Trade, skills and unemployment: a quantitative analysis

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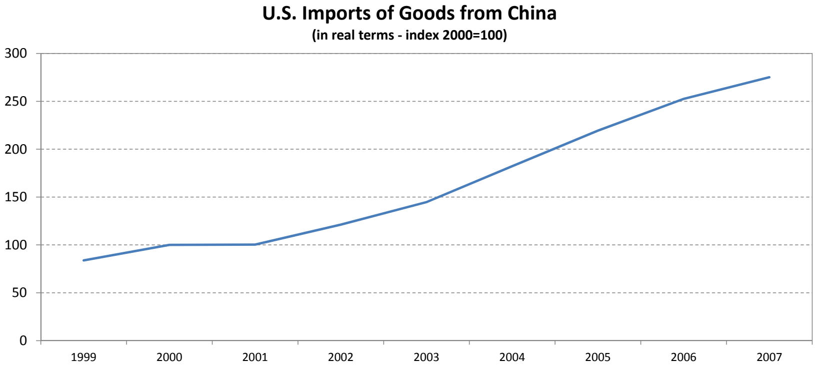
Introduction

- What are the labor market effects of international trade?
  - Trade has an asymmetric impact on industries, firms and regions
    - Direct: more customers for exporters, more competition for importers
    - Indirect: supply more intermediates to exporters, lower demand of intermediates from firms competing with foreign producers
  - If workers are heterogeneous in their characteristics and skills, or
  - If there are labor market frictions (costly reallocation, unemployment), then
  - Trade has an asymmetric impact on workers

Introduction

- U.S. imports from China more than doubled between 2000-2007.



  - Concentrated in a small subset of manufacturing goods
  - Computer and electronics, machinery and equipment, furniture, textiles.

This paper

- I develop a model of trade and labor market dynamics
  - Embed a DMP model of the labor market in an EK model of trade
  - Goods mobility frictions, I-O linkages, geographic factors
- Propose a Roy (1951) model with frictional labor markets
  - Extend the DMP model to many segmented labor markets
  - Workers have heterogeneous skills or human capital
  - Targeted search and costly labor reallocation
- Study how China's import competition affected U.S. labor markets
  - 38 countries, 22 sectors, 21 occupations in the model
  - Compute employment, unemployment, wage losses, and welfare effects
    - ★ Employment effects: Large drop in Routine Manual employment
    - ★ Welfare effects: Positive due to elastic labor supply

Reduced form evidence

- Follow Autor, Dorn and Hanson (2013)
- Exploit differences in exposure of U.S. commuting zones (cities) to Chinese imports
- Construct a measure of exposure to Chinese imports using:

$$\Delta IPW_{ui} = \sum_j \frac{L_{ij}}{L_{uj}} \frac{\Delta M_{ucj}}{L_i}.$$

- And estimate the following regression

$$\Delta \text{Labor market variable}_{ui} = a_0 + a_1 \, \Delta IPW_{ui} + e_i$$

Reduced form evidence

Imports from China and changes in main labor market variables (2000-2007)

	Change in the share of manufacturing employment	Change in the unemployment rate	Change in avg log weekly wage
(Δ Imports from China to US)/Worker	-0.8062*** (0.0663)	0.1199*** (0.0274)	-0.5553** (0.2542)

	Avg Mass layoffs (as share of employment)	Avg Job Destruction rate	Avg Job Creation rate
(Δ Imports from China to US)/Worker	0.4233** (0.2126)	-1.0489*** (0.4189)	-1.6542*** (0.1029)

IV Regression, instrumented by imports from China by other advanced economies. Robust standard errors in parenthesis, clustered on state. Models are weighted by start of period commuting zone share of national population. * $p \leq 0.10$, ** $p \leq 0.05$, *** $p \leq 0.01$.

Reduced form evidence

Employment effects by occupation groups

Imports from China, occupations and skills (2000-2007)

	Change in the share of **employment** in			
	Non-routine Cognitive	Non-routine Manual	Routine Cognitive	Routine Manual
(Δ Imports from China to US)/Worker	0.05008 (0.0627)	0.0829 (0.0673)	0.1258** (0.05301)	-0.5688*** (0.1309)

	Change in the share of **unemployment** in			
	Non-routine Cognitive	Non-routine Manual	Routine Cognitive	Routine Manual
(Δ Imports from China to US)/Worker	0.0165*** (0.0048)	0.0191*** (0.0065)	0.0280*** (0.0100)	0.0430*** (0.0140)

IV Regression, instrumented by imports from China by other advanced economies. Robust standard errors in parenthesis, clustered on state. Models are weighted by start of period commuting zone share of national population. * $p \leq 0.10$, ** $p \leq 0.05$, *** $p \leq 0.01$.

▸ Occupation groups and skills ▸ Occupation shares by industry

Skills and occupations: some suggestive evidence

Occupation mobility matrix (1994-2010)

	probability of	probability conditional on switching occupation			
	stay in same occup	move to NRC	move to RC	move to NRM	move to RM
Non-routine cognitive	0.51	0.44	0.36	0.05	0.14
Routine cognitive	0.52	0.47	0.19	0.13	0.22
Non-routine manual	0.45	0.21	0.26	0.19	0.33
Routine manual	0.55	0.17	0.20	0.17	0.46

Wage loss and occupation switching (1994-2010)

Dep. variable: change in log wage	Coeff	Robust std. error
Stay in same occupation	-0.047 ***	0.008
Different occupation		
same group	-0.106***	0.017
different group	-0.151***	0.013

Computed using workers that were displaced due to plant closing, insufficient work or position abolished in the past three years. Sample restricted to ages between 25 and 65 with full-time jobs at the time of displacement and with a full-time job at the time of the survey. Occupation defined at 2-digit SOC. An occupation switch is defined as a different 2-digit SOC occupation. Occupation groups are non-routine cognitive (NRC), routine cognitive (RC), non-routine manual (NRM), routine manual (RM).

Model - main assumptions

The model has two main blocks:

- International trade and production
  - Ricardian model of trade with iceberg costs (Eaton and Kortum)
  - Free entry and exit, constant returns to scale, zero profits
  - Non-tradeable final goods: CES aggregator of varieties
  - Tradeable intermediate varieties: use structures, value added services and materials
- Frictional labor markets (DMP)
  - Workers and employers match and produce value added services of type/occupation j
  - Workers are heterogeneous with type τ
  - When working with a firm in occupation j produce $y^{j\tau}$ units of value added services of type j. $y^{j\tau}$ determines workers' comparative advantage
  - Unemployed workers may choose in which market j to search
  - Labor markets are segmented by j and τ

Production & Trade - Static sub-problem

- There are N countries, I industries and O occupations
- In each *ni* there is a continuum of **intermediate good** producers with technology as in Eaton and Kortum (2002)
  - Perfect competition, CRS technology, *idiosyncratic* productivity z^{ni} ~Fréchet$(1, \nu^i)$, deterministic sectoral TFP A^{nj}

$$q_t^{ni} = z^{ni} A_t^{ni} \left[h_t^{ni} \right]^{\gamma^{ni,h}} \prod_{j=1}^{O} [Y_t^{ni,j}]^{\gamma^{ni,j}} \prod_{k=1}^{I} [M_t^{ni,k}]^{\gamma^{ni,k}}$$

- where M are material inputs (final goods), Y are value added services, and h are structures
- Trade across countries & regions is only in these intermediate goods
- Trade frictions are modeled as "iceberg" bilateral trade cost
  - must ship $\kappa^{ni,mi} \geq 1$ from m for one unit to arrive in n

Intermediate good prices

- The cost of the input bundle needed to produce varieties in (nj) is

$$x_t^{nj} = B^{ni}\,[r_t^{ni}]^{\gamma^{ni,h}} \prod_{j=1}^{O} [\lambda_t^{nj}]^{\gamma^{ni,j}} \prod_{k=1}^{I} [P_t^{nk}]^{\gamma^{ni,k}}$$

- where r is the rental rate, λ the price of value added services and P the price of the final goods
- The unit cost of a good of a variety with draw z^{nj} in (nj) is

$$\frac{x_t^{ni}}{z^{ni}\,A_t^{ni}}$$

  and so its price under competition is given by

$$p_t^{ni}(z^i) = \min_m \left\{ \frac{\kappa^{ni,mi}\,x_t^{mi}}{z^{mi} A_t^{mi}} \right\}$$

Production & Trade - Static sub-problem

- Each n, i produces a final good (used for consumption and materials)
  - CES (elasticity η) aggregator of sector i goods from the lowest cost supplier in the world subject to $\kappa^{ni,mi} \geq 1$ "iceberg" bilateral trade cost

$$Q_t^{ni} = \left[\int_{\mathbb{R}_{++}^N} [\tilde{q}_t^{ni}(z^i)]^{1-1/\eta^{ni}} \phi^i(z^i) dz^i \right]^{\eta^{ni}/(\eta^{ni}-1)}$$

  where $z^i = (z^{1i}, z^{2i}, ...z^{Ni})$ denotes the vector of productivity draws for a given variety received by the different n

- By properties of the Frechet, the resulting price index in sector i and country n is

$$P_t^{ni} = \Gamma^{ni} \left[\sum_{m=1}^{N} [x_t^{mi} \kappa^{ni,mi}]^{-\nu^i} [A^{mi}]^{\nu^i \gamma^{mi}} \right]^{-1/\nu^i},$$

where Γ^{ni} is a constant

Production - Static sub-problem - Equilibrium conditions

- The share that country n spends in goods of sector i from country m is given by

$$\pi_t^{ni,mi} = \frac{\left[x_t^{mi} \kappa^{ni,mi}\right]^{-\nu^i} \left[A^{mi}\right]^{\nu^i \gamma^{mi}}}{\sum_{\ell=1}^{N} \left[x_t^{\ell i} \kappa^{ni,\ell i}\right]^{-\nu^i} \left[A^{\ell i}\right]^{\nu^i \gamma^{\ell i}}},$$

- Demands for value added services j is

$$Y_t^{nj} = \sum_{i=1}^{I} \frac{\gamma^{ni,j}}{\lambda_t^{nj}} \sum_{m=1}^{N} \pi_t^{mi,ni} X_t^{mi}$$

where X_t^{mi} is total expenditures in goods of sector i from country m.

- Firms will demand structures h, which are in fixed supply in each country and industry.
    - Owners of local structures (rentiers), obtain rents
    - Use income to purchase local goods with same preferences as workers.

Imbalances

Frictional labor markets, occupational choice and skills

- The value for a worker in country n employed in occupation j with skills τ is

$$W_t^{nj,\tau} = \underbrace{w_t^{nj,\tau} \,/,\, P_t^n}_{\text{real wage}} + \beta(1-\delta)\mathbb{E}_t\left[W_{t+1}^{nj,\tau'}|\tau\right] + \beta\delta\mathbb{E}_t\underbrace{\left[S_{t+1}^{n,\tau'}(\epsilon_{t+1})|\tau\right]}_{\text{search}}$$

  - β discount factor. δ exogenous separation probability. No savings
  - skills τ may evolve over time.
  - Consume $c_t^{nj} = \prod_{k=1}^{J}(c_t^{nj,k})^{\alpha^k}$, where P_t^n is country n price index

- The value for an unemployed worker in country n with skills τ is

$$U_t^{n,\tau} = \underbrace{b^n}_{\text{home production}} + \beta\mathbb{E}_t\left[S_{t+1}^{n,\tau'}(\epsilon_{t+1})|\tau\right]$$

- At the beginning of each t, unemployed decide where to search

$$S_t^{n,\tau}(\epsilon_t) = \max_j\left\{\underbrace{\varphi^u(\theta_t^{nj,\tau})}_{\text{match prob}} W_t^{nj,\tau} + \left(1-\varphi^u(\theta_t^{nj,\tau})\right)U_t^{n,\tau} + \sigma\underbrace{\epsilon_t^j}_{\text{iid shock}}\right\}$$

  - $\epsilon \sim$ iid Type-I Extreme Value, $\sigma > 0$ scales the variance of shocks
  - **Larger** σ means search is **more random**. **Lower** σ means search is **more directed**
  - Workers consume the shock when they decide - not part of the surplus

Frictional labor markets, occupational choice and skills

- Using properties of Type-I Extreme Value distributions one obtains:
  - The expected or ex-ante (expectation over ϵ) value of search

$$S_t^{n,\tau} = \sigma \log \left[\sum_j \exp \left(\varphi^u(\theta_t^{nj,\tau}) W_t^{nj,\tau} + \left(1 - \varphi^u(\theta_t^{nj,\tau})\right) U_t^{n,\tau} \right)^{1/\sigma} \right]$$

  - Fraction of unemployed workers that choose occupation j

$$N_t^{nj,\tau} = \frac{\exp \left(\varphi^u(\theta_t^{nj,\tau}) W_t^{nj,\tau} + \left(1 - \varphi^u(\theta_t^{nj,\tau})\right) U_t^{n,\tau} \right)^{1/\sigma}}{\sum_{k=1}^{O} \exp \left(\varphi^u(\theta_t^{nk,\tau}) W_t^{nk,\tau} + \left(1 - \varphi^u(\theta_t^{nk,\tau})\right) U_t^{n,\tau} \right)^{1/\sigma}}$$

- The dynamics of the distribution of workers across occupations, skills and employment status depends on worker's optimal choices

dynamics

Employers

- Employers post vacancies in market j targeted to workers with skills τ.
- If a match is formed workers and employers decide whether to start production or dissolve the match.
- The value of a vacancy is,

$$V_t^{nj,\tau} = -K_t^n + \varphi^v(\theta_t^{nj,\tau}) J_t^{nj,\tau}$$

- Free entry implies $V_t^{nj,\tau} = 0$ for all markets and at all times.
- The value of a job for the employer is equal to,

$$J_t^{nj,\tau} = \underbrace{\frac{\lambda_t^{nj} y^{j\tau}}{P_t^n}}_{\text{revenues}} - \underbrace{\frac{w_t^{nj,\tau}}{P_t^n}}_{\text{wages}} + \beta(1-\delta)\mathbb{E}_t\left[J_{t+1}^{nj,\tau'}|\tau\right]$$

- CRS matching function. Nash bargaining with worker's weight ϕ

Equilibrium

- The definition of equilibrium is standard.

- Note that:

- Conditional on sequences for λ_t^{nj} and $Y_t^{nj,S}$:
  - I can solve all prices and quantities in the Ricardian trade block
  - Temporary equilibrium

- Conditional on sequences for λ_t^{nj} and P_t^n:
  - I can solve the dynamic problem of workers and firms in frictional labor markets
  - Dynamic equilibrium
  - This gives me a sequence for $Y_t^{nj,S}$.

- Markets have to clear at all times

A special case

- Workers' skills do not change if the worker is unemployed
- For each occupation, there is a set of skills for which the output $y^{j\tau}$ is maximal
- learning-by-doing: Mismatched employed workers "acquire" the best skills for her current occupation with probability ρ

Proposition

In the special case, given a sequence for prices λ_t^{nj} and P_t^n, equilibrium conditions in the frictional labor markets must satisfy:

$$\frac{w_t^{nj,\tau}}{P_t^n} = \phi\,\frac{\lambda_t^{nj}\,y^{j\tau}}{P_t^n} + (1-\phi)b + \beta(1-\delta)\,\phi\,K_{t+1}^n\theta_{t+1}^{nj,\tau} - $$
$$-\beta(1-\delta)(1-\phi)\sigma\log\left(N_{t+1}^{nj,\tau}\right) - \beta(1-\delta)(1-\phi)\,\rho\,\left(U_{t+1}^{n,\tau'} - U_{t+1}^{n,\tau}\right)$$

$$\frac{K_t^n}{\varphi^v(\theta_t^{nj,\tau})} = (1-\phi)\left(\frac{\lambda_t^{nj}\,y^{j\tau}}{P_t^n} - b\right) - \beta(1-\delta)\,K_{t+1}^n\left(\phi\,\theta_{t+1}^{nj,\tau} + \left[\frac{(1-\rho)}{\varphi^v(\theta_{t+1}^{nj,\tau})} + \frac{\rho}{\varphi^v(\theta_{t+1}^{nj,\tau'})}\right]\right) +$$
$$+\beta(1-\delta)(1-\phi)\sigma\log\left(N_{t+1}^{nj,\tau}\right) + \beta(1-\delta)(1-\phi)\,\rho\,\left(U_{t+1}^{n,\tau'} - U_{t+1}^{n,\tau}\right)$$

$$N_t^{nj,\tau} = \frac{\exp\left(\frac{\phi K_t^n}{(1-\phi)\sigma}\theta_t^{nj,\tau}\right)}{\sum_{\ell=1}^{O}\exp\left(\frac{\phi K_t^n}{(1-\phi)\sigma}\theta_t^{n\ell,\tau}\right)}$$

$$U_t^{n,\tau'} - U_t^{n,\tau} = \beta\sigma\left[\log\left(\sum_{\ell=1}^{O} e^{\left(\frac{\phi K_{t+1}^n}{(1-\phi)\sigma}\theta_{t+1}^{n\ell,\tau'}\right)}\right) - \log\left(\sum_{\ell=1}^{O} e^{\left(\frac{\phi K_{t+1}^n}{(1-\phi)\sigma}\theta_{t+1}^{n\ell,\tau}\right)}\right)\right] + \beta\left(U_{t+1}^{n,\tau'} - U_{t+1}^{n,\tau}\right)$$

where θ_t^{nj} is labor market tightness of labor market *nj* at time *t*.

Proposition

In the special case, given a sequence for prices λ_t^{nj} and P_t^n, equilibrium conditions in the frictional labor markets must satisfy:

$$\frac{w_t^{nj,\tau}}{P_t^n} = \phi \frac{\lambda_t^{nj} y^{j\tau}}{P_t^n} + (1-\phi) b + \beta(1-\delta)\, \phi\, K_{t+1}^n \theta_{t+1}^{nj,\tau} - $$
$$-\beta(1-\delta)(1-\phi)\sigma \log\left(N_{t+1}^{nj,\tau}\right) - \beta(1-\delta)(1-\phi)\,\rho\,\left(U_{t+1}^{n,\tau'} - U_{t+1}^{n,\tau}\right)$$

$$\frac{K_t^n}{\varphi^v(\theta_t^{nj,\tau})} = (1-\phi)\left(\frac{\lambda_t^{nj} y^{j\tau}}{P_t^n} - b\right) - \beta(1-\delta)\, K_{t+1}^n \left(\phi\, \theta_{t+1}^{nj,\tau} + \left[\frac{(1-\rho)}{\varphi^v(\theta_{t+1}^{nj,\tau})} + \frac{\rho}{\varphi^v(\theta_{t+1}^{nj,\tau'})}\right]\right) +$$
$$+\beta(1-\delta)(1-\phi)\sigma \log\left(N_{t+1}^{nj,\tau}\right) + \beta(1-\delta)(1-\phi)\,\rho\,\left(U_{t+1}^{n,\tau'} - U_{t+1}^{n,\tau}\right)$$

$$N_t^{nj,\tau} = \frac{\exp\left(\frac{\phi K_t^n}{(1-\phi)\sigma}\theta_t^{nj,\tau}\right)}{\sum_{\ell=1}^{O} \exp\left(\frac{\phi K_t^n}{(1-\phi)\sigma}\theta_t^{n\ell,\tau}\right)}$$

$$U_t^{n,\tau'} - U_t^{n,\tau} = \beta\sigma\left[\log\left(\sum_{\ell=1}^{O} e^{\left(\frac{\phi K_{t+1}^n}{(1-\phi)\sigma}\theta_{t+1}^{n\ell,\tau'}\right)}\right) - \log\left(\sum_{\ell=1}^{O} e^{\left(\frac{\phi K_{t+1}^n}{(1-\phi)\sigma}\theta_{t+1}^{n\ell,\tau}\right)}\right)\right] + \beta\left(U_{t+1}^{n,\tau'} - U_{t+1}^{n,\tau}\right)$$

where θ_t^{nj} is labor market tightness of labor market nj at time t.

Calibration

- 22 sectors and 38 countries. Monthly frequency
- Only in the US frictional labor markets - ROW frictionless single market
- Cobb-Douglas matching function
- Cost of occupational mismatch - Barlevy (2002).

$$y^{j\tau} = \begin{bmatrix} 1 & y^{11} & \cdots & y^{1T} \\ y^{21} & 1 & \cdots & y^{2T} \\ \vdots & \vdots & \ddots & \vdots \\ y^{O1} & y^{O2} & \cdots & 1 \end{bmatrix}$$

- 21 occupations ($O = T = 21$). For parsimony, only 2 parameters:
  - same occupation $= 1$
  - different occupation but same group
  - different occupation and group

Occupation groups and skills

Calibration

Parameter		value	target
discount factor	β	0.996	5% annual interest rate
bargaining weight	ϕ	0.72	Shimer (2005)
home production	b	0.4 *	Shimer (2005)
CD match elasticity		0.72	Shimer (2005)
CD match efficiency		0.27	Avg $\theta \approx 1$ and $u \approx 6.0\%$
vacancy posting cost	K_t	0.33**	
death probability		0.003	Approx worklife of 30 years
exogenous separation	δ	0.02	EU rate of 1.5%
Occupation upgrading	ρ	0.02	Approx upgrade in 4 years
dispersion of ϵ shock	σ	0.25	occup mobility EUE $\approx$ 50% and
Cost of occup mismatch	$y^{j\tau}$	0.89 0.80	wage loss across occ groups
"Newborn" distribution			occupation shares of employment

* effective b is lower due to occupation shocks

** K_t changes in the counterfactual with manager's real wage

Calibration - production and trade

- Calibration of trade block is easier using "hat algebra" from DEK (2008) - no need to pin-down A^{ni} or $\kappa^{ni,mi}$ ▸ Hat algebra
- Trade shares π_0 : WIOD year 2000
- *GO*, structures and labor shares: BEA and U.S. IO, WIOD for other countries
- Occupation shares in wage bill of industries: Occupational Employment Statistics (BLS)
- Trade elasticity ν^i: From Caliendo and Parro (2015)
- Trade (current account) deficits. Assume no debt. All are capital income differences within the period. ▸ Imbalances

Identifying the China shock - counterfactual experiment

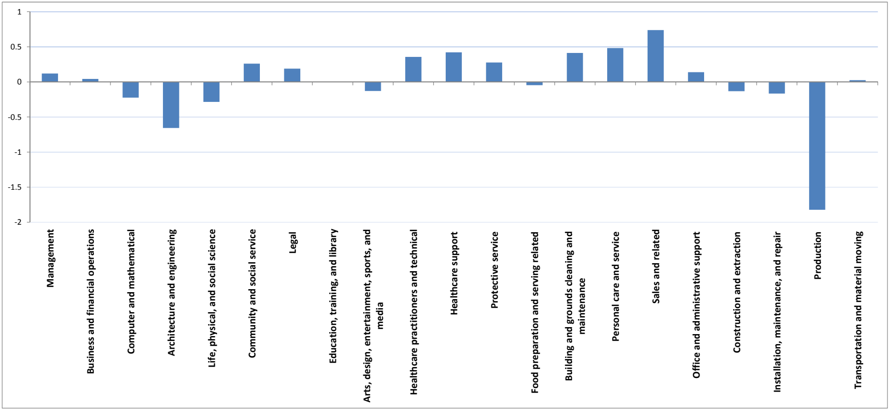
- Idea: find the change in Chinese TFP that matches the changes in US imports from China in the model.
  - Use the model to solve for the change in China's 12 manufacturing industries TFP $\left\{\hat{A}^{China,i}\right\}_{i=1}^{12}$ such that model's imports match predicted US imports from China from 2000 to 2007
- Problem: not all observed changes in imports are due to China
  - Follow Autor, Dorn, and Hanson's (2013) strategy:
  - Use other advanced countries imports as a predictor (first stage)

$$\Delta M_{USA,i} = a_1 + a_2 \Delta M_{other,i} + e_i$$

The China shock

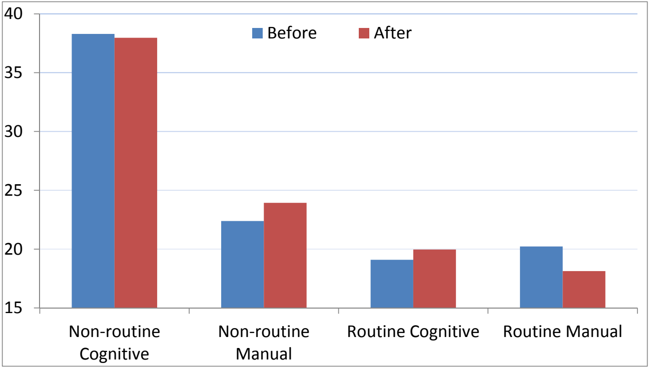
- Compare 2 steady states
- Aggregate unemployment falls 0.3pp

Changes in employment shares by occupation



The China shock

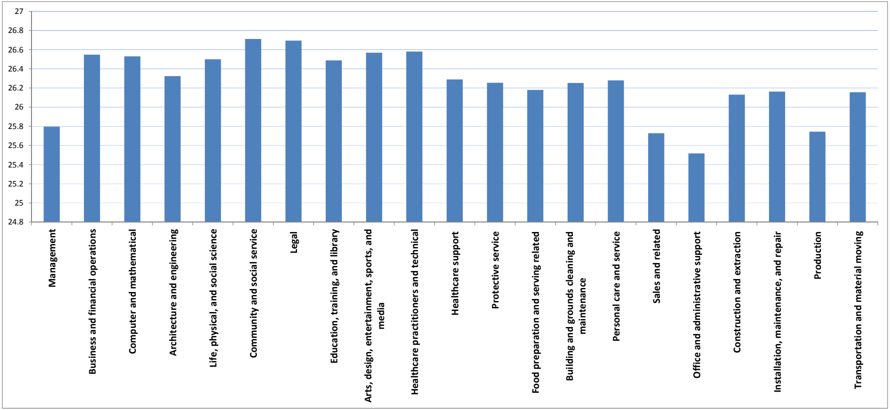
Employment shares by big occupation group



▸ Occ shares by industry

The China shock

Percent change in avg. wage by occupation

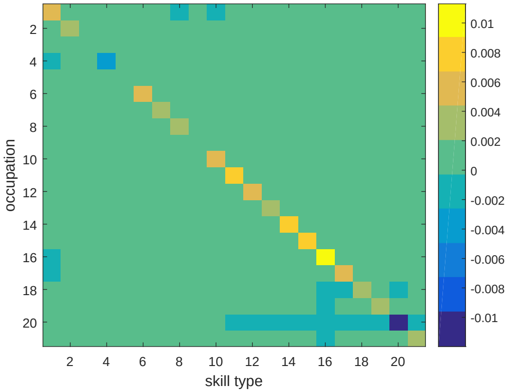


▸ Some evidence

The China shock

- Occupational mismatch & complementarity
- Measure of workers employed in suboptimal occupations
  - Before: 20% – After: 14%

Change in employment distribution by skill type



The China shock

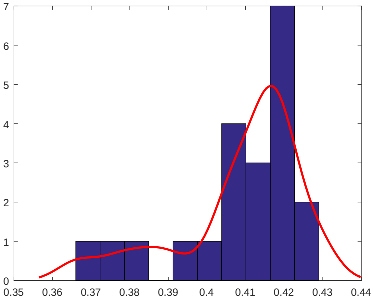
- Where do unemployed workers search?

	probability of			
	searching in same occup		searching in production occup	
	before	after	before	after
Non-routine cognitive	0.52	0.69	0.007	0.002
Routine cognitive	0.55	0.73	0.041	0.017
Non-routine manual	0.44	0.64	0.039	0.026
Routine manual (excl prod)	0.55	0.71	0.041	0.019
Production occ	0.55	0.60	–	–

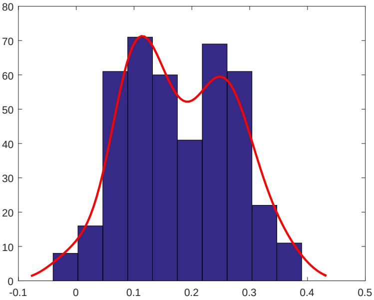
The China shock

- Welfare across labor markets - (share of surplus to workers)

Consumption equivalent variation - percent



(a) good skill match



(b) poor skill match

Conclusion

- This paper brings together two workhorse models of the labor market:
  - The DMP model of frictional labor markets
  - The Roy model of skill heterogeneity and selection
- And embeds it into a standard model of international trade
- I show that after an asymmetric labor market shock due to trade
  - The surplus of workers changes unevenly
  - Labor reallocates away from occupations with low labor demand
  - In the long run, labor supply is elastic and the composition of the skills in the labor force changes
  - Wages and welfare are not very depressed even for the most affected workers due to the option to move to better labor markets
- Work in progress... more results on the way

Thank you!

Temporary equilibrium conditions

How to solve for the temporary equilibrium in time differences?

- Price index

$$P_t^{ni} = \Gamma^{ni} \left[\sum_{m=1}^{N} \left[x_t^{mi} \kappa^{ni,mi} \right]^{-\nu^i} \left[A^{mi} \right]^{\nu^i \gamma^{mi}} \right]^{-1/\nu^i}$$

- Trade shares

$$\pi_t^{ni,mi} = \frac{\left[x_t^{mi} \kappa^{ni,mi} \right]^{-\nu^i} \left[A^{mi} \right]^{\nu^i \gamma^{mi}}}{\sum_{\ell=1}^{N} \left[x_t^{\ell i} \kappa^{ni,\ell i} \right]^{-\nu^i} \left[A^{\ell i} \right]^{\nu^i \gamma^{\ell i}}},$$

Temporary equilibrium - Time differences

How to solve for the temporary equilibrium in time differences?

- Price index

$$\hat{P}^{ni}_{t+1} = \left[\sum_{m=1}^{N} \pi^{ni,mi}_{t} \left[\hat{x}^{mi}_{t+1}\right]^{-\nu^i}\right]^{-1/\nu^i}$$

- Trade shares

$$\pi^{ni,mi}_{t+1} = \frac{\pi^{ni,mi}_{t}\left[\hat{x}^{mi}_{t+1}\right]^{-\nu^i}}{\sum_{\ell=1}^{N} \pi^{ni,\ell i}_{t}\left[\hat{x}^{\ell i}_{t+1}\right]^{-\nu^i}},$$

- Where $\hat{P}^{ni}_{t+1} = P^{ni}_{t+1}/P^{ni}_{t}$
- Same "hat algebra" applies to other equilibrium conditions from Ricardian trade block

Back

Dynamic evolution of the state

- The dynamics of the distribution of workers across occupations, skills and employment status depends on worker's optimal choices

$$\Phi^{nj,\tau}_{E,t} = (1-\delta)\sum_{\tau'}\mu(\tau|\tau')\Phi^{nj,\tau'}_{E,t-1} + \left(\delta\sum_{k=1}^{O}\sum_{\tau'}\mu(\tau|\tau')\Phi^{nk,\tau'}_{E,t-1} + \sum_{\tau'}\mu(\tau|\tau')\Phi^{n,\tau'}_{U,t-1}\right) N^{nj,\tau}_{t}\,\varphi^{u}(\theta^{nj,\tau}_{t})$$

$$\Phi^{n,\tau}_{U,t} = \sum_{j=1}^{O}\left(\delta\sum_{k=1}^{O}\sum_{\tau'}\mu(\tau|\tau')\Phi^{nk,\tau'}_{E,t-1} + \sum_{\tau'}\mu(\tau|\tau')\Phi^{n,\tau'}_{U,t-1}\right) N^{nj,\tau}_{t}\,\left(1-\varphi^{u}(\theta^{nj,\tau}_{t})\right)$$

Back

Closing the model & trade imbalances

- Assume that in each country there is a mass one of Rentiers
  - Owners of local structures, obtain rents $\sum_{i=1}^{I} r_t^{ni} H^{ni}$
  - Send all their local rents to a global pool
  - Receive a constant share ι^n from the global pool, with $\sum_{n=1}^{N} \iota^n = 1$
- Current account imbalances in country n given by

$$\sum_{i=1}^{I} r_t^{ni} H^{ni} - \iota^n \chi_t,$$

where $\chi_t = \sum_{n=1}^{N} \sum_{i=1}^{I} r_t^{ni} H^{ni}$ are the total revenues in the global pool

- Rentier uses her income to purchase local goods
  - Same preferences as workers

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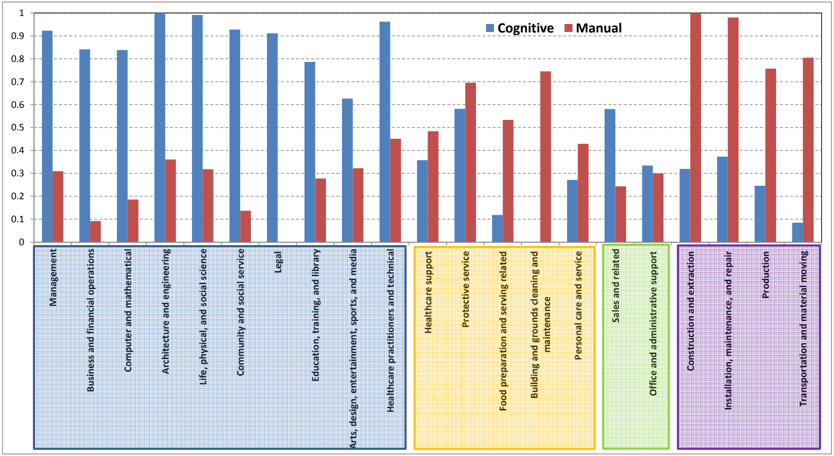
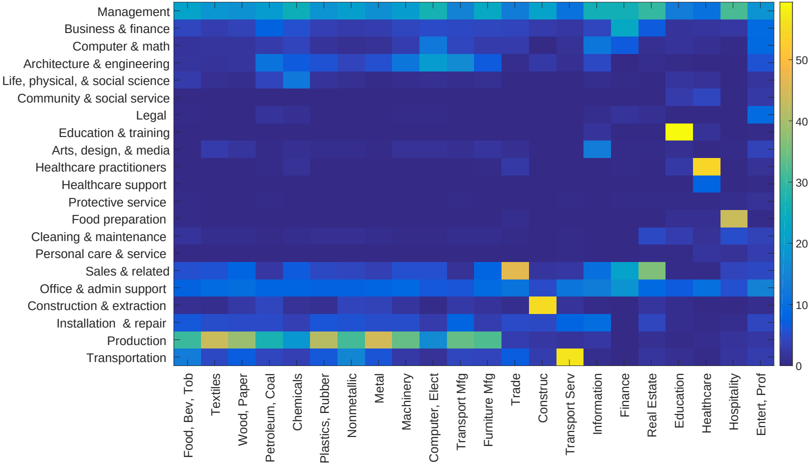
Occupational groups and skills



▸ back to reduced form ▸ back to calibration

Occupational shares by industry



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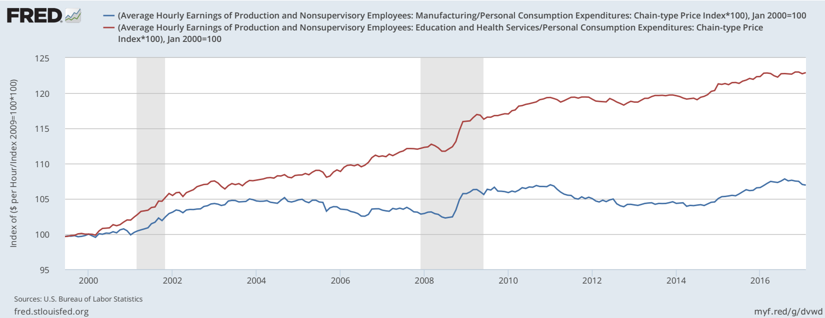
Evolution of real wages in two industries



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