Social interactions and segregation in skill accumulation

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Based on work with

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Introduction

- This lecture explores some causes and implications of geographical segregation w.r.t. human capital investment incentives and inequality theoretically
- A large literature explains persistent inter-household inequality in earnings and human capital, on the basis of capital market imperfections and historical wealth differences
  (Loury 1981; Ray 1990, 2006; Galor-Zeira 1993; Banerjee-Newman 1993; Ljungqvist 1993; Freeman 1996; Maoz-Moav 1999; Mookherjee-Ray 2003; …)
- One could view geographical segregation as a *result* of such inequality, upon combining with patterns of spatial mobility
  (Schelling 1978; Bénabou 1993; Pancs-Vriend 2007)
- Accordingly, geographic inequality would merely be a symptom; policy-makers should not be concerned with segregation *per se*

Introduction, contd.

- Mookherjee, Napel, and Ray (2010a; 2010b) explore the basis for an alternate view, wherein geographical segregation can be a primary independent factor affecting human capital incentives, *even in the absence of any capital market imperfections and spatial mobility*
- We incorporate neighborhood effects in an OLG model of human capital investments:
  high skill of neighbors increases own incentive to invest, through peer effects in formation of aspirations and training, or locally funded learning facilities
- MNRa looks at the existence, macroeconomic and welfare properties of steady states with varying patterns of geographical segregation;
  MNRb investigates how changes in the "local-ness" of interactions affect inequality and welfare

Agenda

I. Baseline model with no local interaction
II. Model with local interaction
III. Segregated and unsegregated equilibria
IV. Decrease in “local-ness” of social interactions

I. Baseline model with no local interaction

- Simple variation of Mookherjee and Ray (2003)
- Unskilled and skilled inputs are essential for production; work in skilled profession requires prior educational investment c
- Single consumption good with concave CRS production function (C^1, Inada)

$\Rightarrow$ Equilibrium skilled wage $w_s(\lambda)$ falls in economy-wide *skill ratio* λ; unskilled wage $w_u(\lambda)$ rises in λ; $\lim_{\lambda\downarrow 0} w_s = \infty$, $\lim_{\lambda\downarrow 0} w_u = 0$, and $\exists\lambda^b$: $w_s(\lambda^b) = w_u(\lambda^b)$

- At each date $t = 0,1,2,\ldots$ a household h divides its income w^h between consumption and educational investment $\mathbf{1}(h)\in\{0,1\}$ so as to maximize

$$u\big(w^h\text{-}c\cdot\mathbf{1}(h)\big) + v\big(\mathbf{1}(h)\cdot w_s+(1\text{-}\mathbf{1}(h))\cdot w_u\big)$$

with u and v strictly $\uparrow$ and C^1, u strictly concave, v unbounded

- No loans, no financial bequests

Results for the baseline model

- A *competitive equilibrium* is a sequence $\{\lambda_t\}_{t\geq 0}$ s.t. given λ_0 and agents' anticipation of λ_{t+1}, individual decisions result in λ_{t+1}; it is a *steady state* if $\lambda_t = \lambda$ for all t

- <u>Result:</u>
  1. *Persistent inequality* and *no social mobility* in any steady state.
  2. There exists a *continuum* of steady states, ordered by human capital, per capita income, and social equality.

Intuition

1. Cost for skill acquisition requires wage premium for skilled; strict concavity implies *c* is a smaller utility sacrifice for the rich

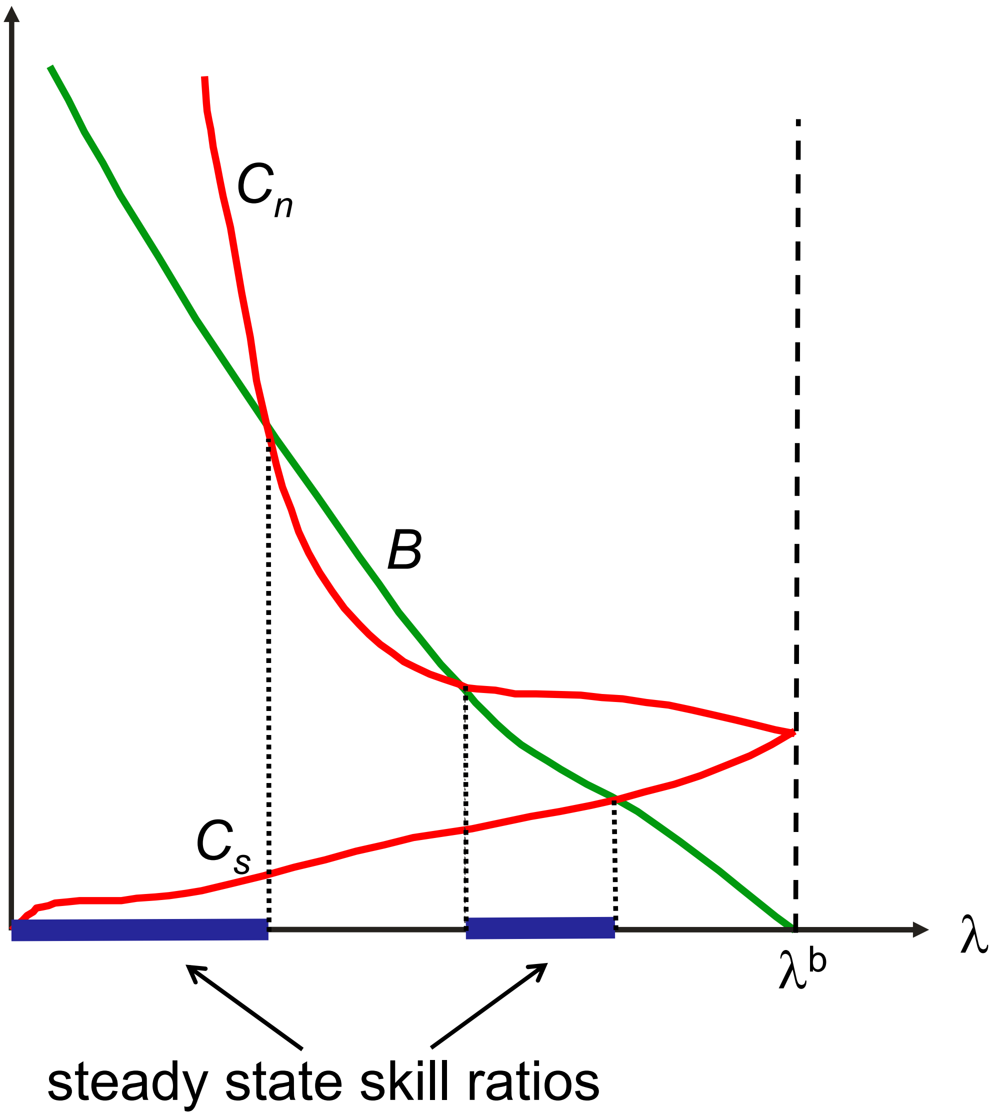
$\Rightarrow$ Skilled parents always have greater net benefits from investing

$\Rightarrow$ No simultaneous upward and downward mobility

2. For some λ^* sufficiently high (i.e., wage premium low), skilled are indifferent and unskilled strictly do not want to invest

$\Rightarrow$ This λ^* is a steady state;
unskilled's strict preference will be preserved by small decreases of λ

Illustration for strictly concave *u*

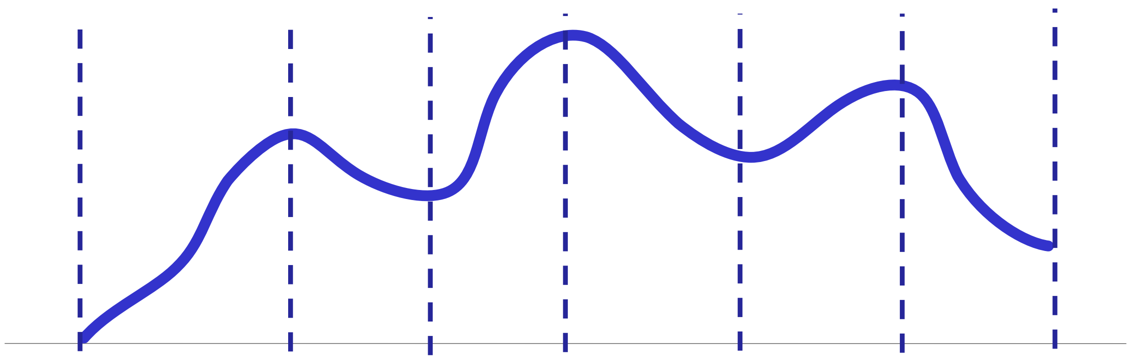


Remarks on baseline model

- If u is *linear*, C_u and C_s both equal $u(c)$ (for $w_u \geq c$);
  strict monotonicity of the (identical) subjective gross benefits
  $$B \equiv v(w_s) - v(w_u)$$
  in this case implies a *unique* steady state λ^*;
  indifference of skilled and unskilled at λ^* allows for *social mobility*
- Social mobility is possible and scope for history-dependence is drastically reduced also if *heterogeneous agents* are considered: steady states with mobility generically are *locally unique*
  (Mookherjee-Napel 2007; Napel-Schneider 2008)
- History-dependence is similarly reduced if *fertility* is endogenized
  (Mookherjee-Prina-Ray 2009)
- Set of steady states shrinks to a singleton when $k \rightarrow \infty$ different occupations are considered
  (Mookherjee-Ray 2003)

II. Model with local interaction

- Now let the unit mass of households have fixed locations on an interval $I \subseteq \mathbf{R}$, described by a continuous density f which is
  - strictly positive in I's interior
  - nowhere flat
  - has a finite number of increasing and decreasing *stretches*



- Each household provides skilled or unskilled labor on the *economy-wide* competitive market, but *local* social interaction creates spillovers in human capital investment incentives (Bénabou 1993, 1996; Durlauf 1994)

Model with local interaction (2)

- MNRa and MNRb focus on two different channels for spillovers:
  1. Subjective gross benefits have a social component;
     e.g., they increase in *parental aspirations* a^h for their offspring, i.e.,
     $$v(w_s, a^h) - v(w_n, a^h) \uparrow \text{ in } a^h,$$
     where a^h increases in the neighborhoods' average earnings
  2. Objective investment costs have a social component;
     e.g., *cost* of acquiring skill is a (bounded) decreasing function $c(x_i)$ of the "*learning effectiveness*" x_i at location *i*
- Both have the same macroeconomic implications, but can lead to different welfare conclusions
- Here, concentrate on cost-driven spillovers with
  $$x_i = \eta\mu_i + (1-\eta)\lambda,$$
  where μ_i is the fraction of skilled in the local peer group of agents at location *i*, and $\eta \in (0,1)$ captures importance of local interactions
- The local peer group is an ε-neighborhood centered at *i*

Model with local interaction (3)

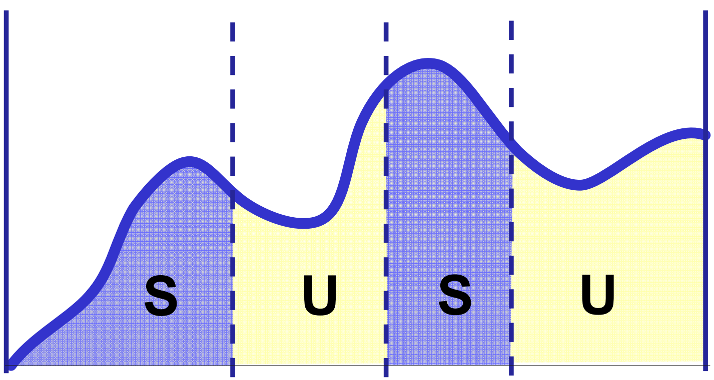
- In order to focus on geography dependence rather than history dependence of inequality, we assume *linear* utility
  $\rightarrow$ implicitly disregarding capital market imperfections
  (see Carneiro-Heckman 2002; Heckman-Krueger 2003 on empirics of CMI)
- Hence, households located at *i* prefer to invest if

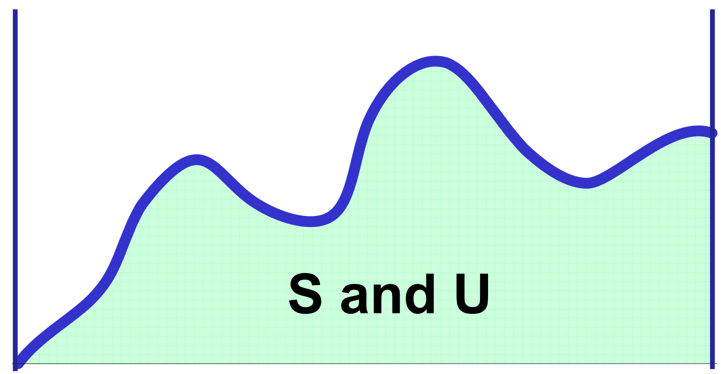
$$B \equiv v(w_s) - v(w_u) > c(x_i)$$

- A (*steady state*) *equilibrium* is a distribution of skills, an aggregate skill level λ, and wages w_s and w_u s.t.
  1. wages are consistent with the aggregate skill level
  2. the aggregate skill level is consistent with the distribution of skills
  3. the distribution of skills results from optimal decisions by all households, given the wages and the local learning effectiveness implied by the distribution of skills

III. Segregated vs. unsegregated equilibria

- We can distinguish (at least) two geographical patterns
  - *segregated equilibria*, where locations are partitioned into alternating intervals of skilled and unskilled agents with a width $\geq 2\varepsilon$,
  - and *unsegregated equilibria*, where $\mu_i \equiv \lambda$





- A segregated equilibrium is called *regular* if all cuts have at least ε distance to f's local extrema

Existence of unsegregated equilibria

- <u>Result:</u>
  An unsegregated equilibrium exists
  (a continuum would exist if *u* is *strictly* concave)
- Intuition:
  $c(x_i)$ is identical at all locations and bounded in λ;
  B varies continuously between infinity at $\lambda \approx 0$ and zero at λ^b
  $\Rightarrow$ at least one intersection
- Given an unsegregated equilibrium λ^*, a further increase of λ
  - reduces the wage premium for skill, and hence gross benefits
  - but also reduces the investment cost
- Effect on net investment benefits is ambiguous;
  if they increase at λ^*, then another unsegregated equilibrium $\lambda^{**} > \lambda^*$ exists

$\Rightarrow$ (Small) scope for history dependence even w/o CMI

Existence of segregated equilibria

- Result:
  A segregated equilibrium exists
  (again, a continuum would exist if u is strictly concave)

- Intuition:
  - Consider a single "cut" at $j \in I$ with unskilled to the left of j and skilled to the right, resulting in cost $c(x_j)$ faced by households at j
  - A necessary and sufficient condition for existence of a single-cut segregated equilibrium is

$$c(x_j) = v(w_s) - v(w_n)$$

    with competitive wages for $\lambda = \lambda(j) \equiv \int_{x>j} f(x)dx$
  - Continuity arguments imply existence of some cut position j s.t. $\lambda(j)$ implies wages so that costs $c(x_j)$ are smaller (greater) than benefits to the right (left) of j

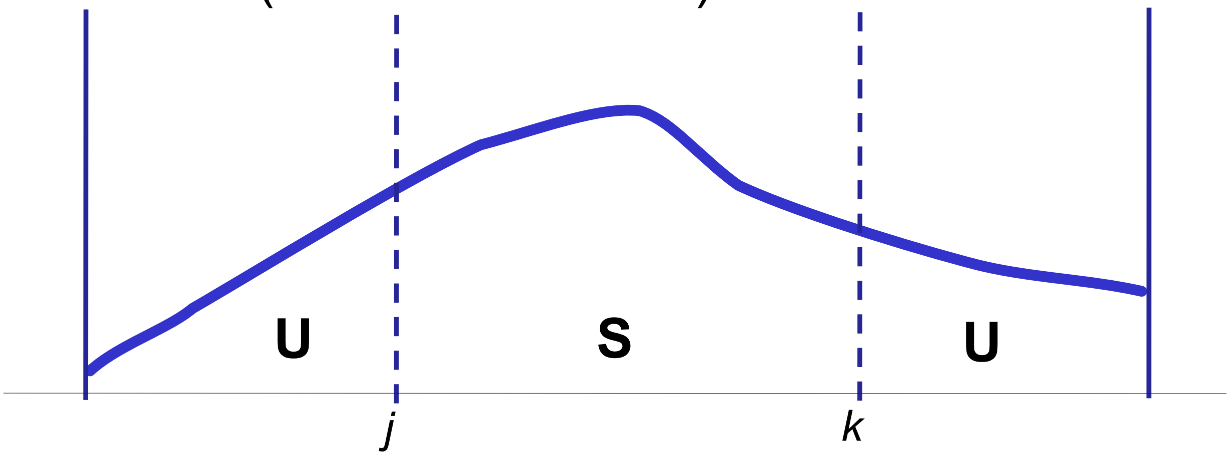
Structure of segregated equilibria

- <u>Lemma</u>
  In any segregated regular equilibrium, each stretch of *f* contains at most one cut

- Intuition:
  - For two consecutive cuts *j* and *k* on the same ↑ or ↓-stretch of *f*: $x_j \neq x_k$
  - Indifference of households at *j* implies strict incentives for those at *k*, i.e., there can be no cut at *k* in equilibrium

Structure of segregated equilibria

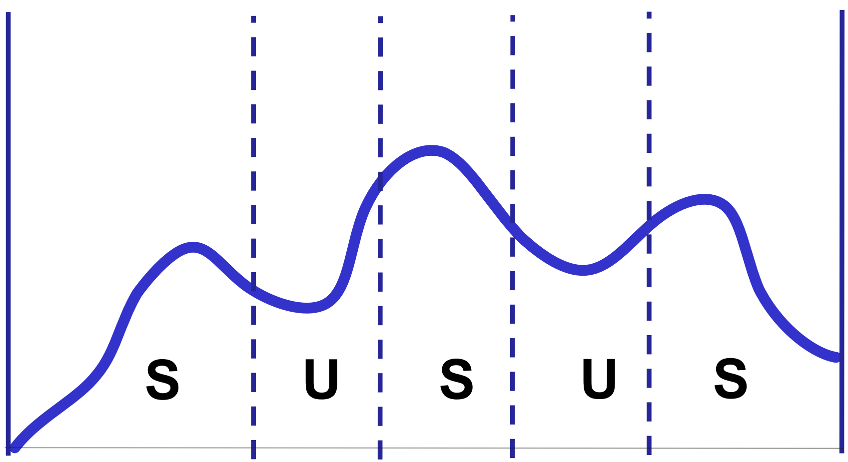
- <u>Corollary</u>
  If *f* is unimodal, then a segregated regular equilibrium can involve at most two cuts (one on each side)

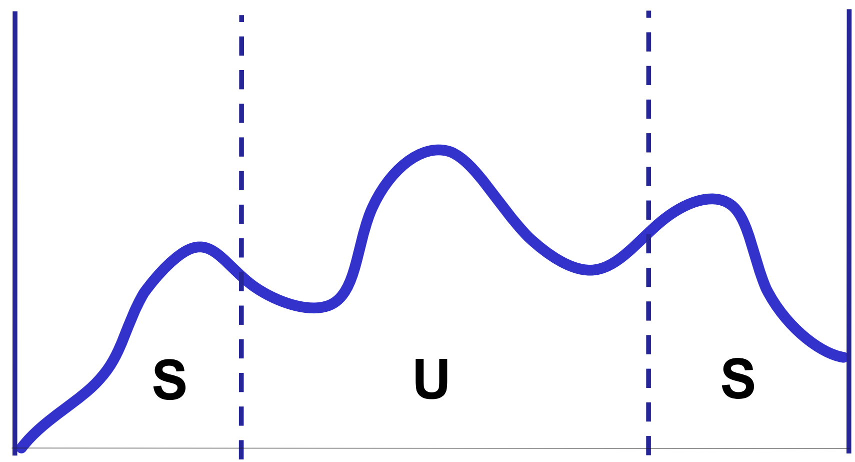


- <u>Corollary</u>
  If *f* has *n* local modes, then a segregated regular equilibrium can involve at most 2*n* cuts;
  consecutive cuts lie on stretches of *f* with slopes of opposite signs
- Multi-cut segregated equilibria need not exist

City-skilled and city-unskilled equilibria

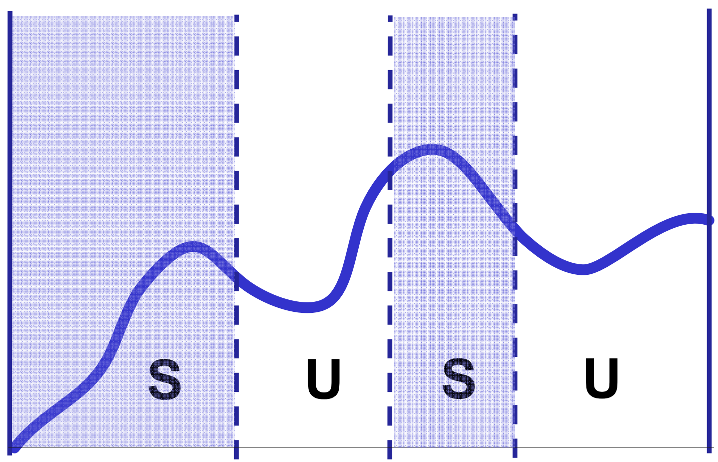
- Call a segregated equilibrium
  - *city-skilled* if some cut divides a skilled mode from an unskilled trough
  - *city-unskilled* if some cut divides an unskilled mode from a skilled trough
- <u>Result</u>
  A segregated regular equilibrium must be either city-skilled or city-unskilled (never both)

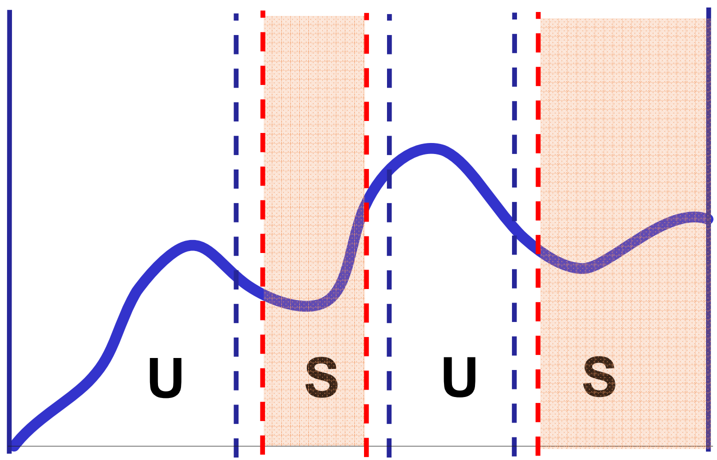




City-skilled vs. city-unskilled equilibria

- <u>Result</u>
  Any city-skilled equilibrium generates more skilled labor and less inequality than any city-unskilled equilibrium for a given economy





Segregated vs. unsegregated equilibria

- When the window size ε becomes very small, households at a cut *j* see approximately *equal* numbers of skilled and unskilled individuals, independently of $f(j)$
- Then *any* purely segregated equilibrium, no matter what its spatial structure, must generate an aggregate quantity of skills λ s.t.

$$v(w_s(\lambda)) - v(w_n(\lambda)) = c(\eta/2 + (1-\eta)\lambda)$$

- <u>Result</u>
  Let $\varepsilon \approx 0$. If the production technology exhibits sufficiently big skill bias, then there exists an unsegregated equilibrium which has a higher skill level than any segregated equilbrium;
  for sufficiently low skill bias, every segregated equilibrium has higher skills than any unsegregated one

IV. Decreased local-ness of interactions

- “Globalization” can be reflected by
  - greater weight on global vis-à-vis local interactions, i.e., $\eta\downarrow$,
  - wider local neighborhoods, i.e., $\varepsilon\uparrow$, or
  - lower geographical mobility costs (initially assumed to be prohibitive)
- Neither affects the macro properties of unsegregated equilibria; we concentrate on implications for regular segregated equilibria
- Note: a rise in the aggregate skill ratio λ is associated with
  - higher per capita income
  - lower wage inequality between skilled and unskilled
  - lower skill acquisition costs for all individuals

  and hence greater welfare

  (for any quasiconcave Bergson-Samuelson function defined on individual payoffs)

Greater weight on global skill ratio

- Result:
  For ε sufficiently small, an increase in global interactions measured by a fall in η
  - improves welfare if the equilibrium is *majority skilled* ($\lambda > ½$)
  - reduces welfare if the equilibrium is *minority skilled* ($\lambda < ½$)

- Intuition:
  - If agents' local window is small relative to the economy ($\varepsilon \approx 0$), border agents perceive an approximately equal skill mix ($\mu_j \approx ½$)
  - The equilibrium skill ratio λ then is approximately described by

$$v(w_s(\lambda)) - v(w_u(\lambda)) = c(\eta/2 + (1-\eta)\lambda)$$

  - If $\lambda > ½$, then a decrease in η raises learning effectiveness and lowers costs for marginal agents at the borders

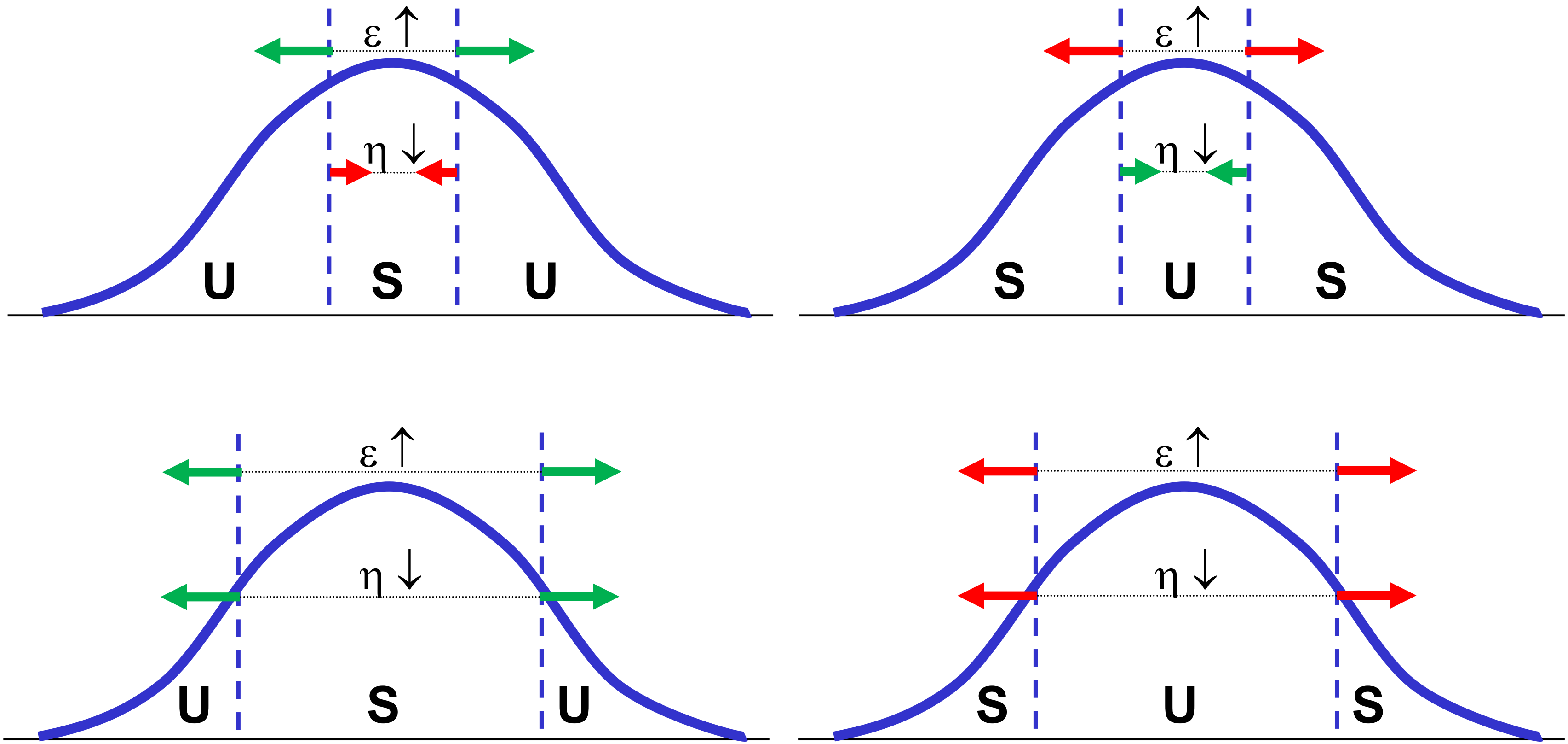
Wider local neighborhoods

- Proposition:
  An increase in global interactions measured by an increase in ε
  - improves welfare if the equilibrium is *city skilled*, and
  - reduces welfare if the equilibrium is *city unskilled*

- Intuition:
  - Let the equilibrium be city skilled;
    as ε increases, perceived local skill share μ_j must increase as relatively more (skilled) agents near the city are added to border agents' "window"
  - This raises learning effectiveness, and lowers costs for marginal agents

Illustration

- Both aspects of “globalization” can increase or decrease skills and inequality; they may reinforce or cancel each other:

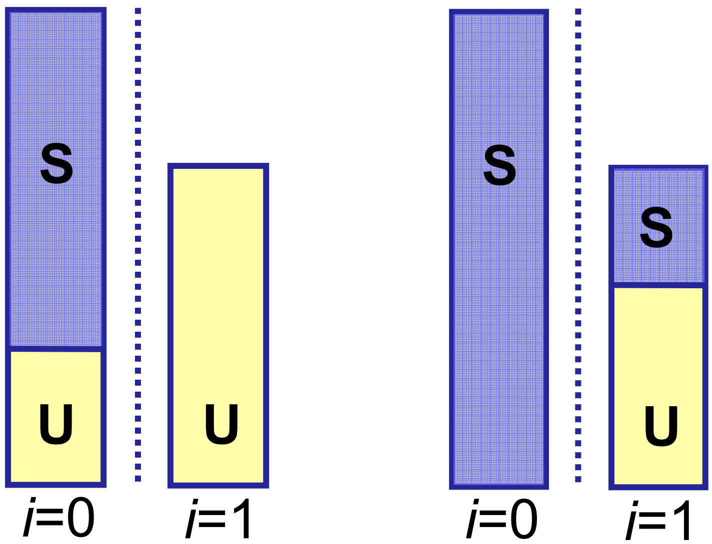


Lower mobility costs

- Suppose agents can move from one location to any other at cost σ
- An equilibrium must satisfy the additional condition that
  4. no agent prefers to relocate
- As σ is lowered from a high initial value, segregated equilibria with more wage inequality are successively eliminated:
  – Agents in the interior of an unskilled interval start having an incentive to move to the interior of a skilled interval
- If σ is sufficiently small, *no* segregated can society satisfy 1.-4., i.e., there is no segregated equilibrium;
  in contrast, an unsegregated equilibrium must always exist
- The move from a segregated society to an unsegregated one increases welfare iff the segregated equilibrium is majority skilled (similar to $\eta\downarrow$-case)

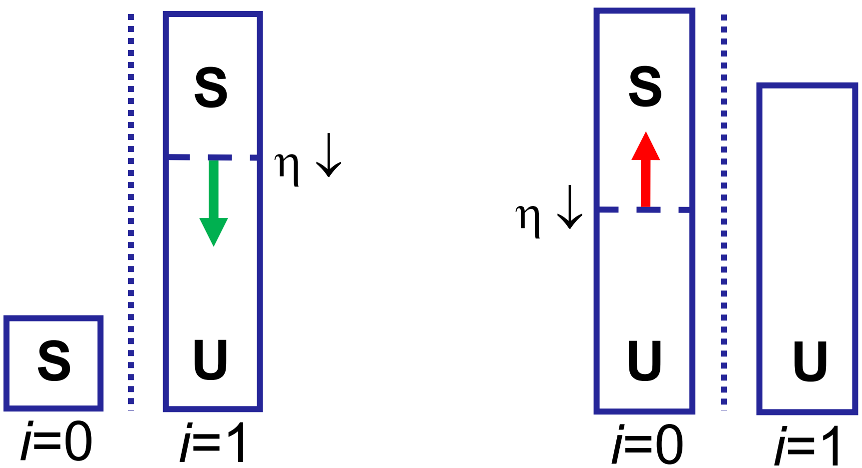
Two social groups

- As an alternative to a convex location space with overlapping neighborhoods, consider two discrete "locations" i = 0 or 1, corresponding to two social groups (e.g., natives vs. immigrants) (Bowles-Loury-Sethi 2009)
- "Segregated" equilibria correspond to societies with $\mu_0 \neq \mu_1$
- We assume $\mu_0 > \mu_1$ and distinguish equilibria in which
  - all immigrants are unskilled ($\Rightarrow$ the "marginal agent" is a native)
  - all natives are skilled ($\Rightarrow$ the "marginal agent" is an immigrant)



Greater weight on global skill ratio

- Result:
  In the case of two social groups, an increase in global interactions measured by a fall in η
  - improves welfare if the equilibrium is *native skilled*
  - reduces welfare if the equilibrium is *immigrant unskilled*



Conclusion

- The considered models illustrate that
  - unsegregated and segregated equilibria co-exist
  - the spatial structure of segregated equilibria is highly restricted by the interaction of economy-wide pecuniary and local social externalities
  - different segregation patterns give rise to different skill levels, per capita incomes, wage inequality, and welfare
  - effects on poverty, inequality and welfare of changes in the “local-ness” of social interactions depend critically on (a) what exactly changes and (b) the properties of the initial equilibrium
- Future research:
  - Policies (redistribution, local subsidies, …) (Mookherjee-Ray 2008)
  - Agent heterogeneity, more occupations
  - Robustness of equilibria w.r.t. to perturbations
  - Endogenous housing market
  - Other topologies