)^{\theta^j \gamma^{ij}}}{\sum_{m=1}^{N} \left(x_t^{mj} \kappa_t^{nj,mj} \right)^{-\theta^j} \left(A_t^{mj} \right)^{\theta^j \gamma^{mj}}}.$$

Appendix 2: Equilibrium Definition in CDP (Continued)

- Market Clearing

$$X_t^{nj} = \sum_{k=1}^{J} \gamma^{nk,nj} \sum_{i=1}^{N} \pi_t^{ik,nk} X_t^{ik} + \alpha^j \left(\sum_{k=1}^{J} w_t^{nk} L_t^{nk} + \iota^n \chi_t \right)$$

$$L_t^{nj} = \frac{\gamma^{nj}\left(1 - \xi^n\right)}{w_t^{nj}} \sum_{i=1}^{N} \pi_t^{ij,nj} X_t^{ij}$$

$$H^{nj} = \frac{\gamma^{nj} \xi^n}{r_t^{nj}} \sum_{i=1}^{N} \pi_t^{ij,nj} X_t^{ij}$$

BACK

Appendix 3: Dynamic Hat Algebra

- Motivation: Hard to pin down a large number of fundamentals
- Dynamic hat algebra enables us to circumvent the level of fundamentals.
- Proposition 1: Given the allocation of the temporary equilibrium at $t, \{L_t, \pi_t, X_t\}$, the solution to the temporary equilibrium at $t+1$ for a given change in $\dot{L}_{t+1}$ and $\dot{\Theta}_{t+1}$ does not require information on the level of fundamentals at t, Θ_t, or $\bar{\Theta}$.
- Proposition 2: Conditional on an initial allocation of the economy, $(L_0, \pi_0, X_0, \mu_{-1})$, given an anticipated convergent sequence of changes in fundamentals, $\left\{\dot{\Theta}_t\right\}_{t=1}^{\infty}$, the solution to the sequential equilibrium in time differences does not require information on the level of the fundamentals $\{\Theta_t\}_{t=0}^{\infty}$ or $\bar{\Theta}$. BACK

Appendix 3: Dynamic Hat Algebra (Continued)

- Proposition 3: Given a baseline economy, $\{L_t, \mu_{t-1}, \pi_t, X_t\}_{t=0}^{\infty}$, and a counterfactual convergent sequence of changes in fundamentals (relative to the baseline change), $\left\{\hat{\Theta}_t\right\}_{t=1}^{\infty}$, solving for the counterfactual sequential equilibrium $\left\{L'_t, \mu'_{t-1}, \pi'_t, X'_t\right\}_{t=1}^{\infty}$ does not require information on the baseline fundamentals $\left(\{\Theta_t\}_{t=0}^{\infty}, \bar{\Theta}\right)$.
- This powerful tool has turned the difficult problem into an easier one similar to putting an elephant into a refrigerator. BACK

Appendix 4: Employment Effects BACK

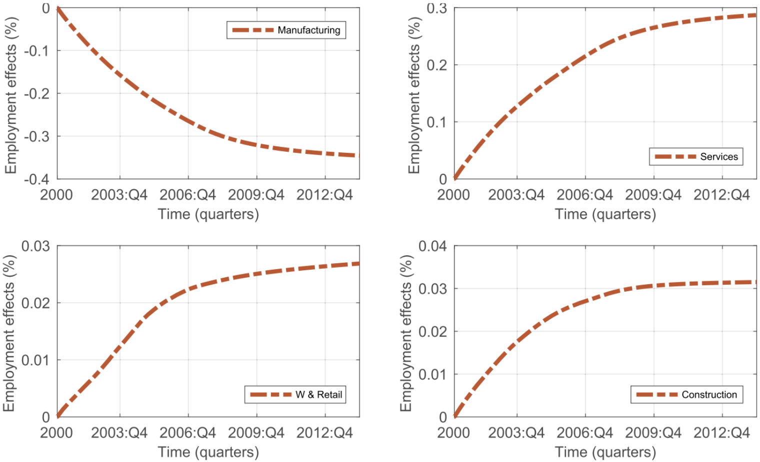


FIGURE 1.—The effect of the China shock on employment shares. Note: The figure presents the effects of the China shock measured as the change in employment shares by sector (manufacturing, services, wholesale and retail, and construction) over total employment between the economy with all fundamentals changing as in the data and the economy with all fundamentals changing except for the estimated sectoral changes in productivities in China (the economy without the China shock).

Appendix 4: Employment Effects (Continued) BACK

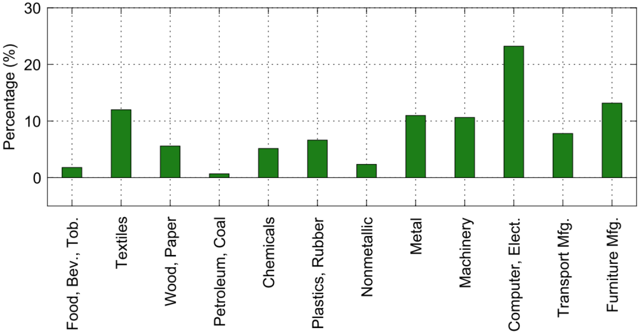


FIGURE 2.—Manufacturing employment declines due to the China trade shock (percent of total). Note: The figure presents the contribution of each manufacturing industry to the total reduction in the manufacturing employment due to the China shock.

Appendix 4: Employment Effects (Continued) BACK

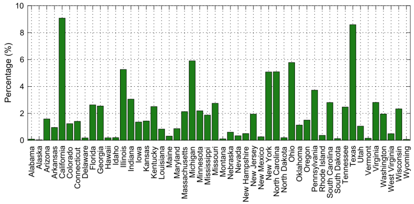


FIGURE 3.—Regional contribution to U.S. aggregate manufacturing employment decline (percent). Note: The figure presents the contribution of each state to the total reduction in manufacturing sector employment due to the China shock.

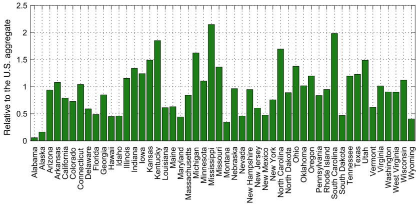


FIGURE 4.—Regional contribution to U.S. aggregate manufacturing employment decline, normalized by regional employment share. Note: The figure presents the contribution of each state to the U.S. aggregate reduction in manufacturing sector employment due to the China shock, normalized by the employment of each state relative to the U.S. aggregate employment.

Appendix 4: Employment Effects (Continued) BACK

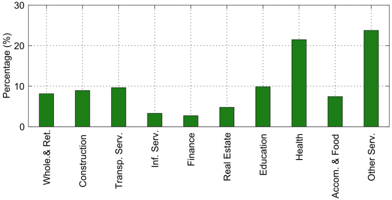


FIGURE 5.—Non-manufacturing employment increases due to the China trade shock (percent of total). Note: The figure presents the contribution of each non-manufacturing sector to the total increase in non-manufacturing employment due to the China shock.

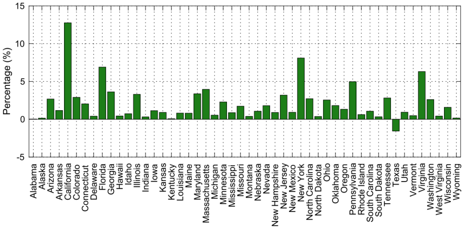


FIGURE 6.—Regional contribution to U.S. aggregate non-manufacturing employment increase (percent). Note: The figure presents the contribution of each state to the total rise in non-manufacturing employment due to the China shock.

Appendix 4: Employment Effects (Continued) BACK

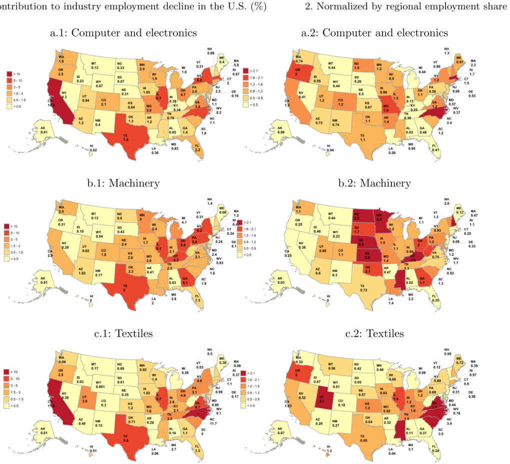


FIGURE 7.—Regional employment declines in manufacturing industries. Note: This figure presents the reduction in local employment in manufacturing industries. Column 1 presents the contribution of each state to the U.S. aggregate reduction in industry employment due to the China shock. Column 2 presents the contribution of each state to the U.S. aggregate reduction in industry employment normalized by the employment size of each state relative to U.S. aggregate employment. Panels a present the results for the computer and electronics industry. Panels b present the results for the machinery industry. Panels c present the results for the textiles industry.

Appendix 4: Employment Effects (Continued)

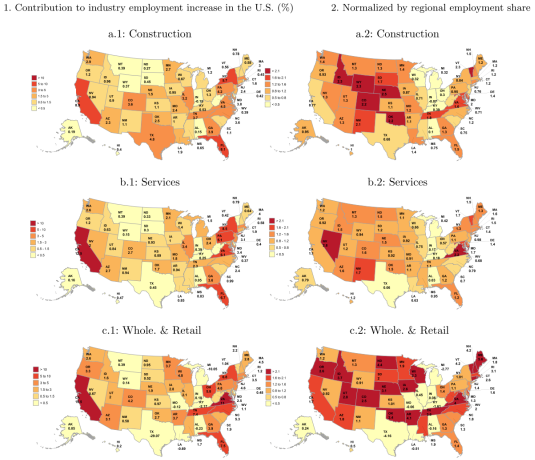


FIGURE 8.—Regional employment increases in non-manufacturing industries. Note: This figure presents the rise in local employment in non-manufacturing industries. Column 1 presents the contribution of each state to the U.S. aggregate increase in industry employment due to the China shock. Column 2 presents the contribution of each state to the U.S. aggregate increase in industry employment normalized by the employment size of each state relative to U.S. aggregate employment. Panels a present the results for construction. Panels b present the results for all services. Panels c present the results for wholesale and retail.

Appendix 4: Welfare Effect BACK

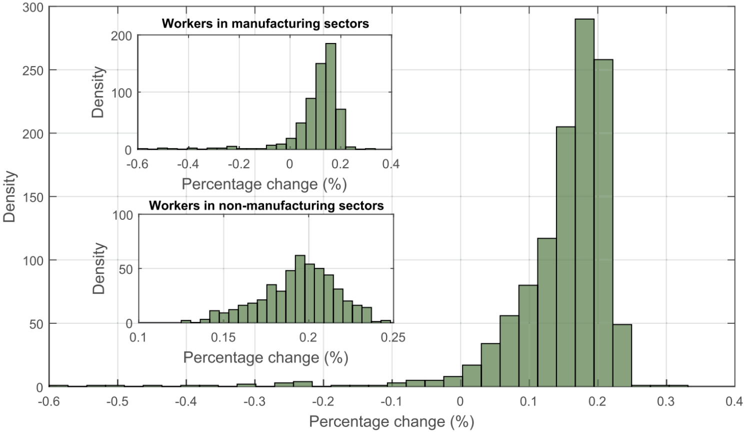
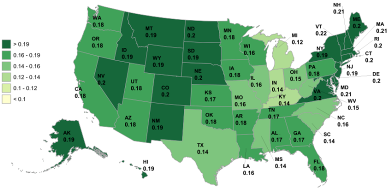


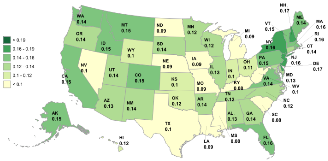
FIGURE 10.—Welfare effects of the China shock across U.S. labor markets. Note: The figure presents the change in welfare across all labor markets (central figure), for workers in manufacturing sectors (top-left panel), and for workers in non-manufacturing sectors (bottom-left panel) as a consequence of the China shock. The largest and smallest 1 percentile are excluded in each figure. The percentage change in welfare is measured in terms of consumption equivalent variation.

Appendix 4: Welfare Effect (Continued) BACK

a.1: Regional



a.2: Manufacturing



a.3: Non-manufacturing

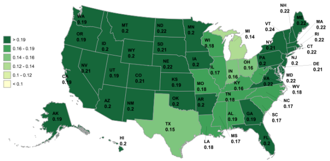


Figure 11: Regional welfare effects (percent)

FIGURE 11.—Regional welfare effects (percent). Note: The figure presents the welfare effects across states in the United States. Panel a.1 shows the regional effects in each state, panel a.2 presents the manufacturing welfare effects in each state, and panel a.3 presents the welfare effects in the non-manufacturing sectors in each state. We aggregate welfare across labor markets within a state using employment shares for the initial year.

Appendix 4: Welfare Effect (Continued) BACK

a.1: One quarter after 2000

a.2: From 2000 to 2007

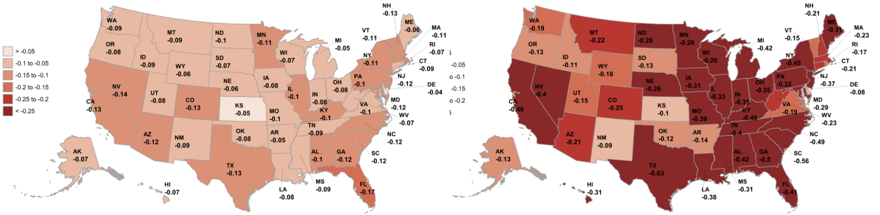


FIGURE 12.—Regional real wage changes in the manufacturing sector (percent). Note: The figure presents the change in real wages in the manufacturing sector across U.S. states. Panel a.1 presents the change in real wages at impact, one quarter after the China shock started. Panel a.2 presents the change in real wages from 2000 to 2007, during the entire period of the China shock. We aggregate the changes in real wages across labor markets within a state using employment shares for the initial year.

Appendix 4: Welfare Effect (Continued) BACK

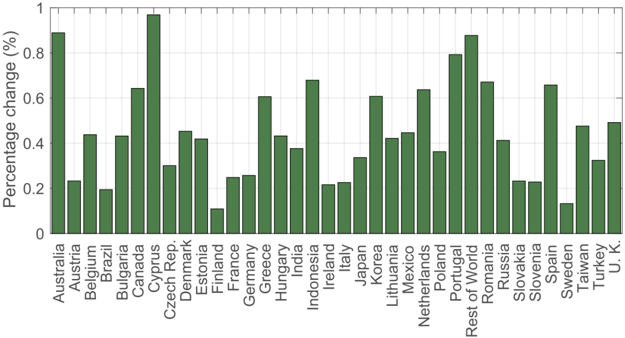


FIGURE 13.—Welfare effects across regions. Note: The figure presents the change in welfare across countries in our sample from the effect of the China shock. The percentage change in welfare is measured as the percentage change in real consumption.

Appendix 4: Welfare Effect (Continued) BACK

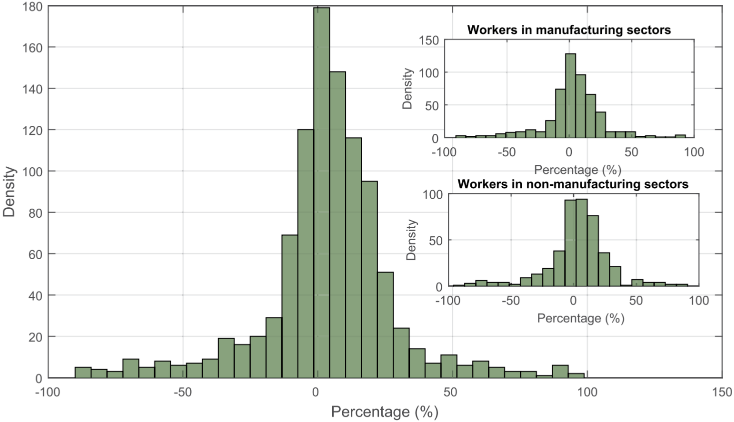


FIGURE 14.—Adjustment costs. Note: The figure presents the transition costs across all labor markets (central figure), for workers in manufacturing sectors (top-right panel), and for workers in non-manufacturing sectors (bottom-right panel) due to the China shock. Labor markets with computed adjustment costs larger than 100 percent and smaller than −100 percent are excluded.