Heterogeneous Workers, Trade, and Migration

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Worker heterogeneity: **type** vs. **level** of skills

Everybody knows:
people have different levels of skills

- Explanation of wage inequality
- Log-supermodularity $\Rightarrow$ positive assortative matching
- Reformulating law of comparative advantage (Ohnsorge & Trefler, 2007, Costinot, 2009, Costinot & Vogel, 2010,2015)
- Trade potentially increases the quality of positive assortative matching (Davidson et al., 2012,2014)
- International migration of people with different levels of skills between different economies

Worker heterogeneity: **type** vs. **level** of skills

Everybody knows ...

- ... people with the same level of skills have different types of skills
- ... different activities/firms ideally require different types of skills
- ... skill-types are not fully specific to activities/firms
  $\Rightarrow$ firms employ people who don't perfectly fit their ideal skill-type
- ... people with the same level of skills earn different incomes

Relatively little theoretical analysis
of horizontal worker heterogeneity

This presentation:

- General equilibrium with horizontal worker heterogeneity
  - ⇒ endogenous monopsony power on the labor market
  - ⇒ endogenous average quality of firm-worker matches
- Consequences for trade (with closed labor markets):
  - Exit of firms ⇒ higher degree of monopsony power
  - ... ⇒ poorer average quality of firm-worker matches (lower aggregate productivity)
- Consequences for migration (with open goods markets):
  - Better firm-worker matches through "cross-border" hiring
  - Explanation of two-way migration between similar countries

Key messages

Model used:

- Krugman-type, featuring scale and variety effects
- Adding horizontal skill-differentiation of workers
- Modeling entry game among firms including endogenous choice of ideal worker type

Questions / Answers:

- Gains from trade? / YES
- Gains from (partial) trade liberalization? / AMBIGUOUS
- Incentives for, and gains from, migration? / YES, YES
- Gains from (partial) integration of labor markets? / YES

Literature background

Trade:

- Scale, variety, competitive effects: Krugman (1979), . . . Arkolakis et al. (2012), Mrázová & Neary (2013,2014)
- Entry and location game: Vogel (2008), Economides (1989)
- Offshoring of specific inputs: Grossman & Helpman (2005)
- Worker heterogeneity and agglomeration: Amiti & Pissarides (2005)
- Worker heterogeneity and sorting/matching: Ohnsorge & Trefler (2007), Costinot & Vogel (2010), Davidson et al. (2008,2012,2014)

Migration:

- Complementarity to trade: Markusen (1983), . . . Felbermayr et al. (2014)
- Two-way migration between similar countries: Fan & Stark (2011), Kreickemeier & Wrona (2013)

Road ahead

Modeling approach - overview

What do I mean by **skill-type**?

- Production: "myriads" of tasks
- Skill-type: specific combination of abilities to perform different types of tasks - innate, or acquired
- "Myriads" of exogenous skill-types among workers
- Horizontal differentiation: every worker has same average "skill-type distance" to others
- Entry of firms: endogenous optimal skill-type ⇒
  - skill-type distance between firms
  - skill-type match between firms and workers

Modeling approach - overview

Structure:

- Given labor endowment, distributed over continuous "skill-circle" [borrowing from Amiti & Pissarides (2005)]
- Technology: only labor, fixed cost plus variable cost
- Goods market: single sector, translog expenditure system (love of variety)
- "Arctic" model: Iceberg trade cost, iceberg migration cost

Behavior: two-stage game

- Firms - stage I: free entry $\rightarrow$ zero profits $\rightarrow$ number of firms, "distance pattern" on skill-circle
- Firms - stage II: Bertrand pricing on goods and labor markets
- Workers: inelastic labor supply, matching with firms

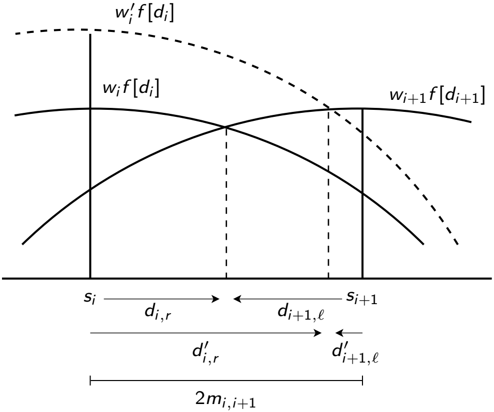
Firm neighborhoods and worker-firm matching

Important notation:

- Mass of labor supply L distributed over "skill-circle" with circumference $2H$
- N: number of firms entering indexed by i
- $\boldsymbol{m}_i$: N-dimensional vector of distances between firms $(2m_{i-1,i}, 2m_{i,i+1}, \ldots, 2m_{i-2,i-1})$
  $i+1$: first right-hand neighbor
  $i-1$: first left-hand neighbor, etc.
  $i-1 = N$ if $i = 1$, ..., and $i+1 = 1$ if $i = N$
- w_i firm $i's$ posted wage per efficiency unit
- $\boldsymbol{w}_{-i}$: $N-1$ vector of wage rates set by all firms other than i
  first element: first right-hand neighbor
  final element: first left-hand neighbor, etc.

Sorting of workers into neighboring firms

- income of worker at skill distance d from i: $w_i f[d]$
- $f(0) = 1,\ f' \leq 0,\ f'(0) = 0,\ f'' < 0,\ f(d) = f(-d)$
- workers know skill distances
- firms know skill distribution
- free entry $\rightarrow$ job surplus appropriated by workers



Firm i's "skill reach": $d_{i,r} = d_r\left[w_i, \boldsymbol{w}_{-i}, \boldsymbol{m}_i\right]$

determined by worker indifference condition

Firm i's labor supply

Labor supply - right and left:

$$L^{S,r} = \int_{0}^{d_r[w_i, \boldsymbol{w}_{-i}, \boldsymbol{m}_i]} \frac{L}{2H} f[d] \mathrm{d}d$$

$$\text{analogously for } L^{S,\ell} = \cdots$$

Total labor supply:

$$L^S[w_i, \boldsymbol{w}_{-i}, \boldsymbol{m}_i, L, H] = \begin{cases} L^{S,\ell} + L^{S,r} & \text{if} \quad d_\ell \leq -d_r \\ 0 & \text{otherwise} \end{cases} \tag{1}$$

with elasticity $\eta > 0$ and $\eta < \infty$, depending on $w_i, \boldsymbol{w}_{-i}, \boldsymbol{m}_i$

Stage II: pricing of incumbent firms

Stage I $\Rightarrow \boldsymbol{m}_i$ and N

Stage II: Bertrand price and wage setting, **conditional on $\boldsymbol{m}_i$,N**:

- First order condition – double markup on w_i:

$$p_i = \frac{\varepsilon_i}{\varepsilon_i - 1} \frac{\eta_i[\cdot] + 1}{\eta_i[\cdot]} w_i \beta \tag{2}$$

$$\frac{\varepsilon_i}{\varepsilon_i - 1} = \mathcal{W}\Big[\underbrace{\frac{\eta_i[\cdot]}{w_i(\eta_i[\cdot]+1)} \exp\left\{1 + \frac{1}{\gamma N} + \overline{\ln p}\right\}}_{\text{market environment}} \Big] \tag{3}$$

$$\mathcal{W}[z]: \quad \text{solution to } \; xe^x = z \quad (\mathcal{W}' > 0)$$

- Firm's labor supply $\Rightarrow$ best response function for w_i:

$$w_i = w_i\left[\boldsymbol{w}_{-i}, \boldsymbol{m}_i, N, \overline{\ln p}, Y, L, H\right] \tag{4}$$

Stage II equilibrium

Nash Equilibrium:

$$w_i^e = w^e\left[\boldsymbol{m}_i, N, L, H\right] \quad (5)$$

$$p_i^e = p^e\left[\boldsymbol{m}_i, N, L, H\right] \quad (6)$$

$$\pi_i^e = \pi^e\left[\boldsymbol{m}_i, N, L, H\right] \quad (7)$$

for $i = 1, \ldots, N$

and (potentially) asymmetric $\boldsymbol{m}_i$

Lemma (stage II equilibrium - pricing)

Existence of unique stage II equilibrium, if the profit function is quasiconcave and β is low enough.

Stage I: Entry and choice of "technology"

- Challenge: consistent story about entry where symmetric dispersion of firms around skill-circle is the only equilibrium
- Game of incomplete information: uncertainty about $\boldsymbol{m_i}$
- Beliefs about conceivable $\boldsymbol{m_i}$, conditional on N
- Decision rule for all $i = 1 \ldots \bar{N}$ (potential entrants, with zero oo)

$$\mathcal{I}_i = \begin{cases} 1 & \text{if} \quad \mathbb{E}_i\big[\pi^e[\boldsymbol{m}_i, N]\big] \geq 0 \text{ and } \nu_i[N] > 0 \\ 0 & \text{otherwise} \end{cases}$$

- $\nu_i[N]$: belief on number of firms entering
- Best response function $\mathcal{I}_i[N]$

Stage I: Entry and choice of "technology"

- Structural symmetry ⇒ symmetric beliefs
- Equilibrium: equilibrium number of entrants N^e satisfies

$$\text{a):} \qquad \sum_{i=1}^{\bar{N}} \mathcal{I}_i[N^e] \geq N^e \tag{8}$$

$$\text{b) for any } \tilde{N} > N^e\text{:} \qquad \sum_{i=1}^{\bar{N}} \mathcal{I}_i[\tilde{N}] = 0 \tag{9}$$

a: Assuming N^e entrants, all will want to enter
b: Assuming more than N^e entrants, none will want to enter

Lemma (stage I equilibrium - entry and skill-type choice)

Consistent beliefs, sufficiently low β
⇒ *unique, symmetric stage I equilibrium with*

$$m_{i-1} = m_{i+1} = m; \quad m^e = H/N^e$$

Symmetric autarky equilibrium: pricing

Symmetry:
- $\ln p_i = \overline{\ln p}$, and $w_i = \bar{w}$
- Number of firms $N[m] := H/m$

Pricing equation (normalizing $w = 1$):

$$p[m] = \rho[m]\psi[m]\beta \tag{10}$$

- goods price markup

$$\rho[m] := 1 + \frac{1}{\gamma N[m]} \quad \text{with } \rho'[m] > 0 \tag{11}$$

- wage markup

$$\psi[m] := \frac{\eta[m] + 1}{\eta[m]} \quad \text{with } \psi'[m] > 0 \tag{12}$$

Symmetric autarky equilibrium: productivity and profits

Average productivity (quality of worker-firm-match):

$$\theta[m] := \frac{1}{m}\int_0^m f[d]\mathrm{d}d \quad \text{with } \theta'[m] < 0 \tag{13}$$

Zero profits plus full labor market clearing (setting $\beta = 1$)

$$p[m] \quad = \quad g[m] := \frac{L\theta[m]}{L\theta[m] - \alpha N[m]} \quad \text{with } g'[m] < 0 \tag{14}$$

Pricing rule plus zero profits:

$$g[m] = \rho[m]\psi[m] \tag{15}$$

$\rightarrow$ endogenous m (and thus N)

Distortions on entry decision

Firms ignore

1. positive variety effect of entry (insufficient entry, m too large)
2. ... negative "business stealing" effect (excess entry)
3. ... positive productivity effect (insufficient entry)
4. ... negative effect on markups (excess entry)

- **Standard CES model:** 1 and 2 offset each other
  $\rightarrow$ efficient entry
- **This model: net effect is excess entry**
- ... converges to Krugman model as $H \rightarrow 0$ (zero heterogeneity)

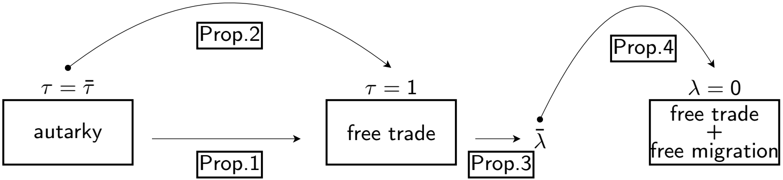
Welfare under autarky

- Worker heterogeneity – aggregate welfare (effects)?
- Ex ante: workers regard each point on the circle as being equally likely to become an ideal type for themselves
- Expected utility of a worker

$$\ln V = \ln \theta[m] - \left(\frac{1}{2\gamma N[m]} + \ln p[m] \right) \tag{16}$$

- θ and N both falling in m
- But p is not unambiguous in m – depends on the type of shock considered

Globalization - overview of propositions



Propositions:

1. Gains from trade theorem survives
2. Piecemeal trade liberalization: welfare non-monotonic in τ
3. Integrating labor markets: beneficial even for prohibitive $\bar{\lambda}$
4. Piecemeal integration of labor markets: unambiguously welfare-increasing

Trading equilibrium

Proposition (gains from trade – extensive margin)

Opening up to free trade among k symmetric countries *has the following effects relative to an autarky equilibrium:*

1. *Exit of firms in each country, but the total number of varieties increases.*
2. *There is a lower price markup coupled with a higher wage markup, but goods prices are unambiguously lower.*
3. *The average matching quality falls, so does average income.*
4. *Real income and aggregate welfare increase (compensation argument).*
5. *Some gain, some lose, but wage inequality increases.*

Trading equilibrium

Proposition (gains from trade – intensive margin)

For two identical countries in a trading equilibrium, a decrease in iceberg trade cost τ within the non-prohibitive range $\tau \in [1, \bar{\tau})$

has the following effects:

1. *There is exit of firms in each country.*
2. *Wage markups rise in each country.*
3. *The price of imported varieties falls.*
4. *The change in the price of domestic goods is ambiguous: falling at low, and increasing at high initial levels of τ.*
5. *Aggregate welfare is ambiguous: rising for sufficiently low, and falling for sufficiently high initial levels of τ.*
6. *Wage inequality rises.*

Trade liberalization – intensive margin

Intuition:

- Symmetric reduction of τ no welfare-increasing “formula” - why?
- Answer: $\Delta\tau < 0$ more trade $\Rightarrow$ more labor for τ

$\rightarrow$ Firm exit: higher wage distortion, lower matching quality

- This effect is stronger, the higher the initial level of τ

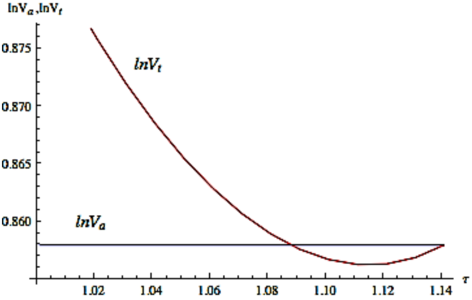
$\rightarrow$ Ambiguous response of domestic prices

Utility of worker with average income:

$$\ln V = \ln \theta[m] - \ln P\big[N(m), p, p^*\big]$$

Piecemeal trade liberalization: ambiguous welfare

$$\widehat{V} = \underbrace{\left(\frac{\partial \ln \theta}{\partial \ln N} - \frac{\partial \ln P}{\partial \ln N}\right)\widehat{N}}_{<0} \underbrace{- N\delta\hat{p}}_{\lesseqgtr 0} \underbrace{- N^{*}\delta^{*}\hat{p}^{*}}_{>0}$$



$^{*}f[d] = 1 - d^{2}, \alpha = 1, \beta = 1, L = 100, H = 1, \gamma = 1.5$

International migration

Symmetric countries - any incentive for international migration?

- Macro-level: equal average worker incomes ⇒ no incentive
- Micro-level: integrated labor markets
  - ⇒ better skill-type match in other country (except for knife edge case)
  - ⇒ re-sorting of workers into home and foreign firms
  - ⇒ relocation of firms in all countries
- Analysis of migration: two-stage game with cross-border hiring/sorting
- Theory of two-way migration between similar countries

Modeling international migration

Migration: new entry/sorting game with cross-border hiring

- Productivity of migrant at skill distance d:

$$(1-\lambda)f[d] \quad \text{with } \lambda \in (0,\bar{\lambda}), \bar{\lambda} \leq 1$$

- Effective mass of labor on the skill circle increases: $(2-\lambda)L$
- Symmetric countries with equal worker heterogeneity and labor force
- "Micro-incentive" for migration also with perfectly integrated goods markets
- Trade cum migration: free trade plus costly migration
- Gains from migration: better skill-type matches / lower monopsony power

Labor supply with alternating location pattern

Equilibrium with alternating location pattern:

- Alternating: any one firm facing two neighbors from other country
- Existence and uniqueness: extension of above Lemma
- Using $2m$ to denote distance between two firms from same country

Employment of natives and migrants:

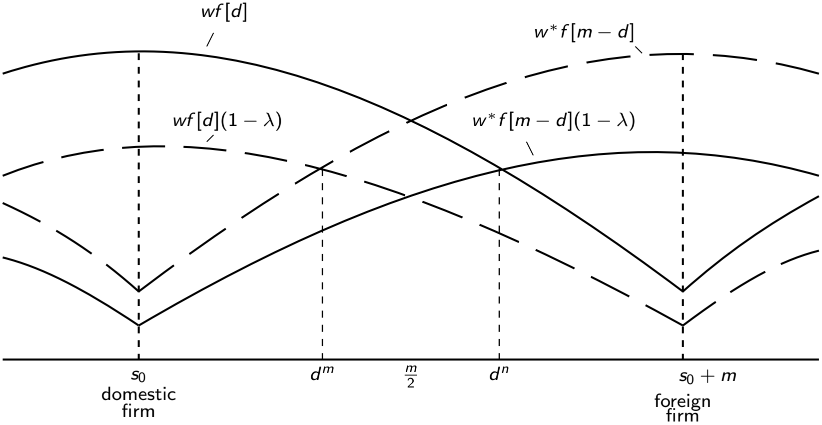
- Skill reach for natives $d_i^n[w_i, w^*, m, \lambda]$ and migrants $d_i^m[\cdot]$:

$$w_i f[d_i^n] = w^* f[m - d_i^n](1 - \lambda) \tag{17}$$

$$w_i f[d_i^m] = w^* f[m - d_i^m]\frac{1}{1 - \lambda} \tag{18}$$

- Prohibitive migration cost $\bar{\lambda}$ determined by $d_i^n = m \Rightarrow d_i^m = 0$

Labor supply with alternating location pattern



Integration of labor markets with prohibitive λ

Proposition (potential migration)

Compared to a free trade equilibrium with national labor markets, a zero profits, second stage equilibrium with free trade and potentially integrated labor markets (prohibitively high level of the migration cost) between two symmetric countries featuring a symmetric alternating pattern of firm locations involves

- *a lower number of firms and*
- *a welfare level which is unambiguously higher*

in each country.

Intuition: Excess entry alleviated through potential migration

However, this is no no Nash equilibrium in the first stage (entry) of the game.

Piecemeal liberalization of migration

Proposition (labor market integration)

In a "trade cum migration" equilibrium of the two-stage game with two symmetric countries, piecemeal integration of labor markets through a marginal reduction in the cost of migration

- *lowers prices of all goods*
- *raises welfare in both countries,*
- *but has an ambiguous effect on the number of firms*

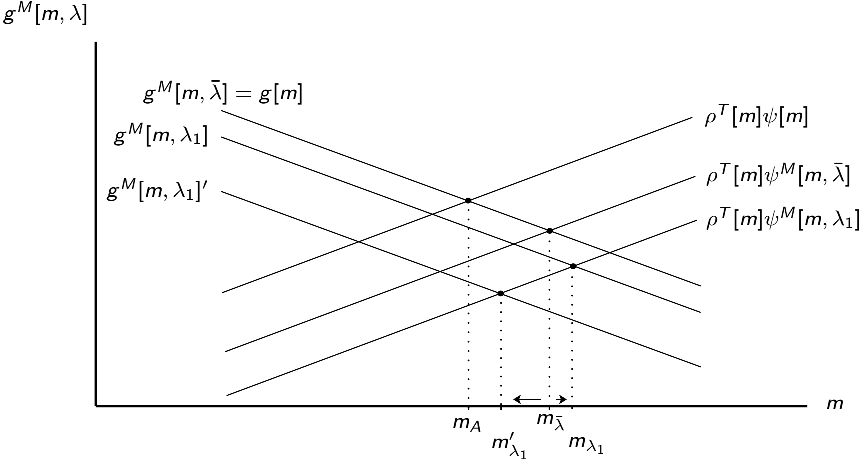
in both countries.

General equilibrium adjustments: $\hat{N} \lesseqgtr 0, \;\; \hat{p} < 0, \;\; \widehat{(\theta/p)} > 0$

Utility of worker with average income:

$$\hat{V} = \underset{+}{\widehat{(\theta/p)}} + \frac{1}{2\gamma N} \underset{+/-}{\hat{N}}$$

From free trade to trade cum migration



Summary and conclusions

1. Trade liberalization has adverse labor market effects:
   - Lower quality of matches, higher monopsony power on labor market
   - Gains from trade survive, but with increase wage inequality
   - Piecemeal trade liberalization welfare increasing only for low trade cost
2. Migration mitigates these labor market effects:
   - Integrating labor markets is beneficial even at the margin of prohibitive migration cost
   - A decrease in migration cost is unambiguously welfare enhancing
3. Two-way migration arises as a consequence of skill diversity
4. Migration and trade are complements
5. An "integrated world equilibrium" can only be reached if goods **and** labor markets are fully integrated

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Symmetric translog expenditure system

back

Indirect utility of individual k with income y_k

$$\ln V_k = \ln y_k - \ln P[p]$$

with

$$\ln P[p] = \frac{1}{2\gamma N} + \frac{1}{N}\sum_{i=1}^{N}\ln p_i + \frac{\gamma}{2N}\sum_{i=1}^{N}\sum_{j=1}^{N}\ln p_i(\ln p_j - \ln p_i)$$

Demand

$$x_{ik}[p, y_k] = \frac{\partial \ln P[p]}{\partial \ln p_i}\frac{y_k}{p_i} = \delta_i \frac{y_k}{p_i} \quad \text{with} \quad \delta_i = \frac{1}{N} + \gamma\left(\frac{1}{N}\sum_{j=1}^{N}\ln p_j - \ln p_i\right)$$