Welfare Effects of Polarization: Occupational Mobility over the Life-cycle

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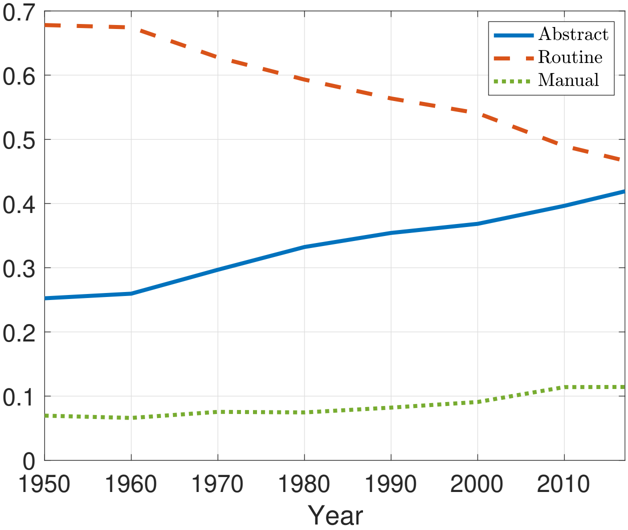
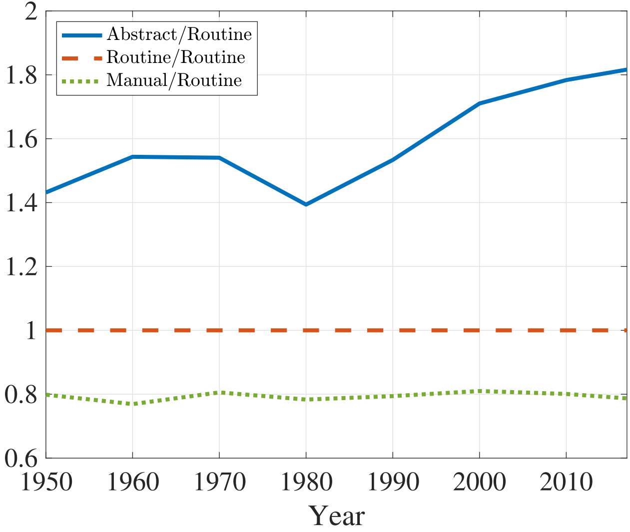
Comments are very welcome at *skikuchi@mit.edu*

Routine occupations are disappearing



US, Employment share by occupation (Male, HH head, Full-time), CPS

Abstract occupations are paid more and more



US, Relative weekly wage by occupation (Male, HH head, Full-time), CPS

Theme: Welfare Effects of Polarization in Labor Market

- Polarization in labor market: employment share and relative wage

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- Traditional dimensions
  - Education (Katz-Murphy)
  - Industry/occupation (Autor-Dorn, Barany-Siegel)

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- This paper: Age is another key dimension
  - Individuals accumulate human capital over the life-cycle
  - Technological changes impact young and old workers differently

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- Polarization in labor market: employment share and relative wage

- Traditional dimensions
  - Education (Katz-Murphy)
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- This paper: Age is another key dimension
  - Individuals accumulate human capital over the life-cycle
  - Technological changes impact young and old workers differently
  - At what age did shock come?

What we do

- A quantitative full-blown OLG model of consumption/saving, labor supply and retirement, occupational decisions, and human capital accumulation
- Parameterize the model to account for a life-cycle pattern of occupational distribution and mobility in the early 1980s
- Evaluate welfare implications of polarization between the early 1980s and the late 2010s
- Assumed exogenous (for now)
  - production (partial equilibrium)
  - education decisions

Contribution

- First paper to quantify welfare effects of polarization using a standard OLG model with consumption/saving and occupational choices

Related literature:

- Polarization: Acemoglu and Autor (2011), Autor and Dorn (2013), Barany and Siegel (2019)
- Welfare effects of rising inequality over the life-cycle (not occupation but educational choice): Heathcote, Storesletten and Violante (2010)
- Simple theoretical framework along age dimensions: Sachs and Kotlikoff (2015), Benzell, et al (2019)
- Polarization and human capital accumulation over the life-cycle **(no consumption/saving decisions of workers)**: Cociuba and McGee (2019, WP), Dvorkin and Monge-Naranjo (2019, WP)

Plans for Today

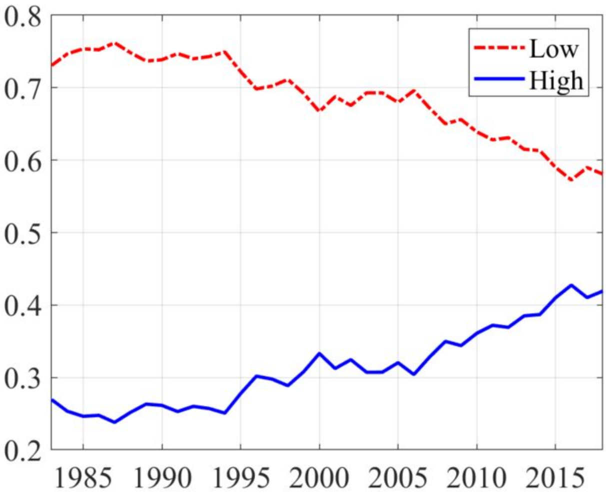
1. Empirical facts: Polarization in the US labor market from 1980s
2. Model: Full-Blown Life-Cycle Model
3. Calibration
4. Numerical Results

1. Empirical facts

Polarization

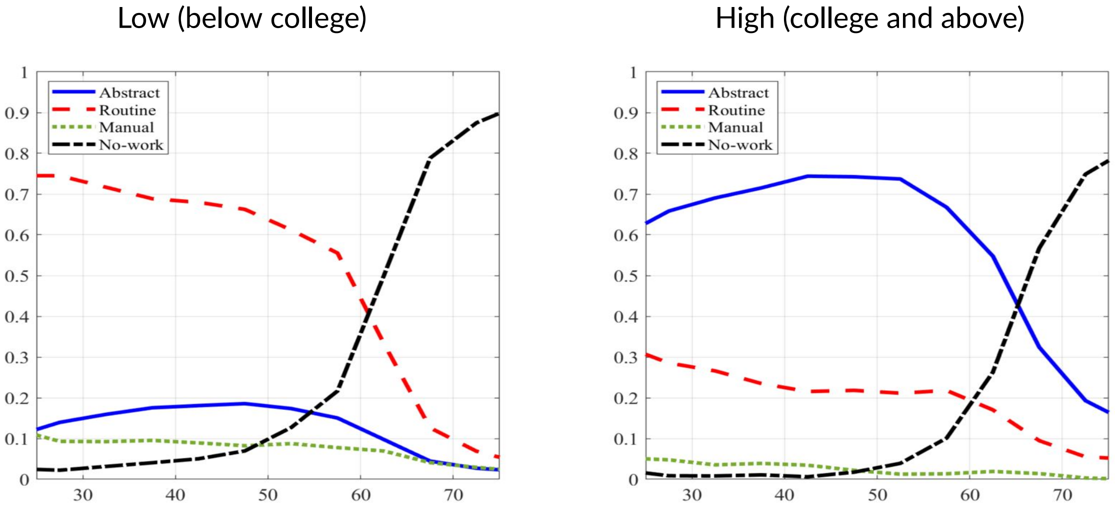
- In “Macro”, polarizations are well-documented (what we say in introduction): Acemoglu and Autor (2011), Autor and Dorn (2013)
  - Employment share of Routine decreasing from 1950s
  - Relative wage of Routine decreasing from 1980s
- Other critical dimensions
  - Skill (education) : More educated and rises in skill premium
  - Age:
- Focus from 1983 onward (for now)
  - Relative wage decrease in Routine started in 1980s
  - Significant revision of occ. codes before/after 1983: Kambourov and Manovskii (2013)
  - Ongoing work to extend analysis from 1950

US is being more educated



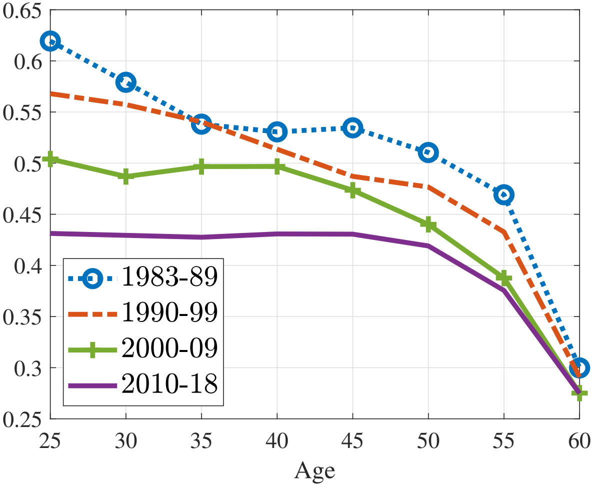
College Graduation rate (Male, HH head), CPS

Occupations Distributions Differ across Skills and Age



Employment share (Male, HH head), 1983/85, CPS

Declines in Routine Sector Differ across Age



- All age groups see declines in Routine sector (same for cohort-base cut)
- The young decreased the most (they go to Manual or Non-employment)
- Trying to attribute "macro" changes in occupations/wages by a representative agent could go very wrong
- Call for a rich life-cycle model

Ratio of employment at Routine/Population by age (Male, HH head), CPS

2. Model

Model: At Glance

- A full-blown OLG model of heterogeneous individuals that go through life-stages: enter, work, consume/save, retire, and die
- Worker heterogeneity in
  - fixed skill (education)
  - occupation (endogenous after entry)
  - occupation-specific human capital, that are accumulated and depreciate
  - idiosyncratic shocks to productivity
- Mobility across occupations and from work to non-employment (retirement)
  - Separation from an occupation occurs both endogenously and exogenously (separation shocks)

Model: Purpose

- Simulate polarization in the transition
  1. Initial economy
     - Approximates the early 1980s, “pre-polarization”
     - Calibration to match features of this economy
  2. Transition dynamics
     - Agents are shocked with polarization ($\equiv$ gradual changes in occupation specific wages over a 30-year period)
     - Also assume an exogenous change in the initial assignment of skills (education) and occupations

- Assess changes in the economy and welfare effects across generations (ages and cohorts) and across skills

Demographics

- Born at age $j = 1$, survive with probability ϕ_{j+1}, live up to $j = J$
- Start with zero asset $a_1 = 0$
- At birth, agents are randomly assigned to an initial skill, $s = \{L, H\}$, and occupation, $o = \{A, R, M, N\}$ (Abstract, Routine, Manual and No-work), with an initial level of human capital $h^s_{1,o}$
- a_j, o_j and h_j will be endogenously chosen and evolve over a life-cycle (as will be specified).

Earnings

- Earnings of an individual of age j, skill s and occupation o at time t

$$y_{t,j,s,o} = h_o \cdot \eta_o \cdot w_{t,o} \cdot l$$

  - h_o: occupation-specific human capital. Follows a law of motion $h' = f^h(h, j, s, o, o')$
  - η_o: idiosyncratic labor productivity
  - $w_{t,o}$: occupation specific wage rate (exogenous in our model)
  - l: labor supply, $l = 0$ if $o = \{N\}$ and $l = 1$ if $o = \{A, R, M\}$.

Uncertainty

- Micro level
  1. With probability $\lambda_{s,o}$, a worker of skill s is separated from occupation o
     - Must choose a new occupation $o' \neq o$ for the next period
     - Lose accumulated occupation-specific human capital
  2. Idiosyncratic labor productivity η_o
     - Occupation specific productivity shock
     - Each individual draws productivity $\overline{\eta} = \{\eta_A, \eta_R, \eta_M\}$ every period and settles with $\eta_{o'}$ if occupation o' is chosen
  3. Survival risks ϕ_j

- Macro level
  - None in the initial economy
  - In period 1 of the transition, agents learn the path of occupation specific wages (polarization shock) and age-1 assignment of skill and occupation. Perfect foresight thereafter

Preferences

- Utility function $u(c, l)$
  - assume a fixed cost of participation B_s, if $l = 1$, no cost otherwise.
- Discount by β
- Mobility cost of switching from one occupation to another ($o \to o'$) in utility, skill-specific $c^s_{oo'}$

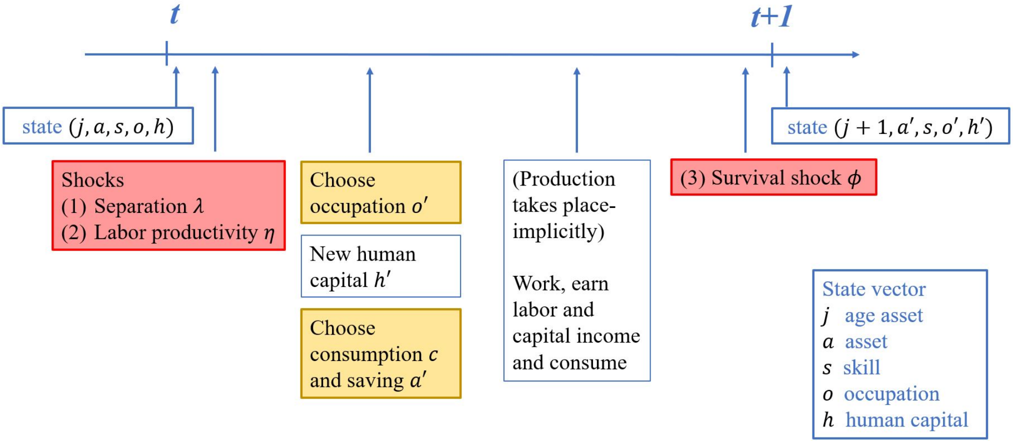
Prices and transfers

- Interest rate r and occupation-specific wage rate $w_{t,o}$, $o = \{A, R, M\}$ (exogenous)
- Social security transfer ss to those aged j^R and above
- Welfare transfer to guarantee minimum consumption $\bar{c}$

Life-cycle problem

- A state vector of an individual $x = \{j, a, s, o, h\}$
  - j age
  - a assets
  - s skill
  - o occupation
  - h human capital

Timing of events



Life-cycle problem

1. Occupation choice (after $\lambda_{s,o}$ and $\eta_{o'}$ shocks)

$$V(j,a,s,o,h) = \int_{\overline{\eta}} \lambda_{s,o} \max_{o'(\neq o)} \left\{ W(j,a,s,o',h',\eta_{o'}) - c^s_{oo'} \right\} \\ + (1-\lambda_{s,o}) \max_{o'} \left\{ W(j,a,s,o',h',\eta_{o'}) - c^s_{oo'} \right\} d\overline{\eta}$$

where $h' = f^h(h,j,s,o,o')$

2. Consumption-saving choice

$$W(j,a,s,o',h',\eta_{o'}) = \max_{c,a'} \left\{ u(c,l) + \beta\phi_{j+1} V(j+1,a',s,o',h') \right\}$$

s.t.

$$a' + c = (1+r)a + h'\eta_{o'} w_{o'} l + tr$$

3. Calibration

Calibration: 0. Preliminaries

- Use of CPS and PSID (only for η process)
- Calibration to approximate the economy in the early 1980s
- All parameters are fixed throughout the transition except for
    - Occupation-specific wage
    - Initial assignment of occupation and skill upon entry

Calibration: 0. Preliminaries

1. Demographics
2. Preferences
3. Human capital
   - 3.1 Human capital growth rate
   - 3.2 Initial human capital
   - 3.3 Separation shock/Occupational mobility cost
4. Productivity shock
5. Government

Calibration: 1. Demographics

- Initial age of 25 ($j = 1$) to max age of 90 ($J = 66$)
- Survival rates ϕ_j based on the U.S. life-table in 1990
- Interest rate at $r = 4\%$

Calibration: 2. Preferences

- Period utility function

$$u(c, l) = \frac{c^{1-\gamma}}{1-\gamma} - B_s \cdot l$$

  - $\gamma = 2.0$

- Participation cost B_s
  - Set to match the participation rate at age 65
  - Low: 40% and $B_L = 0.95$
  - High: 60% and $B_H = 0.58$

Calibration: 3-1. Human capital grwoth rate 1/2

- Data
  - CPS 1983-2018
  - Use hourly wage $\{w^i_{j,s,o,t,\tau}\}$ of an individual i aged j of type $\{s, o\}$ of birth cohort τ at t
- Estimate occupation specific path, $\{w_{o,t}\}$, and age-wage profiles, $g^h_{j,s,o}$
  1. Regress $\{w^i\}$ on age, occupation, skill, cross terms and dummies. Follow Aguiar and Hurst (2013) to attribute wage growth to age and cohort effects and remove cyclical components using year dummies (mean zero and orthogonal to a time trend).
  2. Extract $\{w_{o,t}\}$ and obtain average age-wage profiles for each occupation and skill, assumed to be time-invariant.
  3. From age-wage profiles, compute human capital growth $g^h_{j,s,o}$.

Calibration: 3-1. Human capital grwoth rate 2/2

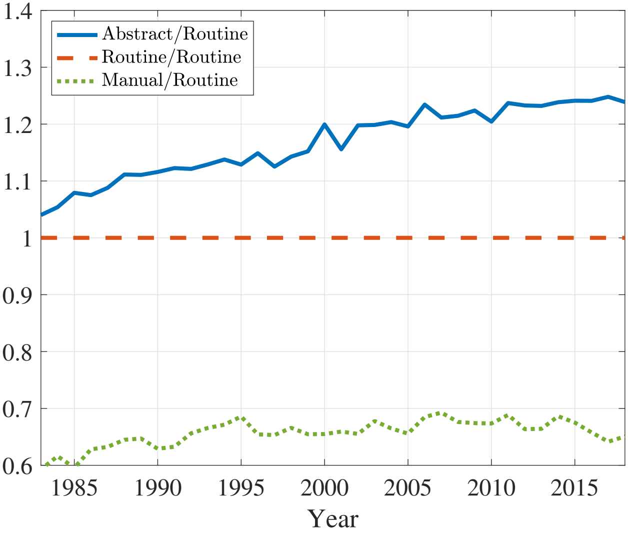
- Initial human capital is given as $h^s_{1,o}$ for each $\{s, o\}$: initial level of the age-wage profiles (age-25 points in previous figures)

- Human capital follows law of motion $h' = f^h(h, j, s, o, o')$

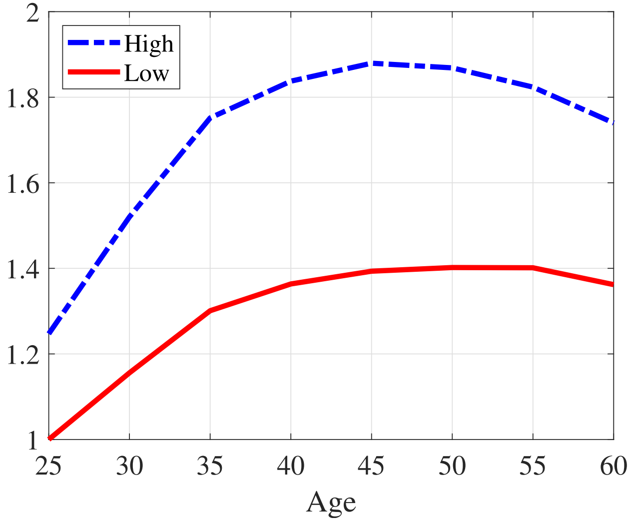
$$h' = (1 + g^h_{j,s,o})h \text{ if } o' = o$$
$$h' = h^s_{1,o'} \text{ if } o' \neq o$$

  - Compute $g^h_{j,s,o}$ from the age-wage profiles.
  - Assume that human capital is occupation specific and it needs to be re-accumulated when an agent switches occupations.

Occupation-specific wage (adjusted)

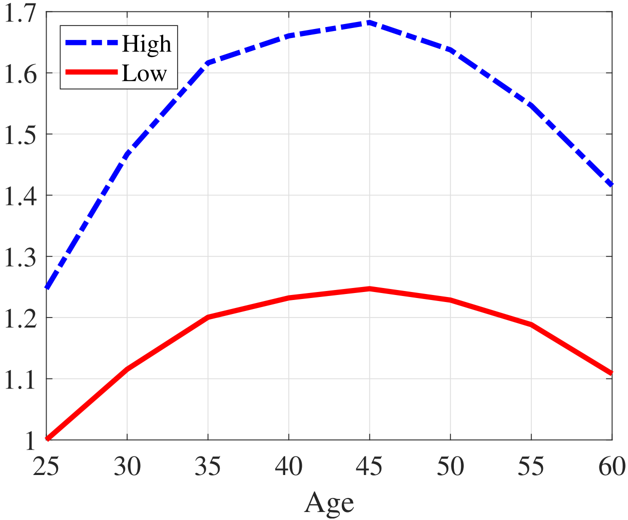


Life-time human capital accumulation: Abstract occupation



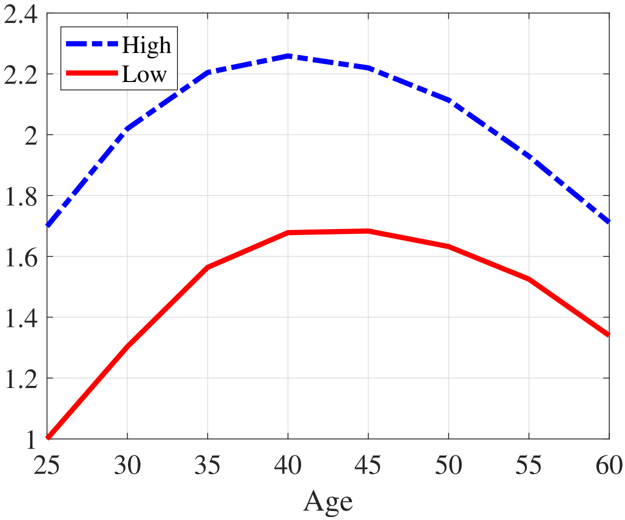
Human capital at the age 25 is normalized to 1.

Life-time human capital accumulation: Routine occupation



Human capital at the age 25 is normalized to 1.

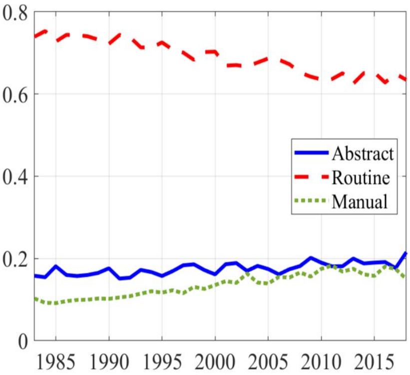
Life-time human capital accumulation: Manual occupation



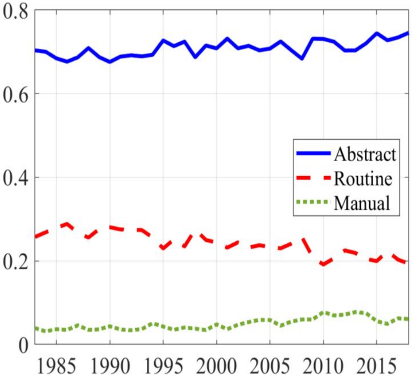
Human capital at the age 25 is normalized to 1.

Calibration: 3-2. Initial occupation

CPS: occupation distribution of workers aged 30/34 in 1983-2018



Low



High

Calibration: 3-3. Separation shock/Occupational mobility cost 1/2

- $\{A, R, M\}$ yearly transition (conditional on continuing to work) from CPS data aged 30/49 in 1983/85

$$
\begin{array}{cccc}
 & A & R & M \\
A & 0.967 & 0.029 & 0.005 \\
R & 0.008 & 0.986 & 0.006 \\
M & 0.009 & 0.047 & 0.944
\end{array}
$$

$$
\text{Low} \quad = \quad \begin{array}{c} A \\ R \\ M \end{array} \begin{bmatrix} 0.967 & 0.029 & 0.005 \\ 0.008 & 0.986 & 0.006 \\ 0.009 & 0.047 & 0.944 \end{bmatrix}
$$

$$
\text{High} \quad = \quad \begin{array}{c} A \\ R \\ M \end{array} \begin{bmatrix} 0.987 & 0.012 & 0.001 \\ 0.036 & 0.961 & 0.003 \\ 0.042 & 0.040 & 0.919 \end{bmatrix}
$$

Calibration: 3-3. Separation shock/Occupational mobility cost 2/2

- Separation rate λ_o^s
  - Set in the model to match total separation rate from each occupation (for each $s \in \{L, H\}$
- Mobility cost $c_{oo'}^s$
  - Assume no mobility from M to A and $c_{MA}^s = \infty$
  - Other entries are zero except for $R \to A$ and $M \to R$
  - Set c_{RA}^s to match the average share of A for $s = \{L, H\}$
  - Set c_{MR}^s to match the mobility from M to R for $s = \{L, H\}$

Calibration: 4. Productivity shock

- Idiosyncratic shock η
  - Assume an iid from $N(0, \sigma_\eta^2)$ in log
- Data: PSID 1983-1997 (annual)
  - Compute hourly wage of 30/59, employed in the three occupations consistent with CPS
  - Compute residuals by removing age and occupation specific component as estimated from the CPS
  - Variance of the errors in the wage growth: 0.18, discretize with 3 grids
  - Assume a draw from the same distribution for $o' \neq o$

Calibration: 5. Government

- Consumption floor: 10% of average earnings
- Pension: set to 38% of average earnings, based on the average replacement rate
- Assume taxation outside of the model

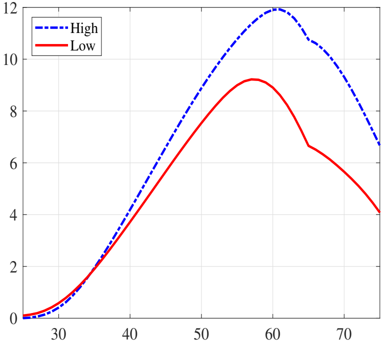
4. Numerical Results

Numerical Results

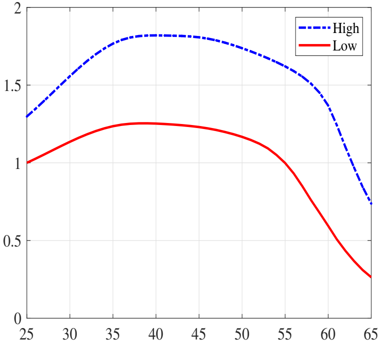
1. Initial Economy: 1983/85
2. Transition with polarization from 1980s
3. Welfare effects

4. Numerical Results: Initial Economy

Initial economy: Asset and Earnings



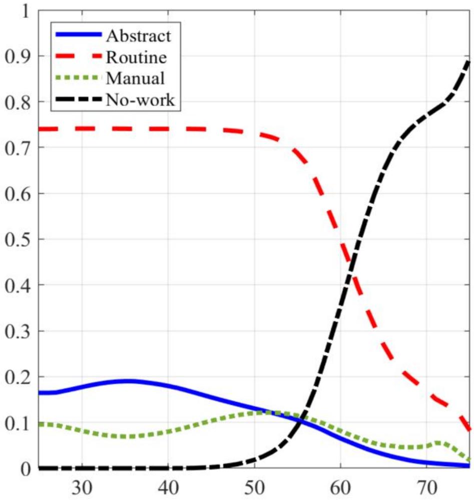
Asset



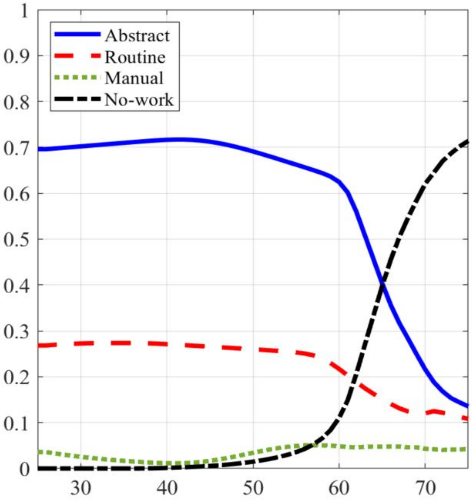
Earnings

(Normalized by earnings of low-type at age 25)

Initial economy: Occupation by age and skill, Model

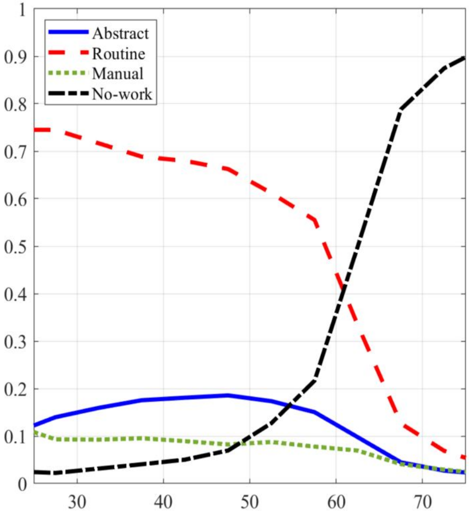


Low

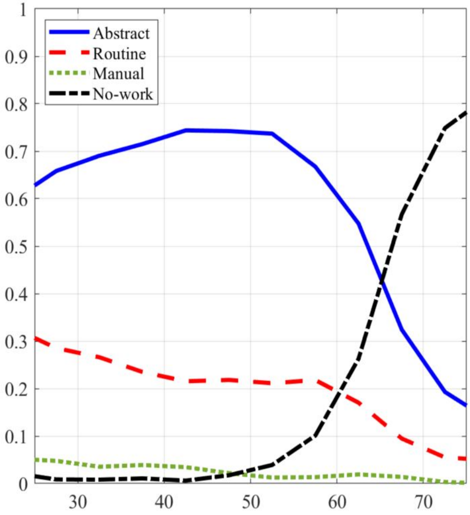


High

Initial economy: Occupation by age and skill, Data



Low



High

4. Numerical Results: Transition

Transition: Preliminaries

- Start from the initial economy (year 1983)
- From CPS data, feed changes in
  1. occupation-specific wages
  2. initial assignment of the occupation
- Compute the transition backward from a final economy in a distant future to the initial economy
- Keep all the other parameter values fixed throughout the transition

Transition: Summary of changes from 1980s to 2015/18

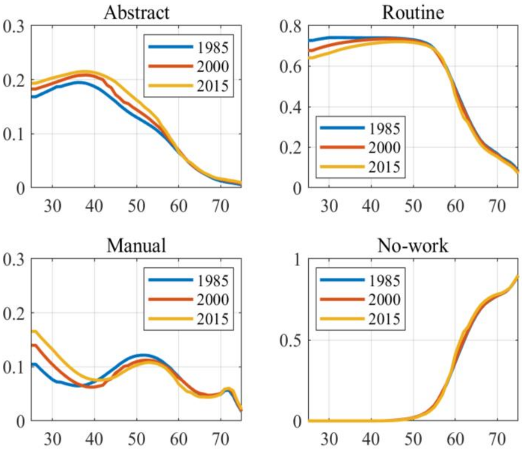
- Occupation-specific wage (Routine wage in (1) normalized to 1)

	Abstract	Routine	Manual
(1) Initial	1.06	1.00	0.60
(2) Final	1.15	0.92	0.61

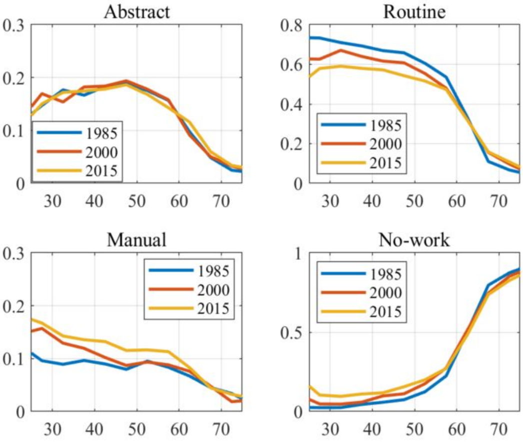
- Initial assignment of occupation

	Abstract	Routine	Manual	Total
Low				
(1) Initial	0.16	0.74	0.10	1.00
(2) Final	0.19	0.64	0.17	1.00
High				
(1) Initial	0.70	0.27	0.04	1.00
(2) Final	0.74	0.20	0.06	1.00

Transition: changes in occupation, Low type

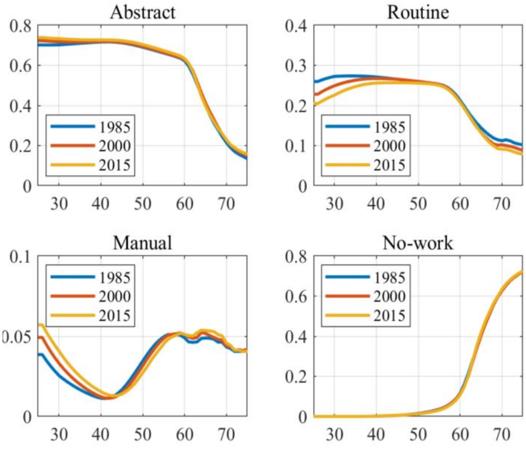


Model

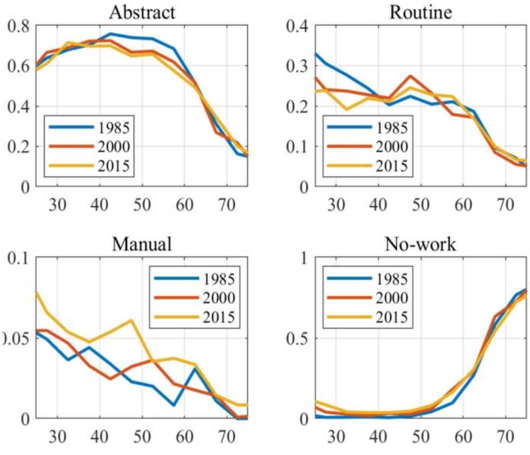


CPS data

Transition: changes in occupation, High type

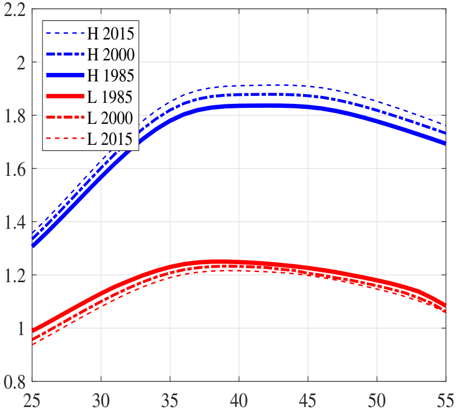


Model

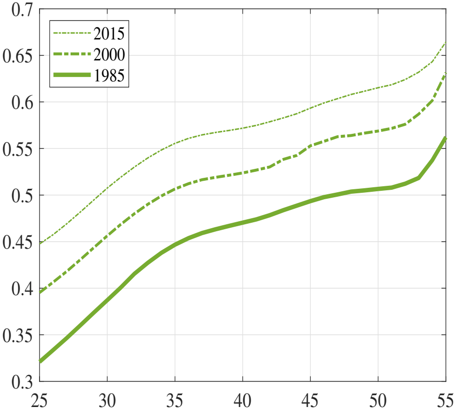


CPS data

Earnings by skill



Earnings by skill



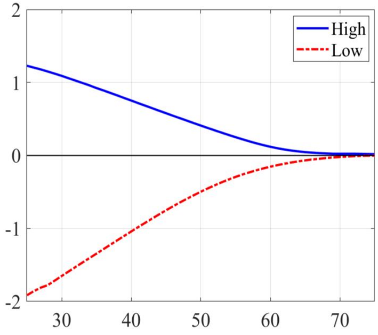
Skill premium (H/L ratio)

4. Numerical Results: Welfare Effects

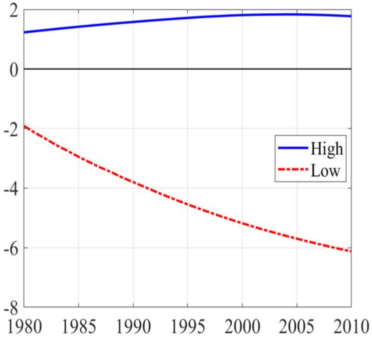
Welfare effects

- Evaluate welfare effects in terms of consumption equivalent variation (*CEV*)
  - Compute a percentage change in consumption in the baseline (economy with no polarization) to make an agent indifferent between baseline and polarization (holding utilities from participation and mobility fixed in each scenario)
- Compute *CEV* for agents of different ages in the initial economy (1980), as well as generations that are enter in 1980 and later

Welfare effects of polarization



By age in 1980

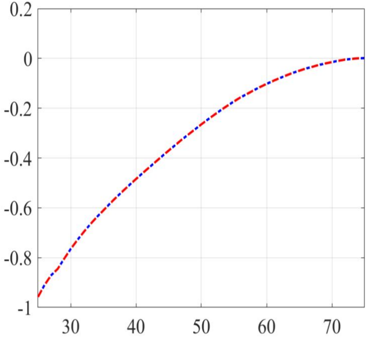


By entry year (at age-25)

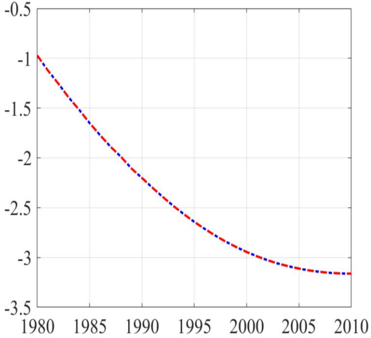
Welfare effects in *CEV* (%)

Welfare effects of polarization

- By generation (weighted average of consumption equivalence for low and high)



By age in 1980



By entry year (at age-25)

Welfare effects in *CEV* (%)

Welfare effects of polarization

- By skill, polarization benefits the high type (across ages in 1980 and all later years to enter) and hurts the low type
- By age, it hurts the young and later generations by more than the old
  - NOT because the old are more skilled than the young, but because the low-type among the young would have to endure a declining wage for a longer duration
- Conditionally on being high-type (low-type), the gain (loss) is larger for younger and more future generations

Conclusion

Conclusion

- Show in data that polarization experiences differ across age/cohorts
- Construct a quantitative full-blown OLG model of consumption/saving, labor supply and retirement, occupational choice
- Account for the occupational patterns in 1980s and the transition
- Quantify welfare effects
    - By skill, benefit high-types and hurt low-types
    - By generation, benefits old and hurt young
    - Conditionally on being high-type (low-type), the gain (loss) is larger for younger and more future generations $\rightarrow$ Expanding inequality within generations

Thank you!