

# Disappearing Stepping Stones: Technological Change and Career Paths

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## Motivation: Career Paths to NRC & Stepping Stones

- Workers may not be able to join **high-skill, non-routine cognitive (NRC)** occ. when young
  - lack of experience/human capital
- Career paths to NRC occ. may go through **middle-skill routine (R)** occ.
- Young workers may use R as **stepping stones** to NRC **app**
  - accumulate cognitive-abstract experience early in life (Adda & Dustmann, 2023)

- New technologies *hollow out* employment opportunities in R occ. (Autor, 2010)
- Employment opportunities in R  $\downarrow \Rightarrow$  chances of progressing to NRC  $\downarrow$
- Workers stuck in **low-skill, non-routine manual (NRM)** occ. or **NE** — **bottleneck effect**

**Is there a bottleneck and what it implies for NRC employment and wages/prod.?**

- Career Paths to NRC in the Data
- Quantitative Model Specification and Estimation
- Counterfactuals: Stepping Stones and Bottleneck

# What We Do: Empirical Analysis

- Use PSID data to...
  - > ... study the the career paths leading to NRC occupations
  - > ... establish the plausibility of bottleneck effect

# Key Empirical Findings

1. 21% of older NRC workers pass through **routine cognitive (RC)** occ. at younger age  
→
  2. Probability of NRC employment later in life is ↓ for younger cohorts
    - 26% for > 1975 entry cohorts vs 20% for 2000 – 2004 entry cohorts →
  3. Emp. in RC occ. early in life is positively correlated with NRC emp. after the age of 50  
→
- **Findings (1)-(3) + technological change suggest possible bottleneck effect:**

*Workers have lower chances to follow RC-to-NRC paths & get stuck in lower skilled occ. or NE*

- Develop a structural model
  1. Workers make occ. choices over lifetime, s.t. employment opportunities
  2. Productivity of HC is different across occ.
  3. Rate of HC accumulation/depreciation is different across occ.

→ Endogenously generate realistic career paths with stepping stones
- Estimate model using PSID and job ads data from Atalay et al. (2020)
- Quantify the bottleneck effect
- **Key (tentative) result:**

> 1.37 million NRC workers of older age lost between 1970 and 2000 due to bottleneck

- **Labor Reallocation:** Autor and Dorn (2009), Cortes, Jaimovich, and Siu (2017), Jaimovich et al. (2020), Guner, Ruggieri, and Tybout (2021), **Bocquet (2025)**
  - **This paper:** brings in career path/progression story
- **Initial Economic Conditions:** Oyer (2006), Kahn (2010), von Wachter (2012), Altonji et al. (2016), Elsby et al.(2016), Schwandt and von Wachter (2019), **Garcia-Penalosa, Petit, and van Ypersele (2022)**, Erosa, Galvez-Iniesta, and Kredler (2025)
  - **This paper:** discusses importance of initial conditions in RBTC context
- **Occupational Choice:** Gibbons et al. (2005), Kambourov and Manovskii (2009), Costinot and Vogel (2010), **Jung and Mercenier (2014)**, **Cortes (2016)**
  - **This paper:**
    - > Develops quantitative model of occupational choice under RBTC and ...
    - > Disciplines it by individual-level and **job ads** data

- Career Paths to NRC in the Data
- **Quantitative Model Specification and Estimation**
- Counterfactuals: Stepping Stones and Bottleneck

## Workers' Problem

- Risk-neutral workers live **3 periods**  $a \in \{1, 2, 3\}$  (young, mid-age, older)
- ...may work in **4 occupations**  $j \in \{NRC, RC, RM, NRM\}$  or not work ( $j = NE$ )
- In each period, choosing between available alternatives  $j_a$  to **maximize lifetime utility**:

$$\max_{\{j_a\}} E \sum_{a=s}^3 \beta^{a-1} w_{j_a}(h_a)$$

- **Timing for worker of age  $a$  :**
  1. Observes and chooses among available emp. opportunities  
↓
  2. Skill accumulation/depreciation  
↓
  3. Receives wage based on emp. situation and current skills  
↓
  4. Next period starts

# Employment Opportunities

- An offer from occ.  $j \in \{NRC, RC, RM, NRM\}$  arrives to a worker with prob.  $p_{j,t}$ .
- Arrivals of new offers from different occ. are independent
- 16 possible cases:

Case no.	# offers	Offers received	Case probability
$k = 1$	4 offers	$NRC, RC, RM,$ and $NRM$	$q_1 = p_{NRC,t} \cdot p_{RC,t} \cdot p_{RM,t} \cdot p_{NRM,t}$
$k = 2$	3 offers	$NRC, RC,$ and $NRM$	$q_2 = p_{NRC,t} \cdot p_{RC,t}$ $\cdot (1 - p_{RM,t}) \cdot p_{NRM,t}$
...	...	...	
$k = 6$	1 offer	$NRC$	$q_6 = p_{NRC,t} \cdot (1 - p_{RC,t})$ $\cdot (1 - p_{RM,t}) \cdot (1 - p_{NRM,t})$
...	...	...	
$k = 16$	no offers	-	$q_{16} = (1 - p_{NRC,t}) \cdot (1 - p_{RC,t})$ $\cdot (1 - p_{RM,t})(1 - p_{NRM,t})$

- A worker chooses out of several alternatives:
  - 1 To stay in the current labor status
  - 2 To switch into one of offered jobs
  - 3 To shift into non-employment

## Occupational Sorting

- Earnings  $w_{j,t}(h_a)$  are determined by

$$w_{j,t}(h_a) = \lambda_{j,t} \cdot \phi_j(h_a), \quad j \in \{NRC, RC, RM, NRM\},$$

where

- $\phi_j(h_a) = \exp(a_j h_a)$  is **occ. productivity of HC** ( $\neq$  rate of HC accumulation)  
Figure
  - > Interpretation:  $h_a$  is HC productive in cognitive tasks
- $\lambda_{j,t}$  is an **occ. wage rate**, independent of HC stock
  - > Interpretation: component of earnings beyond HC productive in cognitive tasks

- In principle, we would expect:

$$0 \leq \frac{\partial \ln \phi_{NRM}}{\partial h_a} < \frac{\partial \ln \phi_{RM}}{\partial h_a} < \frac{\partial \ln \phi_{RC}}{\partial h_a} < \frac{\partial \ln \phi_{NRC}}{\partial h_a} \quad \forall h_a.$$

- Occ. sorting is **also driven by job offer arrival** rates and **by HC acc.** across occ.

# Human Capital and Stepping Stones

- HC of young workers  $h_0$  is drawn from distribution  $\mathcal{H}(\cdot)$ ;
- Rate of **HC accumulation/depreciation** is **different across occ.:**

$$h_a = b_j \cdot h_{a-1}, \text{ where } b_j \geq 0 \text{ and } j \in \{NRC, RC, RM, NRM, NE\}$$

- $b_j > 1 \rightarrow$  HC accumulation;  $b_j < 1 \rightarrow$  HC depreciation
- **Stepping stone occupations:**
  - Lower  $h_0$  workers may choose occ. with lower  $\lambda_{j,t}$  but higher  $b_j$  ...
  - ... to accumulate HC and join occ. with higher  $\phi_j(h_a)$  later on
  - Our candidate for stepping stone occupation: RC

# Routine-Biased Technological Change

- Intuition by Autor (2010): RBTC “hollows out” employment opportunities in R occ.
- **In the model:** arrival rate  $p_{RC,t} \downarrow$  (along with  $p_{RM,t} \downarrow$ )
  - Movements in  $p_{j,t}$  disciplined by job ads data
  - > Current work: making  $p_{j,t}$  state-dependent
- Offers from RC occ. are less likely to appear in workers' choice sets
- Young workers have lower opportunities to build up HC in RC.

## Parameters

- Set changes in  $\{p_{NRC}, p_{RC}, p_{RM}, p_{NRM}\}$  based on job ads data Est. Changes
- $\beta = 0.54$  (yearly discount rate 0.96)
- The rest of parameters:
  1. **HC returns:**  $\{a_{NRC}, a_{RC}, a_{RM}, a_{NRM}\}$
  2. **Occ wage rates and U benefit:**  $\{\lambda_{NRC}, \lambda_{RC}, \lambda_{RM}, \lambda_{NRM}\}_t$ , time-varying and  $\{w_U\}$
  3. **Occ wage rate before 1970:**  $\{\lambda_{NRC}, \lambda_{RC}, \lambda_{RM}, \lambda_{NRM}\}_{pre}$
  4. **Occ wage rate after 2000:**  $\{\lambda_{NRC}, \lambda_{RC}, \lambda_{RM}, \lambda_{NRM}\}_{post}$
  5. **HC accumulation and depreciation:**  $\{b_{NRC}, b_{RC}, b_{RM}, b_{NRM}, b_U\}$
  6. **Init. HC distrib.:**  $\{\mu_{h_0}, \sigma_{h_0}^2\} \sim N$
  7. **Arrival rates in 1944:**  $\{p_{NRC}, p_{RC}, p_{RM}, p_{NRM}\}_{1944}$
  8. **Separation rate:**  $\{p_U\}_t$ , time-varying
  9. **Utility scaling factor in RM:**  $\{\kappa\}$

*107 parameters*

- Chosen to match (jointly) a set of empirical targets

# Simulations

- For each set of parameters, simulate the model biannually from 1942 until 2028
  - Targeted period is from 1970-2000 (Current work: extending to 2021)
  - First cohort is old in 1970
  - Last cohort is young in 2000
- In any given year, 3 generations of workers
- In total, in each run of the model, simulate 43 cohorts of workers
- Each cohort consists of 10k simulated workers
  - Heterogeneous in initial skill endowment  $h_0$
  - Heterogeneous in job offer arrivals realizations
  - Naïve expectations (no job ads data after 2000)

# Targets

## 1 Allocations: occupational shares by age

$$\rightarrow \{p_{NRC}, p_{RC}, p_{RM}, p_{NRM}\}_{1944}, \{p_U\}_t, \{w_U\}, \{\mu_{h_0}, \sigma_{h_0}^2\}, \{\kappa\}, \{a_{NRC}, a_{RC}, a_{RM}, a_{NRM}\}$$

## 2 Wages: mean log-wages across age and occupations

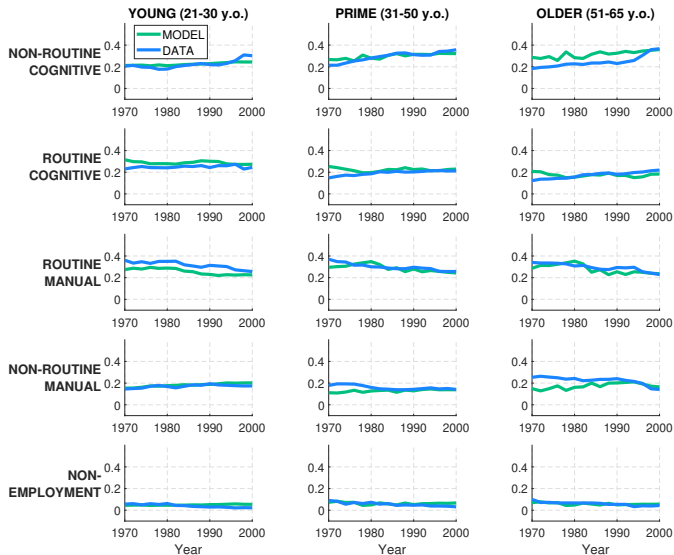
$$\rightarrow \{\lambda_{NRC}, \lambda_{RC}, \lambda_{RM}, \lambda_{NRM}\}_t, \{b_{NRC}\}, \{\mu_{h_0}, \sigma_{h_0}^2\}, \{a_{NRC}, a_{RC}, a_{RM}, a_{NRM}\}$$

## 3 Transitions: average prob. of switches between occupations and non-employment

$$\rightarrow \{b_{RC}, b_{RM}, b_{NRM}, b_U\}$$

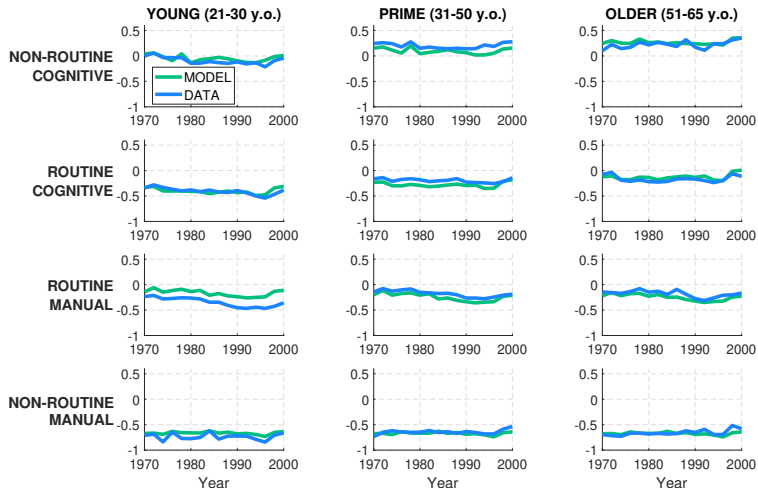
482 targets Param. Val.

## Model Fit: Allocations



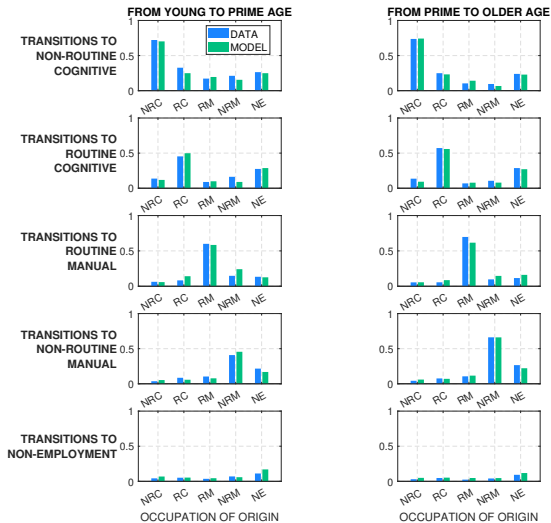
- Model overestimates the share of NRC workers among older workers  
→ Quantified bottleneck will be a lower bound

## Model Fit: Log-Wages



- As workers get older,  $\uparrow$  wage profiles in NRC and RC
  - $\rightarrow$  Informs  $b_{NRC}$  and  $b_{RC}$

## Model Fit: Transitions

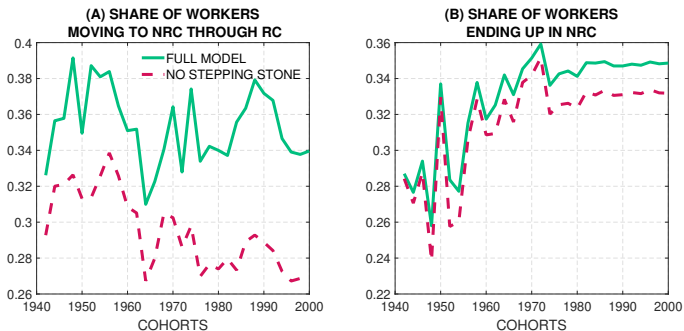


- In the model,  $Pr(j_a = NRC | j_{a-1} = RC) = 25\%$ 
  - vs.  $Pr(j_a = NRC | j_{a-1} = RM) = 20\%$  and  $Pr(j_a = NRC | j_{a-1} = NRM) = 15\%$

- Career Paths to NRC in the Data
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# Contribution of Stepping Stone Career Paths

- Switch-off the stepping stone mechanism: set  $b_{RC} = b_{RM}$
- No incentive to choose  $RC$  occupations for HC accumulation

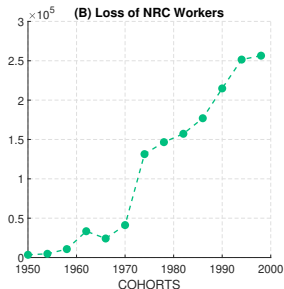
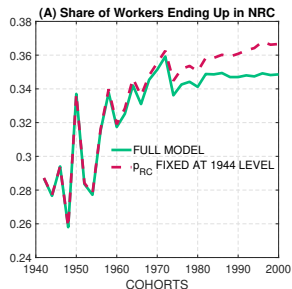


- **Pan. A:** On average, 6% of workers observed in NRC follow stepping stone career path
- **Pan. B:** Only for 1980 cohort, 1.8% of young labor force ( $\approx 288k$  workers)

Alt.:  $b_j = b_{RC} \forall j$

## Bottleneck Effect

- Switch-off the “hollowing out” of employment opportunities in RC: fix  $p_{RC} = p_{RC,1944}$
- No decline in RC opportunities  $\Rightarrow$  workers can follow stepping stone path as before



- **Pan. A:** After 1980 stagnation in the share of workers ending up in NRC in full model
  - vs. growth in  $p_{RC} = p_{RC,1944}$
  - $\Rightarrow$  progressing bottleneck effect
- **Pan. B:**  $> 1.37$  million NRC workers lost between 1970 and 2000 due to bottleneck
  - If not for bottleneck, the number of workers ending up NRC would be  $\approx 12\% \uparrow$

$$p_j = p_{j,1944} \forall j$$

# Alternative Paths towards NRC

- Workers can avoid bottleneck and try reaching NRC through alternative paths
  - Largest increase in frequency of paths through RM and NRM occupations pic.
- More workers are moving to NRC through occ. associated with depreciation of HC
- Wage loss in NRC due to lower RC employment opportunities:

	All		5th quantile		25th quantile		50th quantile		95th quantile	
	1980	2000	1980	2000	1980	2000	1980	2000	1980	2000
Prime	0.6%	1.8%	2.1%	2.9%	0.9%	3.2%	0.5%	2.6%	0.2%	0.4%
Older	0.5%	2.5%	1.1%	3.1%	0.6%	4.7%	1.4%	5.0%	0.6%	1%

- By 2000, average wages in NRC 1.8% ↓ for prime age and 2.5% ↓ for older workers
- Most pronounced in the middle of NRC wage distribution: up to 5% for older workers
  - The middle is the most reliant on stepping stones

# Takeaways

1. A substantial number of workers use RC occupations as stepping stones
2. Lower employment opportunities in RC lead to bottleneck effect and lower NRC emp.
3. Workers can avoid bottleneck, arriving to NRC occupations through RM and NRM
4. However, 3. results in wage losses
  - Losing HC on the way towards NRC
  - Most pronounced in the middle of NRC wage distribution
  - Middle is the most reliant on stepping stones

# Appendix

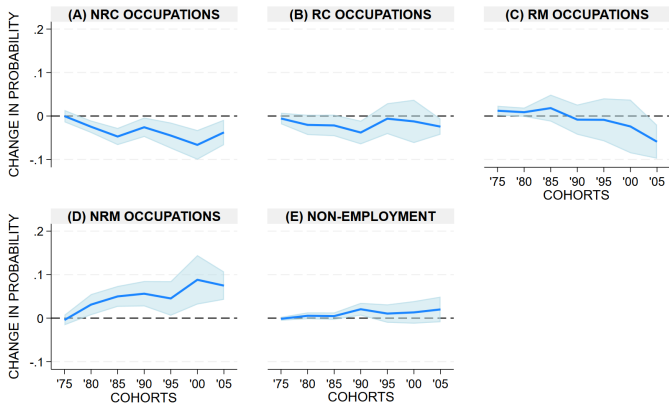
- On individual level, we use PSID sample:
  - Divide sample into young (21 – 30), middle (31 – 50), and old (> 50)
  - Assign occupations as the mode of all observed occupations in the given age

Occ. Path:	Share	N
<i>NRC</i> → <i>NRC</i> → <i>NRC</i>	50.11%	643
<i>RC</i> → <i>NRC</i> → <i>NRC</i>	10.98%	141
<i>RC</i> → <i>RC</i> → <i>NRC</i>	10.28%	132
<i>RM</i> → <i>NRC</i> → <i>NRC</i>	5.61%	72
<i>RM</i> → <i>RM</i> → <i>NRC</i>	5.22%	67

[Full Table](#)
[Mid+Old](#)

## Occupational Paths Across Cohorts

How does the probability of being employed in NRC later in life change across cohorts?  
*(Probability for cohorts entering before 1975  $\approx 0.26$ )*



Note: Logit estimator is used, AMEs across cohorts  $c$  with 95% c.i. are shown

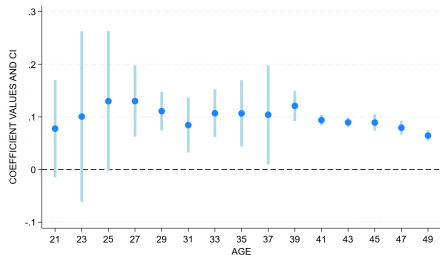
[Reg. Spec.](#)

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# Detailed Employment Histories

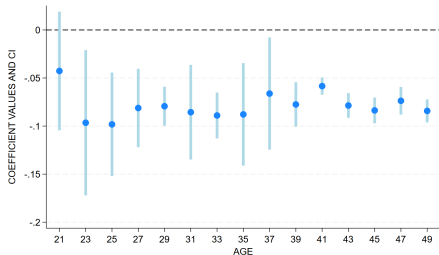
- Correlations between probability of being in NRC when old ...

... and being in RC when younger:



Reg. Spec.

... and being in RM when younger:



Reg. Spec.

- RC occ.: relatively more skilled, relevant experience for NRC
- RM occ.: rely heavily on use of physical skills
- ⇒ RC occ. are the main candidate for stepping stone occupations

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## Job Ads Data and Employment Opportunities

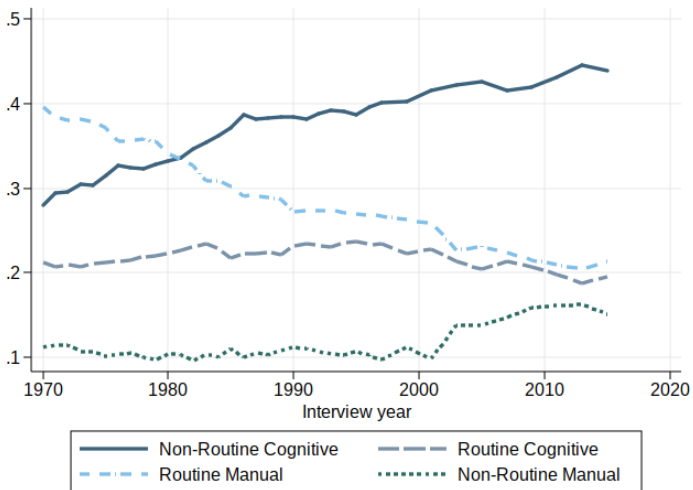
Are  $\uparrow$  opportunities in R associated with  $\uparrow$  chances of being in NRC when older?

Dep.: prob. of being in NRC when old	(1)	(2)	(3)	(4)	(5)
Share of RC job ads in the entry year	-0.176 (0.637)	0.107 (0.252)	0.243 (0.277)	0.565** (0.177)	0.545*** (0.124)
Share of NRC job ads in the entry year	0.142 (0.651)	-0.035 (0.474)	0.254 (0.408)	0.620** (0.244)	0.736*** (0.127)
Constant	0.309 (0.528)	-584.664 (316.183)	-348.584 (242.470)	399.246* (198.686)	547.742** (154.957)
Time Trend		✓	✓	✓	✓
Individual Controls			✓	✓	✓
Aggregate Controls				✓	✓
Old Age Year FE					✓
Observations	7,842	7,842	7,842	7,842	7,842

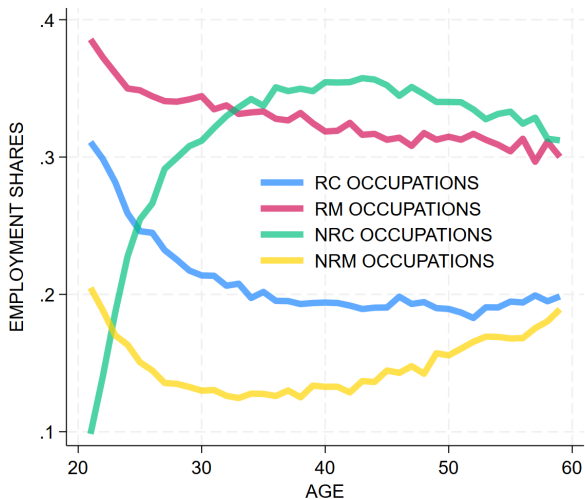
Note: Standard errors in parentheses \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . Standard errors in all specifications are clustered at the cohort level

Reg. Spec.

## Occupational Employment Shares



## Occupational Shares by Age

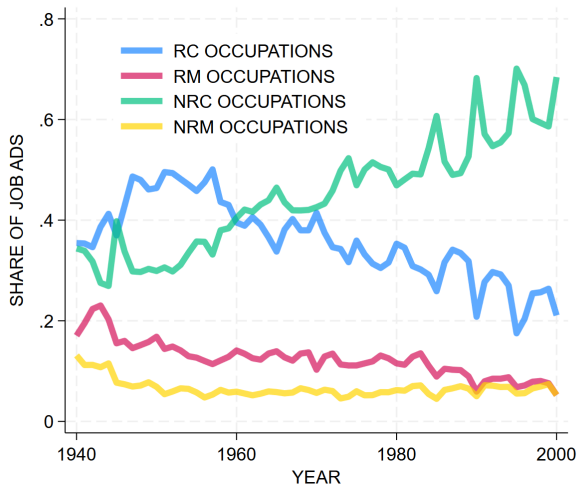


## Major Occupational Groups

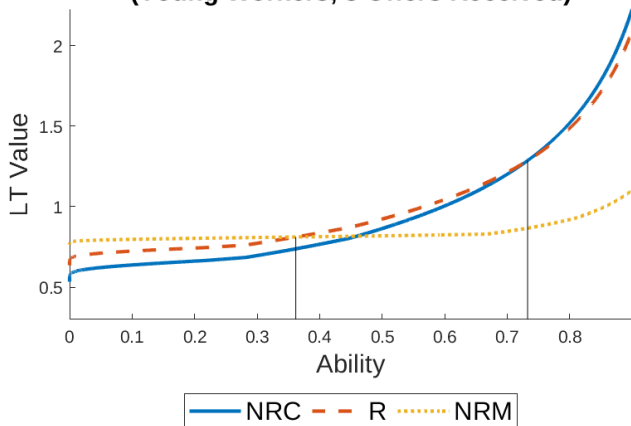
Broad category	Occupation included	2000SOC
Non-routine cognitive (NRC)	Professional and technical workers	100-354
	Managers, business, and financial occupations	001-095
	Managers of retail and non-retail sales workers	470-471
Routine Cognitive (RC)	Sales workers, except managers	472-496
	Office and administrative support	500-593
Routine Manual (RM)	Construction and extraction	620-694
	Installation, maintenance, and repair	700-762
	Production occupations	770-896
	Transportation and material moving	900-975
Non-routine manual (NRM)	Service workers	360-465

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## Shares of Job Ads by Broad Occ. Groups, based on Atalay et al. (2020)



## Occupational Choice, Example

**Occ. Sorting, Based on Lifetime Values  
(Young Workers, 3 Offers Received)**

## Model Solution I, Older Workers

- Value functions for each case  $k$ :

Case no.	Offers	Value function $V_{3,k}(h)$
$k = 1$	$NRC, RC, RM,$ and $NRM$	$V_{3,1}(h) = \max_{j \in \{C, NRC, RC, RM, NRM, NE\}} \{w_j(h)\}$
$k = 2$	$NRC, RC$ and $NRM$	$V_{3,2}(h) = \max_{j \in \{C, NRC, RC, NRM, NE\}} \{w_j(h)\}$
...	...	...
$k = 6$	$NRC$	$V_{3,6}(h) = \max_{j \in \{C, NRC, NE\}} \{w_j(h)\}$
...	...	...
$k = 16$	-	$V_{3,16}(h) = \max_{j \in \{C, NE\}} \{w_j(h)\}$

- Expected value, age  $a = 3$ :

$$EV_3(h) = \sum_{k=1}^{16} V_{3,k}(h)q_k$$

## Model Solution II, Younger Workers

- Value functions for each case  $k$ :

Case no.	Offers	Value function $V_{a,k}(h)$
$k = 1$	$NRC, RC, RM, \text{ and } NRM$	$V_{a,1}(h) = \max_{j \in \{C, NRC, RC, RM, NRM, NE\}} \{w_j(h) + EV_{a+1}(h'   j)\}$
$k = 2$	$NRC, RC, \text{ and } NRM$	$V_{a,2}(h) = \max_{j \in \{C, NRC, RC, NRM, NE\}} \{w_j(h) + EV_{a+1}(h'   j)\}$
...	...	...
$k = 6$	$NRC$	$V_{a,6}(h) = \max_{j \in \{C, NRC, NE\}} \{w_j(h) + EV_{a+1}(h'   j)\}$
...	...	...
$k = 16$	-	$V_{a,16}(h) = \max_{j \in \{C, NE\}} \{w_j(h) + EV_{a+1}(h'   j)\}$

- Expected value, age  $a < 3$ :

$$EV_a(h) = \sum_{k=1}^{16} V_{a,k}(h)q_k$$

## Occ. Paths in PSID: Young→Mid→Old

<b>Occ. Path:</b>	<b>Share</b>	<b>N</b>
<i>NRC</i> → <i>NRC</i> → <i>NRC</i>	50.11%	643
<i>RC</i> → <i>NRC</i> → <i>NRC</i>	10.98%	141
<i>RC</i> → <i>RC</i> → <i>NRC</i>	10.28%	132
<i>RM</i> → <i>NRC</i> → <i>NRC</i>	5.61%	72
<i>RM</i> → <i>RM</i> → <i>NRC</i>	5.22%	67
<i>NRM</i> → <i>NRC</i> → <i>NRC</i>	4.20%	54
<i>NE</i> → <i>NRC</i> → <i>NRC</i>	2.49%	32
<i>NRM</i> → <i>NRM</i> → <i>NRC</i>	2.18%	28
Other transitions	8.88%	129
<b>Total</b>	<b>100%</b>	<b>1283</b>

## Occ. Paths in PSID: Young→Mid+Old

<b>Occ. Path</b>	<b>Share</b>	<b>N</b>
<i>NRC</i> → <i>NRC</i>	65.35%	2848
<i>RC</i> → <i>NRC</i>	18.12%	790
<i>RM</i> → <i>NRC</i>	8.32%	363
<i>NRM</i> → <i>NRC</i>	6.49%	283
<i>NE</i> → <i>NRC</i>	1.69%	74
<b>Total</b>	<b>100%</b>	<b>4358</b>

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## Probability of Employment in NRC Later in Life

$$l_{itc}^* = \eta_0 + \omega \cdot \mathbf{cohort}_c + \theta \cdot \mathbf{ind\_ctrl}_i + \psi \cdot \mathbf{agg\_ctrl}_t + \epsilon_{itc},$$

so that

$$l_{itc}^* > 0, \quad \text{if } l_{itc}(\text{occ}_{>30} = E) = 1,$$

$$l_{itc}^* \leq 0, \quad \text{if } l_{itc}(\text{occ}_{>30} = E) = 0.$$

- Indexing:  $i$  — individuals,  $t$  — years,  $c$  — cohorts
- $E \in \{\text{NRC, RC, RM, NRM, NE}\}$
- $\mathbf{cohort}_c$ : set of 5-year cohort dummies
- $\mathbf{ind\_ctrl}_i$ : gender, college, race
- $\mathbf{agg\_ctrl}_t$ : GDP, shares of ICT and non-ICT capital, unemployment rate in the labor market entry year  $t$
- **Base cohort**: workers entering before 1975

## Probability of Getting to R and NRC

$$\begin{aligned}
 I_{it}(occ_{old} = NRC) = & \eta_0 + \eta_1 \cdot RC\_adshare_t + \eta_2 \cdot RM\_adshare_t + \\
 & + \omega_1 \cdot t + \omega_2 \cdot t^2 + \omega_3 \cdot year\_old_i + \\
 & + \theta \cdot ind\_contrl_i + \psi \cdot agg\_contrl_t + \epsilon_{it}
 \end{aligned}$$

- ***RC\_share<sub>t</sub>*** and ***NRC\_share<sub>t</sub>*** are the shares of RC and NRC job ads in the year *t* when *i* entered the labor market

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## Detailed Employment Histories: RC Regressions

- Each coefficient is obtained from a separate regression of the form:

$$I_{ic}(occ_{old} = NRC) = \psi_0 + \psi_1 I_{i}(occ_{age} = RC) + \psi_2 cohort_c + \psi_3 year_i + \zeta ind\_contrl_i + \epsilon_{ic}$$

- The base category are the workers in either RM or NRM occupations or in NE
- **year<sub>i</sub>** is for vector of dummies for a year of observation of an ind. *i* at a particular age

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## Detailed Employment Histories: RM Regressions

- Each coefficient is obtained from a separate regression of the form:

$$I_{ic}(occ_{old} = NRC) = \psi_0 + \psi_1 I_i(occ_{age} = RM) + \psi_2 cohort_c + \psi_3 year_i + \zeta ind\_ctrl_i + \epsilon_{ic}$$

- The base category are the workers in either RC or NRM occupations or in NE
- **year<sub>i</sub>** is for vector of dummies for a year of observation of an ind. *i* at a particular age

back

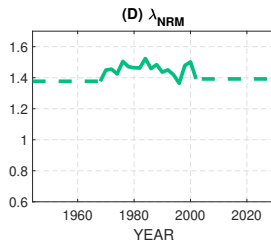
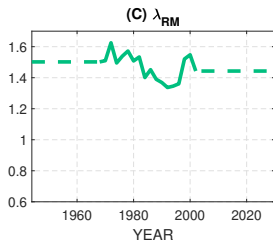
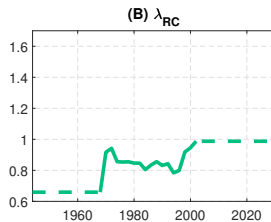
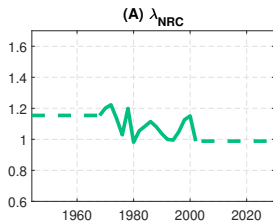
## Parameter Values of The Calibrated Model

Parameter Description	Parameter Notation	Value	Comments
Discount factor	$\beta$	0.54	0.96 yearly discount rate
Human capital returns	$\{a_{NRC}, a_{RC}, a_{RM}, a_{NRM}\}$	$\{1.07, 1.2, 0.65, 0.04\}$	
Occupational wage rate in NRC	$\{\lambda_{NRC,t}\}_{t=1970\dots 2000}$	[0.98, 1.22]	Figure 21 (A)
Occupational wage rate in NRC before 1970	$\lambda_{NRC,pre}$	1.15	
Occupational wage rate in NRC after 2000	$\lambda_{NRC,post}$	0.99	
Occupational wage rate in RC	$\{\lambda_{RC,t}\}_{t=1970\dots 2000}$	[0.78, 0.95]	Figure 21 (B)
Occupational wage rate in RC before 1970	$\lambda_{RC,pre}$	0.66	
Occupational wage rate in RC after 2000	$\lambda_{RC,post}$	0.99	
Occupational wage rate in RM	$\{\lambda_{RM,t}\}_{t=1970\dots 2000}$	[1.34, 1.62]	Figure 21 (C)
Occupational wage rate in RM before 1970	$\lambda_{RM,pre}$	1.50	
Occupational wage rate in RM after 2000	$\lambda_{RM,post}$	1.44	

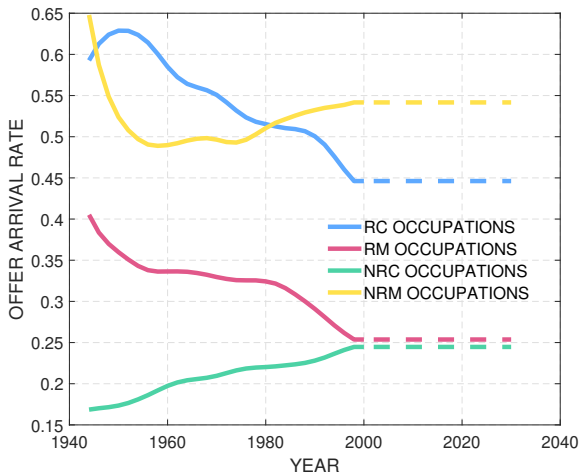
## Parameter Values of The Calibrated Model (Cont.)

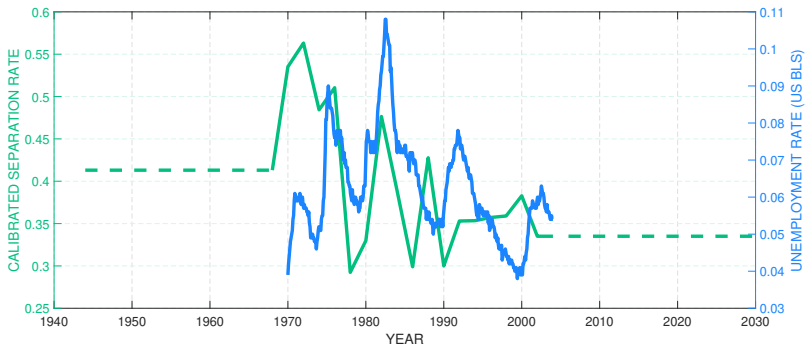
Parameter Description	Parameter Notation	Value	Comments
Occupational wage rate in NRM	$\{\lambda_{NRM,t}\}_{t=1970\dots 2000}$	[1.36, 1.52]	Figure 21 (D)
Occupational wage rate in NRM before 1970	$\lambda_{NRM,pre}$	1.38	
Occupational wage rate in NRM after 2000	$\lambda_{NRM,post}$	1.39	
Human capital accumulation	$\{b_{NRC}, b_{RC}, b_{RM}, b_{NRM}, b_{NE}\}$	{1.34, 1.19, 0.80, 0.48, 1.1}	
Initial human capital distribution	$N(\mu_{h_0}, \sigma_{h_0}^2)$	$N(0.86, 0.32)$	
Arrival rates in 1944	$\{p_{NRC,1944}, p_{RC,1944}, p_{RM,1944}, p_{NRM,1944}\}$	{0.17, 0.59, 0.41, 0.65}	Figure 22
Separation Rate	$\{p_{U,t}\}_{t=1970\dots 2000}$	[0.29, 0.56]	Figure 23
Separation rate before 1970	$p_{U,pre}$	0.41	
Separation rate after 2000	$p_{U,post}$	0.34	
Unemployment Benefit	$w_U$	0.30	
Utility scaling factor for older RM workers	$\kappa$	0.84	

## Calibrated Wage Rates



## Job Offer Arrival Rates



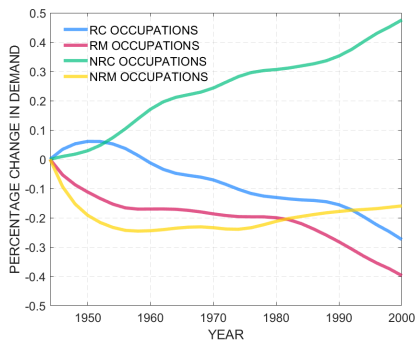
Separation Rate  $p_{U,t}$ [back](#)

# Changes in Demand for Jobs in 4 Occupational Categories

- Data set constructed by **Atalay et al. (2020)**:
  - Job ad data from three major US newspapers (BG, NYT, WSJ)
  - 7.8 mil observations between 1950 and 2000
  - Texts of job ads are mapped into 3-digit occupational codes

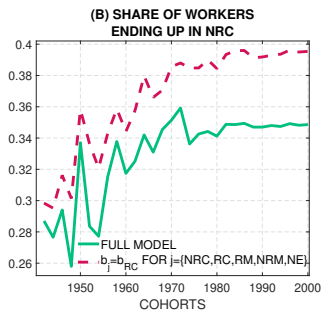
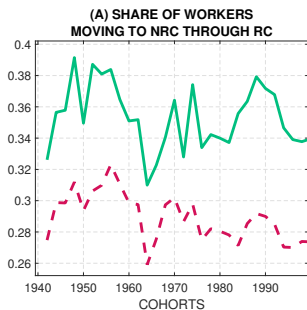
[Shares](#)
[back](#)

$$\frac{p_{j,t} - p_{j,t-1}}{p_{j,t-1}} = \Delta_{j,t} - \Delta_t$$



# Contribution of Stepping Stone Career Paths

- Set  $b_j = b_{RC} \forall j$
- All occupations can be used as stepping stones towards NRC

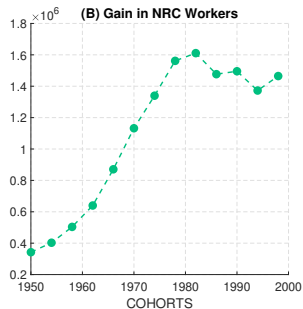
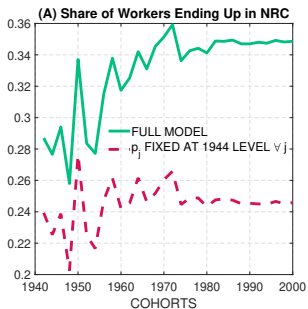


- Up to 4.7p.p. higher share of workers ending up in NRC occ.

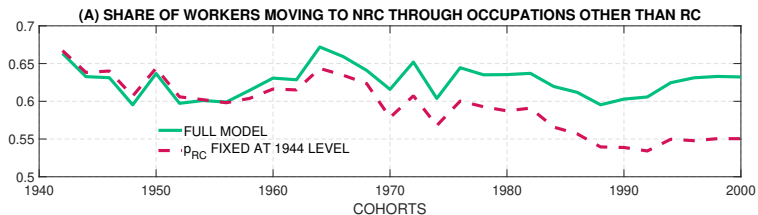
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## Bottleneck Effect

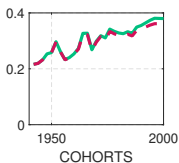
- Switch-off changes in all arrival rates: fix  $p_j = p_{j,1944}, \forall j$
- Changes in emp. opp. between '70 and '00  $\Rightarrow$  net gain of  $> 11.45$  mil. NRC workers



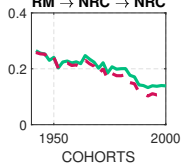
## Alternative Paths towards NRC



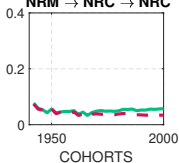
**(B) SHARE FOLLOWING  
NRC → NRC → NRC**



**(C) SHARE FOLLOWING  
RM → RM → NRC /  
RM → NRC → NRC**



**(D) SHARE FOLLOWING  
NRM → NRM → NRC /  
NRM → NRC → NRC**



**(E) SHARE FOLLOWING  
NE → NE → NRC /  
NE → NRC → NRC**

