Trade and Labor Market Dynamics

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March, 2016

Introduction

- Aggregate trade shocks can have different disaggregate effects (across locations, sectors, locations-sectors) depending on
  - degree of exposure to foreign trade
  - indirect linkages through internal trade, sectoral trade
  - labor reallocation process
- We develop a model of trade and labor market dynamics that explicitly recognizes the role of labor mobility frictions, goods mobility frictions, I-O linkages, geographic factors, and international trade

This paper

- Models with large # of unknown fundamentals: productivity, mobility frictions, trade frictions, and more...
- Propose a new method to solve dynamic discrete choice models
  - Solve the model and perform large scale counterfactuals without estimating *level* of fundamentals
  - By expressing the equilibrium conditions of the model in relative time differences
- Study how China's import competition impacted U.S. labor markets
  - 38 countries, 50 U.S. regions, and 22 sectors version of the model
  - Employment and welfare effects across more than 1000 labor markets
    - Employment: approx. 0.8 MM manuf. jobs lost, reallocation to services
    - Welfare: aggregate gains; very heterogeneous effects across labor markets; transition costs reflect the importance of dynamics

Literature

- Substantial progress in recent quantitative trade models, including Eaton and Kortum (2002) and its extensions: multiple sectors Caliendo and Parro (2015), spatial economics Caliendo et al. (2015), and other extensions Monte (2015), Tombe et al. (2015), Fajgelbaum et.al. (2015), much more
  - One limitation is their stylized treatment of the labor market (static models, labor moves costessly or does not move)
- We build on advances that underscore the importance of trade and labor market dynamics: Artuç and McLaren (2010), Artuç Chaudhuri and McLaren (2010), Dix-Carneiro (2014)
- Relates to dynamic discrete choice models in IO, labor, macro literature Hotz and Miller (1993), Berry (1994), Kennan and Walker (2011), Dvorkin (2014)
- Relates to recent research on the labor market effects of trade
  - Because of direct import exposure: Autor, Dorn and Hanson (2013), and sectoral linkages: Acemoglu, Autor, Dorn and Hanson (2015), other channels Handley and Limao (2015) Pierce and Schott (2015)

Road map

- Model
    - Households' dynamic problem
    - Production structure
    - Equilibrium
- Solution method
- Application: calibration and results
- Conclusion

Model

Households' problem

- N locations (index n and i) and each has J sectors (index j and k)
- The value of a household in market nj at time t given by

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

$$s.t.\ u(c_t^{nj}) \equiv \begin{cases} \log(b^n) & if\ \ j=0, \\ \log(w_t^{nj}/P_t^n) & \text{otherwise}, \end{cases}$$

  - $\beta \in (0,1)$ discount factor
  - $\tau^{nj,ik}$ additive, *time invariant* migration costs to ik from nj
  - ϵ_t^{ik} are stochastic *i.i.d idiosyncratic* taste shocks
    - $\epsilon \sim$ Type-I Extreme Value distribution with zero mean
    - $\nu > 0$ is the dispersion of taste shocks

- *Unemployed* obtain home production b^n
- *Employed* households supply a unit of labor inelastically
  - Receive the competitive market wage w_t^{nj}
  - Consume $c_t^{nj} = \prod_{k=1}^{J}(c_t^{nj,k})^{\alpha^k}$, where P_t^n is the local price index

Households' problem - Dynamic discrete choice

- Using properties of Type-I Extreme Value distributions one obtains:
- The expected (expectation over ϵ) lifetime utility of a worker at nj

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

- Fraction of workers that reallocate from market nj to ik

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

- Evolution of the distribution of labor across markets

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

▸ Frechet and Multiplicative costs

Production - Static sub-problem

- Notice that at each t, labor supply across markets is fully determined
  - We can then solve for wages such that labor markets clear, using a very rich static spatial structure (CPRHS 2015)
- In each nj there is a continuum of intermediate good producers with technology as in Eaton and Kortum (2002)
  - Perfect competition, CRS technology, *idiosyncratic* productivity $z^{nj} \sim$Fréchet$(1, \theta^j)$, deterministic sectoral regional TFP A^{nj}

$$q_t^{nj}(z^{nj}) = z^{nj}\left[A^{nj}\,[l_t^{nj}]^{\xi^n}[h_t^{nj}]^{1-\xi^n}\right]^{\gamma^{nj}}\prod_{k=1}^{J}[M_t^{nj,nk}]^{\gamma^{nj,nk}}$$

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

▸ Intermediate goods ▸ Final goods

Production - Static sub-problem - Equilibrium conditions

- Sectoral price index,

$$P_t^{nj}(\mathbf{w}_t) = \Gamma^{nj}\left[\sum_{i=1}^{N} A^{ij}\left[x_t^{ij}(\mathbf{w}_t)\kappa^{nj,ij}\right]^{-\theta^j}\right]^{-1/\theta^j}$$

- Let $X_t^{ij}(\mathbf{w}_t)$ be total expenditure. Expenditure shares given by

$$\pi_t^{nj,ij}(\mathbf{w}_t) = \frac{\left[x_t^{ij}(\mathbf{w}_t)\kappa^{nj,ij}\right]^{-\theta^j} A^{ij}}{\sum_{m=1}^{N}\left[x_t^{mj}(\mathbf{w}_t)\kappa^{nj,mj}\right]^{-\theta^j} A^{mj}},$$

  where $x_t^{ij}(\mathbf{w}_t)$ is the unit cost of an input bundle

- Labor Market clearing

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

  where $\gamma^{nj}(1-\xi^n)$ labor share

▸ Input bundle

Sequential and temporary equilibrium

- State of the economy = distribution of labor $L_t = \{L_t^{nj}\}_{n=1,j=0}^{N,J}$
  - Let $\Theta \equiv \left(\{A^{nj}\}, \{\kappa^{nj,ij}\}, \{\tau^{nj,ik}\}, \{H^{nj}\}, \{b^n\}\right)_{n=1,j=0,i=1,k=0}^{N,J,J,N}$

Definition

Given (L_t, Θ), a **temporary equilibrium** is a vector of $w_t(L_t, \Theta)$ that satisfies the equilibrium conditions of the static sub-problem

Definition

Given (L_0, Θ), a **sequential competitive equilibrium** of the model is a sequence of $\{L_t, \mu_t, V_t, w_t(L_t, \Theta)\}_{t=0}^{\infty}$ that solves HH dynamic problem and the temporary equilibrium at each t

- With $\mu_t = \{\mu_t^{nj,ik}\}_{n=1,j=0,i=1,k=0}^{N,J,J,N}$, and $V_t = \{V_t^{nj}\}_{n=1,j=0}^{N,J}$

Solution Method

Solving the model

- Solving for an equilibrium of the model requires information on Θ
  - Large # of unknowns $N + 2NJ + N^2 J + N^2 J^2$
  - Productivity, endowments of local structures, labor mobility costs, home production, and trade costs
- As we increase the dimension of the problem—adding countries, regions, or sectors—the number of parameters grows geometrically
- We solve this problem by computing the equilibrium dynamics of the model in time differences
- Why is this progress?
  - As in DEK (2008), Caliendo and Parro (2015), by conditioning on observables one can solve the model without knowing the *levels* of Θ
    - ★ We apply this idea to a dynamic economy
  - Condition on last period migration flows, trade flows, and production
    - ★ Solve for the value function in time differences

Equilibrium conditions

- Expected lifetime utility

$$V_t^{nj} = \log(\tfrac{w_t^{nj}}{P_t^n}) \; + \nu \log \left[\sum_{i=1}^{N} \sum_{k=0}^{J} \exp\left(\beta V_{t+1}^{ik} - \tau^{nj,ik}\right)^{1/\nu} \right]$$

- Transition matrix (migration flows)

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

Equilibrium conditions

- Transition matrix (migration flows) at $t = -1$, Data

$$\mu_{-1}^{nj,ik} = \frac{\exp\left(\beta V_0^{ik} - \tau^{nj,ik}\right)^{1/\nu}}{\sum_{m=1}^{N}\sum_{h=0}^{J} \exp\left(\beta V_0^{mh} - \tau^{nj,mh}\right)^{1/\nu}}$$

Equilibrium conditions

- Transition matrix (migration flows) at $t = -1$, Data

$$\mu_{-1}^{nj,ik} = \frac{\exp\left(\beta V_0^{ik} - \tau^{nj,ik}\right)^{1/\nu}}{\sum_{m=1}^{N}\sum_{h=0}^{J} \exp\left(\beta V_0^{mh} - \tau^{nj,mh}\right)^{1/\nu}}$$

- Transition matrix (migration flows) at $t = 0$, Model

$$\mu_{0}^{nj,ik} = \frac{\exp\left(\beta V_1^{ik} - \tau^{nj,ik}\right)^{1/\nu}}{\sum_{m=1}^{N}\sum_{h=0}^{J} \exp\left(\beta V_1^{mh} - \tau^{nj,mh}\right)^{1/\nu}}$$

Equilibrium conditions

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- Take the time difference

$$\frac{\mu_{0}^{nj,ik}}{\mu_{-1}^{nj,ik}} = \frac{\frac{\exp\left(\beta V_1^{ik} - \tau^{nj,ik}\right)^{1/\nu}}{\exp\left(\beta V_0^{ik} - \tau^{nj,ik}\right)^{1/\nu}}}{\sum_{m=1}^{N}\sum_{h=0}^{J} \frac{\exp\left(\beta V_1^{mh} - \tau^{nj,mh}\right)^{1/\nu}}{\sum_{m'=1}^{N}\sum_{h'=0}^{J} \exp\left(\beta V_0^{m'h'} - \tau^{nj,m'h'}\right)^{1/\nu}}}$$

Equilibrium conditions

- Take the time difference

$$\frac{\mu_0^{nj,ik}}{\mu_{-1}^{nj,ik}} = \frac{\frac{\exp\left(\beta V_1^{ik} - \tau^{nj,ik}\right)^{1/\nu}}{\exp\left(\beta V_0^{ik} - \tau^{nj,ik}\right)^{1/\nu}}}{\sum_{m=1}^{N} \sum_{h=0}^{J} \quad \frac{\exp\left(\beta V_1^{mh} - \tau^{nj,mh}\right)^{1/\nu}}{\sum_{m'=1}^{N} \sum_{h'=0}^{J} \quad \exp\left(\beta V_0^{m'h'} - \tau^{nj,m'h'}\right)^{1/\nu}}}$$

Equilibrium conditions

- Take the time difference

$$\frac{\mu_0^{nj,ik}}{\mu_{-1}^{nj,ik}} = \frac{\frac{\exp\left(\beta V_1^{ik} - \tau^{nj,ik}\right)^{1/\nu}}{\exp\left(\beta V_0^{ik} - \tau^{nj,ik}\right)^{1/\nu}}}{\sum_{m=1}^{N}\sum_{h=0}^{J} \frac{\exp\left(\beta V_1^{mh} - \tau^{nj,mh}\right)^{1/\nu}}{\sum_{m'=1}^{N}\sum_{h'=0}^{J} \exp\left(\beta V_0^{m'h'} - \tau^{nj,m'h'}\right)^{1/\nu}}}$$

- Simplify

$$\frac{\mu_0^{nj,ik}}{\mu_{-1}^{nj,ik}} = \frac{\exp\left(V_1^{ik} - V_0^{ik}\right)^{\beta/\nu}}{\sum_{m=1}^{N}\sum_{h=0}^{J} \frac{\exp\left(\beta V_1^{mh} - \tau^{nj,mh}\right)^{1/\nu}}{\sum_{m'=1}^{N}\sum_{h'=0}^{J} \exp\left(\beta V_0^{m'h'} - \tau^{nj,m'h'}\right)^{1/\nu}}}$$

Equilibrium conditions

- Take the time difference

$$\frac{\mu_0^{nj,ik}}{\mu_{-1}^{nj,ik}} = \frac{\frac{\exp\left(\beta V_1^{ik} - \tau^{nj,ik}\right)^{1/\nu}}{\exp\left(\beta V_0^{ik} - \tau^{nj,ik}\right)^{1/\nu}}}{\sum_{m=1}^{N} \sum_{h=0}^{J} \quad \frac{\exp\left(\beta V_1^{mh} - \tau^{nj,mh}\right)^{1/\nu}}{\sum_{m'=1}^{N} \sum_{h'=0}^{J} \quad \exp\left(\beta V_0^{m'h'} - \tau^{nj,m'h'}\right)^{1/\nu}}}$$

- Simplify

$$\frac{\mu_0^{nj,ik}}{\mu_{-1}^{nj,ik}} = \frac{\exp\left(V_1^{ik} - V_0^{ik}\right)^{\beta/\nu}}{\sum_{m=1}^{N} \sum_{h=0}^{J} \quad \frac{\exp\left(\beta V_1^{mh} - \tau^{nj,mh}\right)^{1/\nu}}{\sum_{m'=1}^{N} \sum_{h'=0}^{J} \quad \exp\left(\beta V_0^{m'h'} - \tau^{nj,m'h'}\right)^{1/\nu}}}$$

- Use $\mu_{-1}^{nj,mh}$ once again

$$\mu_0^{nj,ik} = \frac{\mu_{-1}^{nj,ik} \exp\left(V_1^{ik} - V_0^{ik}\right)^{\beta/\nu}}{\sum_{m=1}^{N} \sum_{h=0}^{J} \mu_{-1}^{nj,mh} \exp\left(V_1^{mh} - V_0^{mh}\right)^{\beta/\nu}}$$

Equilibrium conditions

- Expected lifetime utility

$$V_t^{nj} = \log\left(\frac{w_t^{nj}}{P_t^n}\right) + \nu \log\left[\sum_{i=1}^{N}\sum_{k=0}^{J} \exp\left(\beta V_{t+1}^{ik} - \tau^{nj,ik}\right)^{1/\nu}\right]$$

- Transition matrix

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

Equilibrium conditions - Time differences

- Expected lifetime utility

$$V_{t+1}^{nj} - V_t^{nj} = \log\left(\frac{w_{t+1}^{nj}/w_t^{nj}}{P_{t+1}^n/P_t^n}\right) + \nu \log\left[\sum_{i=1}^{N}\sum_{k=0}^{J} \mu_t^{nj,ik} \exp\left(V_{t+2}^{ik} - V_{t+1}^{ik}\right)^{\beta/\nu}\right]$$

- Transition matrix

$$\frac{\mu_{t+1}^{nj,ik}}{\mu_t^{nj,ik}} = \frac{\exp\left(V_{t+2}^{ik} - V_{t+1}^{ik}\right)^{\beta/\nu}}{\sum_{m=1}^{N}\sum_{h=0}^{J} \mu_t^{nj,mh} \exp\left(V_{t+2}^{mh} - V_{t+1}^{mh}\right)^{\beta/\nu}}$$

where $\frac{w_{t+1}^{nj}/w_t^{nj}}{P_{t+1}^n/P_t^n}$ is the solution to the temporary equilibrium in time differences

Temporary equilibrium conditions

How to solve for the temporary equilibrium in time differences?

- Price index

$$P_t^{nj}(\mathbf{w}_t) = \Gamma^{nj} \left[\sum_{i=1}^{N} A^{ij} [x_t^{ij}(\mathbf{w}_t) \kappa^{nj,ij}]^{-\theta^j} \right]^{-1/\theta^j},$$

- Trade shares

$$\pi_t^{nj,ij}(\mathbf{w}_t) = \frac{[x_t^{ij}(\mathbf{w}_t) \kappa^{nj,ij}]^{-\theta^j} A^{ij}}{\sum_{m=1}^{N} [x_t^{mj}(\mathbf{w}_t) \kappa^{nj,mj}]^{-\theta^j} A^{mj}},$$

Temporary equilibrium - Time differences

How to solve for the temporary equilibrium in time differences?

- Price index

$$\hat{P}^{nj}_{t+1}(\hat{\mathbf{w}}_{t+1}) = \left[\sum_{i=1}^{N} \pi^{nj,ij}_{t} \left[\hat{x}^{ij}_{t+1}(\hat{\mathbf{w}}_{t+1})\right]^{-\theta^j}\right]^{-1/\theta^j},$$

- Trade shares

$$\pi^{nj,ij}_{t+1}(\hat{\mathbf{w}}_{t+1}) = \frac{\pi^{nj,ij}_{t} \left[\hat{x}^{ij}_{t+1}(\hat{\mathbf{w}}_{t+1})\right]^{-\theta^j}}{\sum_{m=1}^{N} \pi^{nj,mj}_{t} \left[\hat{x}^{mj}_{t+1}(\hat{\mathbf{w}}_{t+1})\right]^{-\theta^j}},$$

- Where $\hat{P}^{nj}_{t+1} = P^{nj}_{t+1}/P^{nj}_{t}$, $\hat{x}^{ij}_{t+1} = x^{ij}_{t+1}/x^{ij}_{t}$, $\hat{\mathbf{w}}_{t+1} = \mathbf{w}_{t+1}/\mathbf{w}_t$
- Same "hat trick" applies to all equilibrium conditions

Solving the model

Proposition

Given $\left(L_0, \mu_{-1}, \pi_0, VA_0, GO_0\right)$, (ν, θ, β), *solving the equilibrium in time differences does not require the level of* Θ, *and solves*

$$Y^{nj}_{t+1} = (\hat{w}^{nj}_{t+1} / \hat{P}^{n}_{t+1})^{1/\nu} \textstyle\sum_{i=1}^{N} \sum_{k=0}^{J} \mu_t^{nj,ik} [Y^{ik}_{t+2}]^{\beta},$$

$$\mu^{nj,ik}_{t+1} = \frac{\mu_t^{nj,ik} [Y^{ik}_{t+2}]^{\beta}}{\sum_{m=1}^{N} \sum_{h=0}^{J} \mu_t^{nj,mh} [Y^{mh}_{t+2}]^{\beta}},$$

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

where $\hat{w}^{nj}_{t+1} / \hat{P}^{n}_{t+1}$ *solves the temporary equilibrium given* $\hat{L}_{t+1}$, *where* $Y^{ik}_{t+1} \equiv \exp(V^{ik}_{t+1} - V^{ik}_{t})^{1/\nu}$.

Example

Solving for counterfactuals

- Want to study the effects of changes in fundamentals $\hat{\Theta} = \Theta'/\Theta$
  - Recall that $\Theta \equiv \left(\{A^{nj}\}, \{\kappa^{nj,ij}\}, \{\tau^{nj,ik}\}, \left\{H^{nj}\right\}, \{b^n\} \right)_{n=1,j=0,i=1,k=0}^{N,J,J,N}$
  - TFP, trade costs, labor migration costs, endowments of local structures, home production
- We can use our solution method to study the effects of changes in Θ
  - One by one or jointly
  - Changes across time and space

Proposition

Appplication: The Rise of China

The rise of China

- U.S. imports from China almost doubled from 2000 to 2007
  - At the same time, manufacturing employment fell while employment in other sectors, such as construction and services, grew
- Several studies document that an important part of the employment loss in manufactures was a consequence of China's trade expansion
  - e.g., Pierce and Schott (2012); Autor, Dorn, and Hanson (2013), Acemoglu, Autor, Dorn, and Hanson (2014)
- We use our model, and apply our method, to quantify and understand the effects of the rise of China's trade expansion, "China shock"
  - Initial period is the year 2000
  - We calculate the sectoral, regional, and aggregate employment and welfare effects of the China shock

Identifying the China shock

- Follow Autor, Dorn, and Hanson (2013)
  - We estimate
    $$\Delta M_{USA,j} = a_1 + a_2 \Delta M_{other,j} + u_j,$$
    where j is a NAICS sector, $\Delta M_{USA,j}$ and $\Delta M_{other,j}$ are changes in U.S. and other adv. countries, imports from China from 2000 to 2007
- Obtain predicted changes in U.S. imports with this specification
- Use the model to solve for the change in China's 12 manufacturing industries TFP $\left\{\hat{A}^{China,j}\right\}_{j=1}^{12}$ such that model's imports match predicted imports from China from 2000 to 2007
  - We feed in to our model $\left\{\hat{A}^{China,j}\right\}_{j=1}^{12}$ by quarter from 2000 to 2007 to study the effects of the shock

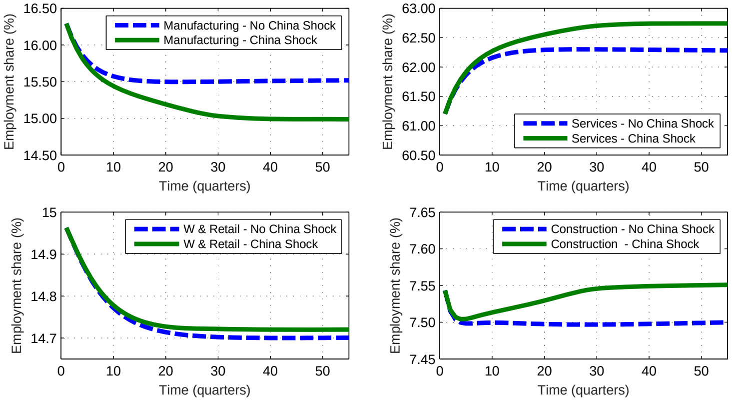
Figure: shock and predicted imports

Taking the model to the data (quarterly)

- Model with 50 U.S. states, 22 sectors + unempl. and 38 countries
  - More than 1000 labor markets
- Need data for $(L_0, \mu_{-1}, \pi_0, VA_0, GO_0)$
  - L_0 : PUMS of the U.S. Census for the year 2000
  - μ_{-1} : Use CPS to compute intersectoral mobility and ACS to compute interstate mobility Details Table
  - π_0 : CFS and WIOD year 2000
  - VA_0 and GO_0 : BEA VA shares and U.S. IO, WIOD for other countries
- Need values for parameters (ν, θ, β)
  - θ : We use Caliendo and Parro (2015)
  - $\beta = 0.99$ Implies approximately a 4% annual interest rate
  - $\upsilon = 5.34$ (implied elasticity of 0.2) Using ACM's data and specification, adapted to our model Estimation
- Need to deal with trade deficits. Do so similar to CPRHS Imbalances

Employment effects

Figure: The Evolution of Employment Shares



- Chinese competition reduced the share of manufacturing employment by 0.5% in the long run, ~0.8 million employment loss
  - About 50% of the change not explained by a secular trend

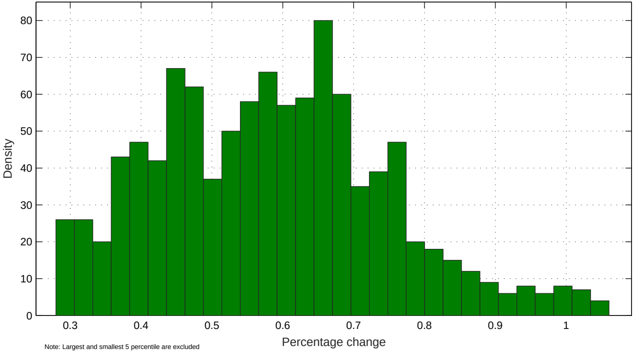
▸ Proposition ▸ Validation

Manufacturing employment effects

- Sectors most exposed to Chinese import competition contribute more
  - 1/2 of the decline in manuf. employment originated in the Computer & Electronics and Furniture sectors ▸ Sectoral contributions
    - ★ 1/4 of the total decline comes from the Metal and Textiles sectors
  - Food, Beverage and Tobacco, gained employment
    - ★ Less exposed to China, benefited from cheaper intermediate goods, other sectors, like Services, demanded more of them (I-O linkages)
- Unequal regional effects ▸ Spatial distribution
  - Regions with a larger concentration of sectors that are more exposed to China lose more jobs ▸ Regional contributions
    - ★ California, the region with largest share of employment in Computer & Electronics, contributed to about 12% of the decline

Welfare effects across labor markets

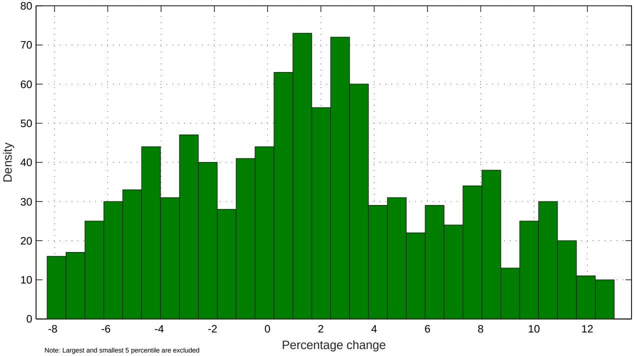
Figure: Welfare changes across labor markets



- Very heterogeneous response to the same aggregate shock ▸ welfare
  - Most labor markets gain as a consequence of cheaper imports from China
  - Unequal regional effects ▸ welfare reg

Transition cost to the steady state

Figure: Transition cost to the steady state across labor markets

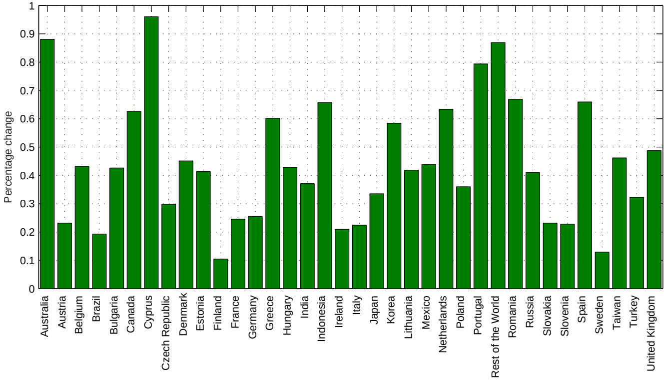


- Adjustment costs reflect the importance of labor market dynamics
  - With free labor mobility AC=0
- Heterogeneity shaped by trade and migration frictions as well as geographic factors.

AC

Welfare effects across countries

Figure: Welfare effects across countries



Conclusion

- Develop a dynamic and spatial model to quantify the disaggregate effects of aggregate shocks
- Show how to perform counterfactual analysis in a very rich spatial model without having to estimate a large set of unobservables
- Dynamics and realistic structure matters for capturing very heterogenous effects at the disaggregate level
- Our model can be applied to answer a broader set of questions: changes in productivity or trade costs in any location in the world, commercial policies, and more...

- Where we go from here:
  1- Migration crisis in Europe.
  2- Human capital accumulation

This is the END

Results with Fréchet and Multiplicative Costs

- Expected lifetime utility

$$V_t^{n,j} = u\left(c_t^{n,j}\right) + \left(\sum_{i=1}^{N} \sum_{k=0}^{J} \left(\beta V_{t+1}^{i,k}\, \tau^{n,j;i,k}\right)^{1/\nu}\right)^{\nu},$$

- Measure of workers that reallocate (Choice equation)

$$\mu_t^{n,j;i,k} = \frac{\left(\beta V_{t+1}^{i,k}\, \tau^{n,j;i,k}\right)^{1/\nu}}{\sum_{m=1}^{N} \sum_{h=0}^{J} \left(\beta V_{t+1}^{m,h}\, \tau^{n,j;m,h}\right)^{1/\nu}}.$$

Back

Information in CPS and ACS

		State A				State B			
		Ind 1	Ind 2	...	Ind J	Ind 1	Ind 2	...	Ind J
State A	Ind 1	x	x	...	x				
	Ind 2	x	x	...	x				
	...	...	...	...	...				
	Ind J	x	x		x				
	Total	**y**	**y**	**...**	**y**	**y**	**y**	**...**	**y**
State B	Ind 1					x	x	...	x
	Ind 2					x	x	...	x
	...					...	...	...	...
	Ind J					x	x		x
	Total	**y**	**y**	**...**	**y**	**y**	**y**	**...**	**y**

Back

Model - Intermediate goods

- Representative firms in each region n and sector j produce a continuum of intermediate goods with *idiosyncratic* productivities z^{nj}
  - Drawn independently across goods, sectors, and regions from a Fréchet distribution with shape parameter θ^{j}
  - Productivity of all firms is also determined by a deterministic productivity level A^{nj}
- The production function of a variety with z^{nj} and A^{nj} is given by

$$q_t^{nj}(z^{nj}) = z^{nj}\left[A^{nj}\,[l_t^{nj}]^{\xi^n}[h_t^{nj}]^{1-\xi^n}\right]^{\gamma^{nj}}\prod_{k=1}^{J}[M_t^{nj,nk}]^{\gamma^{nj,nk}},$$

with $\sum_{k=1}^{J}\gamma^{nj,nk} = 1-\gamma^{nj}$

Model - Intermediate good prices

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

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

- The unit cost of a good of a variety with draw z^{nj} in (nj) is

$$\frac{x_t^{nj}}{z^{nj}} [A^{nj}]^{-\gamma^{nj}}$$

and so its price under competition is given by

$$p_t^{nj}(z^j) = \min_i \left\{ \frac{\kappa^{nj,ij} \, x_t^{ij}}{z^{ij} [A^{ij}]^{\gamma^{ij}}} \right\},$$

with $\kappa^{nj,ij} \geq 1$ are "iceberg" bilateral trade cost

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Model - Final goods

- The production of final goods is given by

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

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

- The resulting price index in sector j and region n, given our distributional assumptions, is given by

$$P_t^{nj} = \varrho \left[\sum_{i=1}^{N} [x_t^{ij} \kappa^{nj,ij}]^{-\theta^j} [A^{ij}]^{\theta^j \gamma^{ij}} \right]^{-1/\theta^j},$$

where ϱ is a constant

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Data - Quarterly gross flows

- Current Population Survey (CPS) monthly frequency
  - Information on intersectoral mobility
  - Source of official labor market statistics
  - We match individuals surveyed three months apart and compute their employment (industry) or unemployment status
    - ★ Our 3-month match rate is close to 90%
- American Community Survey (ACS) to compute interstate mobility
  - Representative sample (0.5 percent) of the U.S. population for 2000
  - Mandatory and is a complement to the decennial Census
  - Information on current state and industry (or unemployment) and state they lived during previous year
  - Limitation: no information on workers past employment status or industry

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Data - Quarterly gross flows

Table: U.S. interstate and intersectoral labor mobility

Probability	p25	p50	p75
Changing j in same n	3.74%	5.77%	8.19%
Changing n but not j	0.04%	0.42%	0.73%
Changing j and n	0.03%	0.04%	0.06%
Staying in same j and n	91.1%	93.6%	95.2%

Note: Quarterly transitions. Data sources: ACS and CPS

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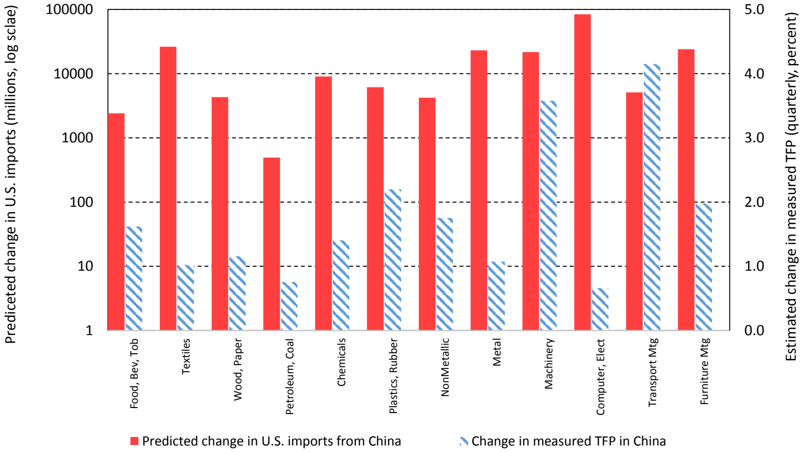
Identifying the China shock

Figure: Predicted change in imports vs. model-based Chinese TFP change



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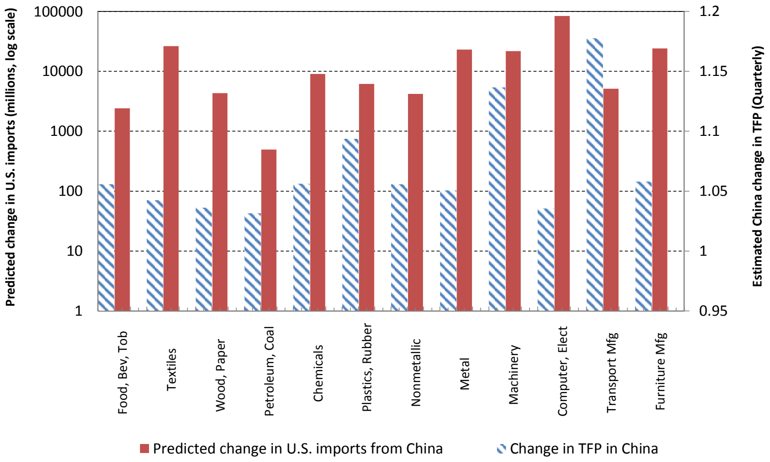
Identifying the China shock

Figure: Predicted change in imports vs. model-based Chinese TFP change



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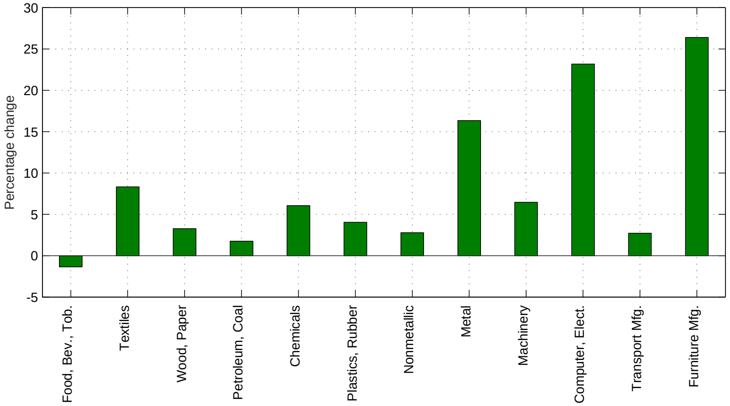
Manufacturing Employment Effects

Figure: Sectoral contribution to the change in manuf. employment



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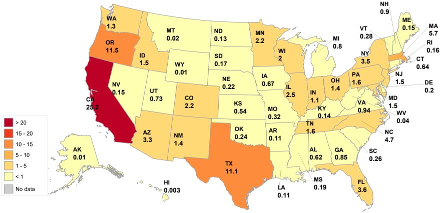
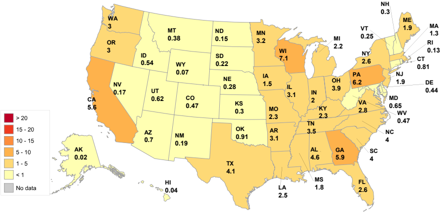
Sectoral concentration across regions

Computers an Electronics (shares)



Wood and Paper (shares)



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Manufacturing employment effects

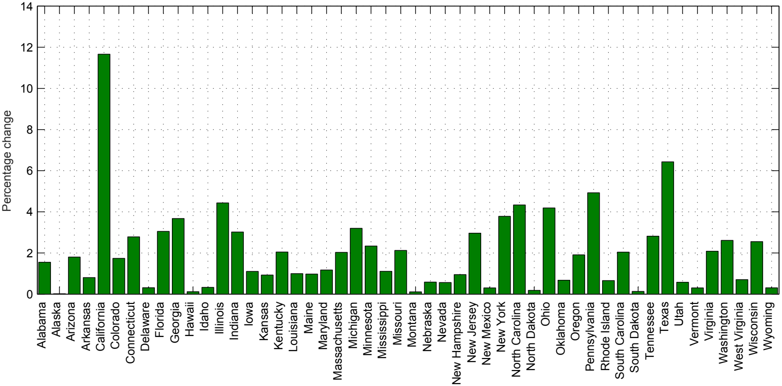

Figure: Regional contribution to the change in manuf. employment

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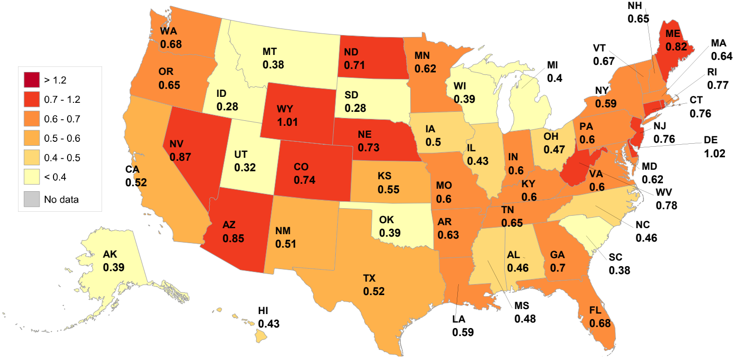
Regional welfare effects



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Sectoral and regional welfare effects

- Sectoral effects very different in the long run than in the short run
  - Services and Construction gain the most Sectoral effects
    - Reasons: no direct exposure, benefit from cheaper intermediate inputs, increased inflow of workers from manufacturing
  - Welfare gains are more uniform in the long run
    - Workers reallocate from depressed industries
- U.S. regions fare better in the short and the long run Regional effects
  - Regions benefit directly from cheaper intermediate goods from China
    - and indirectly from the effect of imports on the cost of inputs purchased from other U.S. regions
  - The regional welfare distribution is more uniform in the long run
    - workers reallocate from regions with lower real income
- Worst off individual labor markets
  - - Wood and Paper in Nevada, Transport and Equip. in Louisiana, and Wholesale and Retail in Alaska

Solving the model

Proposition

Given $\left(L_0, \mu_{-1}, \pi_0, VA_0, GO_0\right)$, (ν, θ, β), *and* $\hat{\Theta} = \{\hat{\Theta}_t\}_{t=1}^{\infty}$, *solving the equilibrium in time differences does not require* Θ, *and solves*

$$Y_{t+1}^{nj} = (\tilde{w}_{t+1}^{nj} / \tilde{P}_{t+1}^{n})^{1/\nu} \sum_{i=1}^{N} \sum_{k=0}^{J} \mu_t^{nj,ik} [Y_{t+2}^{ik}]^{\beta},$$

$$\mu_{t+1}^{nj,ik} = \frac{\mu_t^{nj,ik} [Y_{t+2}^{ik}]^{\beta}}{\sum_{m=1}^{N} \sum_{h=0}^{J} \mu_t^{nj,mh} [Y_{t+2}^{mh}]^{\beta}},$$

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

where $\tilde{w}_{t+1}^{nj} / \tilde{P}_{t+1}^{n}$ *solves the temporary equilibrium at* $\tilde{L}_{t+1}$ *given* $\hat{\Theta}_{t+1}$, *and* $Y_{t+1}^{ik} \equiv \exp(V_{t+1}^{ik} - V_t^{ik})^{1/\nu}$

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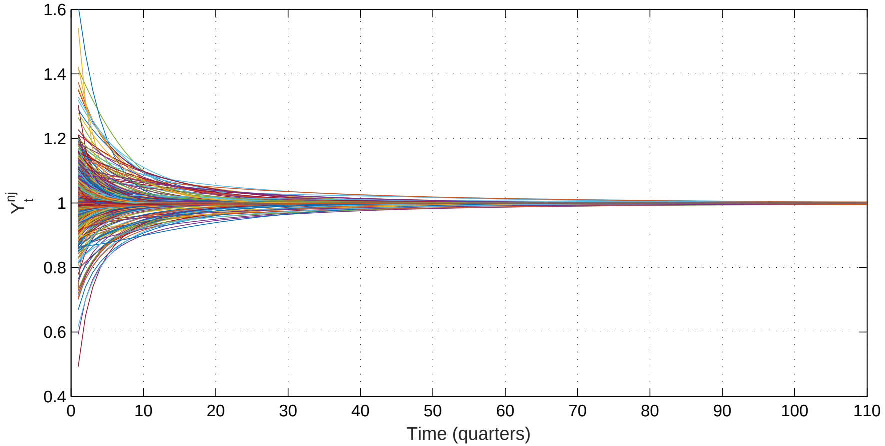
How to perform counterfactuals?

- Solve the model conditioning on observed data at an initial period
  - Value added, Trade shares, Gross production, all consistent with observed labor allocation across labor market at $t = 0$
  - Use the labor mobility matrix μ_{-1}. For this, we we need to specify agents expectations at $t = -1$ about future policies

- **Assumption:** *Policy changes are unanticipated at* $t = -1$
  - Allows us to condition on observed data and solve for the sequential equilibrium with no policy changes
  - Let $\{V_t\}_{t=0}^{\infty}$ be the equilibrium sequence of values with constant policies, where $V_t = \{V_t^{i,k}\}_{i=1,k=1}^{N,J}$.
  - The assumption implies that the initial observed labor mobility matrix μ_{-1} is the outcome of forward looking behavior under $\{V_t\}_{t=0}^{\infty}$.

Solving the model (example)

Figure: Equilibrium Value Functions in Time Differences



▸ Proposition

Taking the model to the data (quarterly)

- $\upsilon = 5.34$ (implied elasticity of 0.2) Using ACM's data and specification, adapted to our model
  - Data: migration flows and real wages for 26 years between 1975-2000, using March CPS
  - We deal with two issues: functional forms, and timing
- Estimating equation

$$\log \mu_t^{nj,ik} / \mu_t^{nj,nj} = C + \frac{\beta}{\upsilon} \log w_{t+1}^{ik} / w_{t+1}^{nj} + \beta \log \mu_{t+1}^{nj,ik} / \mu_{t+1}^{nj,nj} + \varpi_{t+1},$$

  - We transform migration flows from five-month to quarterly frequency
  - GMM estimation, past flows and wages used as instruments
  - ACM estimate $\upsilon = 1.88$ (annual), $\upsilon = 2.89$ (five-month frequency)

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Model validation

- Compare reduced-form evidence with model's predictions
  - First run second-stage regression in ADH with our level of aggregation
  - Then, run same regression with model generated data

Table: Reduced-form regression results

	ΔL_{it}^{m}		$\Delta \bar{u}_{it}$	
	data	model	data	model
	(1)	(2)	(3)	(4)
ΔIPW_{uit}	-1.718	-1.124	0.461	0.873
	(0.194)	(0.368)	(0.138)	(0.252)
Obs	49	50	49	50
R^2	0.51	0.16	0.13	0.20

- Results are largely aligned with those in ADH

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Adjustment costs

- We follow Dix-Carneiro (2014)'s measure of adjustment cost
- The steady-state change in the value function due changes in fundamentals is given by $V_{SS}^{nj}(\hat{\Theta}) - V_{SS}^{nj}$
- Therefore, the transition cost for market nj to the new long-run equilibrium, $AC^{nj}(\hat{\Theta})$, is given by

$$AC^{nj}(\hat{\Theta}) = \log\left(\frac{\frac{1}{1-\beta}\left(V_{SS}^{nj}(\hat{\Theta}) - V_{SS}^{nj}\right)}{\sum_{t=0}^{\infty}\beta^t\left(V_{t+1}^{nj}(\hat{\Theta}) - V_{t+1}^{nj}\right)}\right),$$

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Imbalances

- Assume that in each region there is a mass of one of Rentiers
  - Owners of local structures, obtain rents $\sum_{k=1}^{J} r_t^{ik} H^{ik}$
  - Send all their local rents to a global portfolio
  - Receive a constant share ι^i from the global portfolio, with $\sum_{n=1}^{N} \iota^n = 1$
- Imbalances in region i given by

$$\sum_{k=1}^{J} r_t^{ik} H^{ik} - \iota^i \chi_t,$$

  where $\chi_t = \sum_{i=1}^{N} \sum_{k=1}^{J} r_t^{ik} H^{ik}$ are the total revenues in the global portfolio
- Rentier uses her income to purchase local goods
  - Same preferences as workers

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Welfare effects from changes in fundamentals

- Let $W_t^{nj}(\hat{\Theta})$ be the welfare effect of change in $\hat{\Theta} = \Theta'/\Theta$

$$W_t^{nj}(\hat{\Theta}) = \sum_{s=t}^{\infty} \beta^s \log \frac{\hat{c}_s^{nj}}{(\hat{\mu}_s^{nj,nj})^{\nu}},$$

  - Note that this is a consumption equivalent measure of welfare
  - $(\hat{\mu}_s^{nj,nj})^{\nu}$ is the change in the option value of migration

- In our model, $\hat{c}_t^{nj} = \hat{w}_t^{nj}/\hat{P}_t^n$ is shaped by several mechanisms,

$$\hat{c}_t^{nj} = \frac{\hat{w}_t^{nj}}{\prod_{k=1}^{J}(\hat{w}_t^{nk})^{\alpha^k}} \prod_{k=1}^{J} \left(\frac{\hat{w}_t^{nk}}{\hat{P}_t^{nk}}\right)^{\alpha^k},$$

  - First component reflects the unequal effects within a region
  - Second component is common to all HH residing in region n, given by

$$\sum_{k=1}^{J} \alpha^k \left(\log(\hat{\pi}_t^{nk,nk})^{-\gamma^{nk}/\theta^k} - \xi^n \log \frac{\hat{L}_t^{nk}}{\hat{H}^{nk}} \right).$$

Welfare effects from changes in fundamentals

- Let $W_t^{nj}(\hat{\Theta})$ be the welfare effect of change in $\hat{\Theta} = \Theta' / \Theta$

$$W_t^{nj}(\hat{\Theta}) = \sum_{s=t}^{\infty} \beta^s \log \frac{\hat{c}_s^{nj}}{(\hat{\mu}_s^{nj,nj})^{\nu}},$$

  - Note that this is a consumption equivalent measure of welfare
  - $(\hat{\mu}_s^{nj,nj})^{\nu}$ is the change in the option value of migration

- In a one sector model with no materials and structures, $\hat{c}_t^n = \hat{w}_t^n / \hat{P}_t^n$

$$W_t^n(\hat{\Theta}) = \sum_{s=t}^{\infty} \beta^s \log \frac{\left(\hat{\pi}_s^{n,n}\right)^{-1/\theta}}{(\hat{\mu}_s^{n,n})^{\nu}},$$

- Similar to a ACM (2010) + ACR (2012)

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