Workers, Firms and Wage Dynamics

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Life-Cycle Wage Inequality

- Wage inequality increases over the life-cycle
  - Human capital returns and accumulation
  - Search and matching

- Information on wage dynamics identifies permanent and transitory components of inequality

- Wage mobility: highlight sources of inequality growth and policy implications

Life-Cycle Wage Inequality

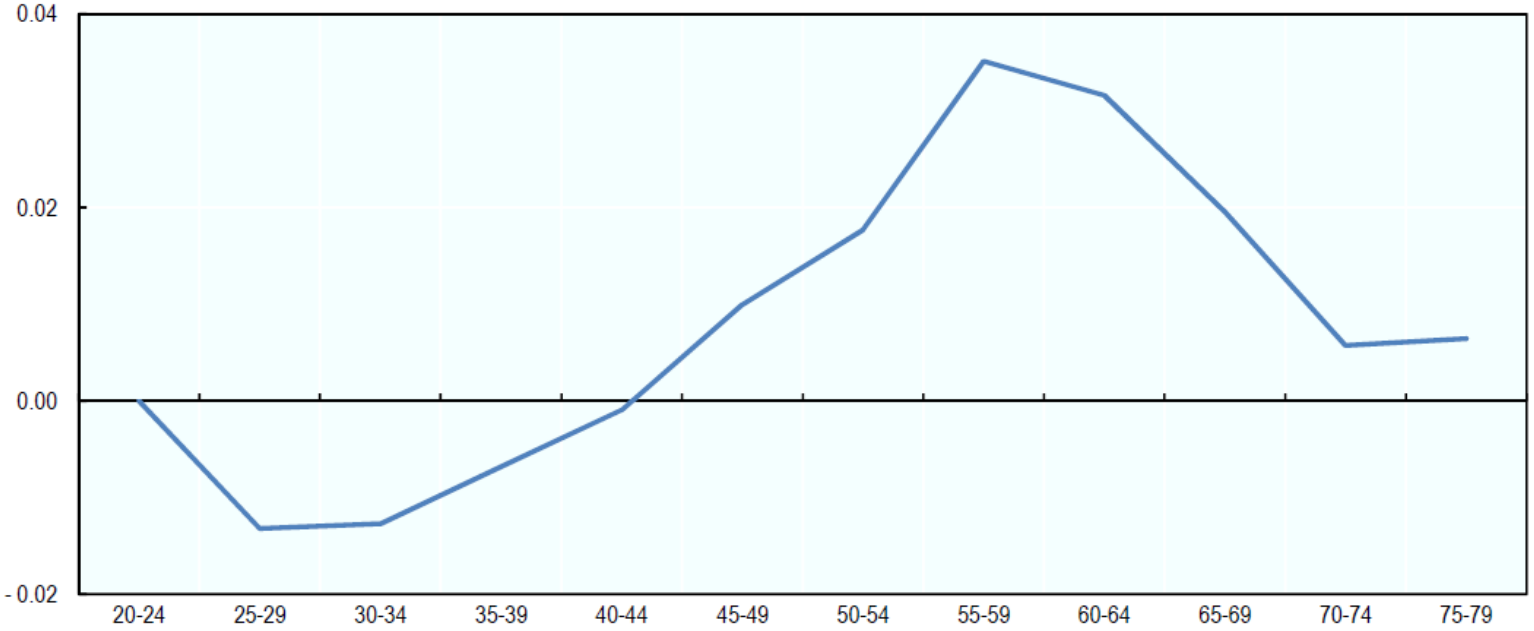
- Sources of income risk and insurance policies
  - Pre-market (starting wages: family background, schooling)
  - In-market (wage growth: reallocation of labor, training)

- Intergenerational concerns
  - Widening wage differences among prime age workers may result in unequal opportunities for their children

Figure 1.10. Income inequality reaches a peak at age 55-59 over the life course for the same generation

Estimated age pattern within cohorts of the Gini index of income, average across cohorts and countries

Reference age group = 20-24



Note: The age pattern is estimated using cohort and country fixed effects. On average across countries and cohorts, the Gini index falls between the 20-24 and the 25-29 age groups and then reaches a peak at age 55-59 at a level which is 3.5 points above that at age 20-24.

Source: OECD calculations from the Luxembourg Income Study data.

StatLink http://dx.doi.org/10.1787/888933566229

OECD (2017): *Preventing Ageing Unequally*

Life-Cycle Wage Inequality

A large literature

- In Labor:
  - Baker and Solon (2003); Cappellari (2004); Moffitt and Gottschalk (2012); Bingley, Cappellari and Westergård-Nielsen (2013); Blundell, Graber and Mogstad (2015); Sologon and Van Kerm (2017)

- In Macro/Consumption:
  - Meghir and Pistaferri (2004); Guevenen (2007); Huggett, Ventura and Yaron (2011); Bowlus and Robin (2012); Blundell (2014)

Life-Cycle Wage Inequality

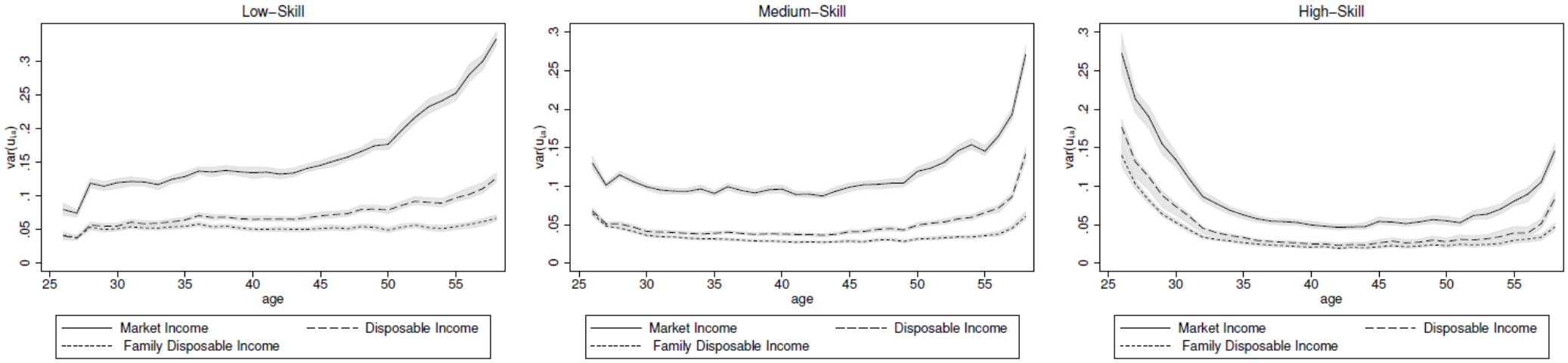
- Typical model

$$w_{it} = \alpha_t \lambda_{it} + \gamma_t \varepsilon_{it}$$

w_{it}: residualized log wages
λ_{it} «permanent wage» (e.g. unit root $\lambda_{it} = \lambda_{i(t-1)} + u_{it}$)
ε_{it} «transitory wage» (e.g. ARMA(1,1) $\varepsilon_{it} = \rho \varepsilon_{i(t-1)} + \theta v_{it}$)
α_t and γ_t time shifters

- Using data on cohorts over the same time window separates time and age
- Estimable from longitidinal samples of workers

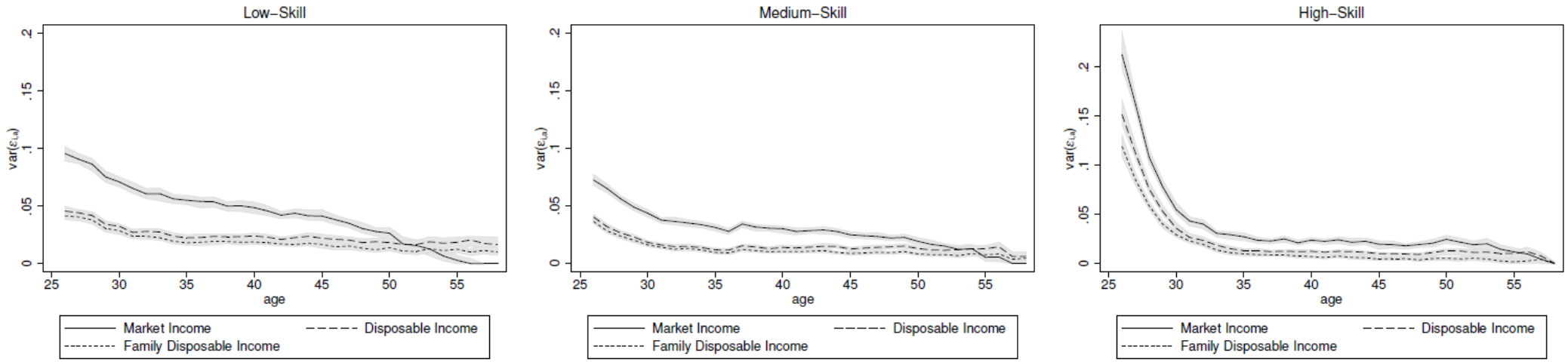
Life-Cycle Wage Inequality: Blundell et al. JPubE 2015



(a) Low-Skilled (b) Medium-Skilled (c) High-Skilled

Figure 3. Age profiles in the variances of permanent shocks to income

Life-Cycle Wage Inequality: Blundell et al. JPubE 2015



(a) Low-Skilled (b) Medium-Skilled (c) High-Skilled

Figure 4. Age profiles in the variances of transitory shocks to income

Life-Cycle Wage Inequality: Moffitt and Gotttschalk JHR 2012

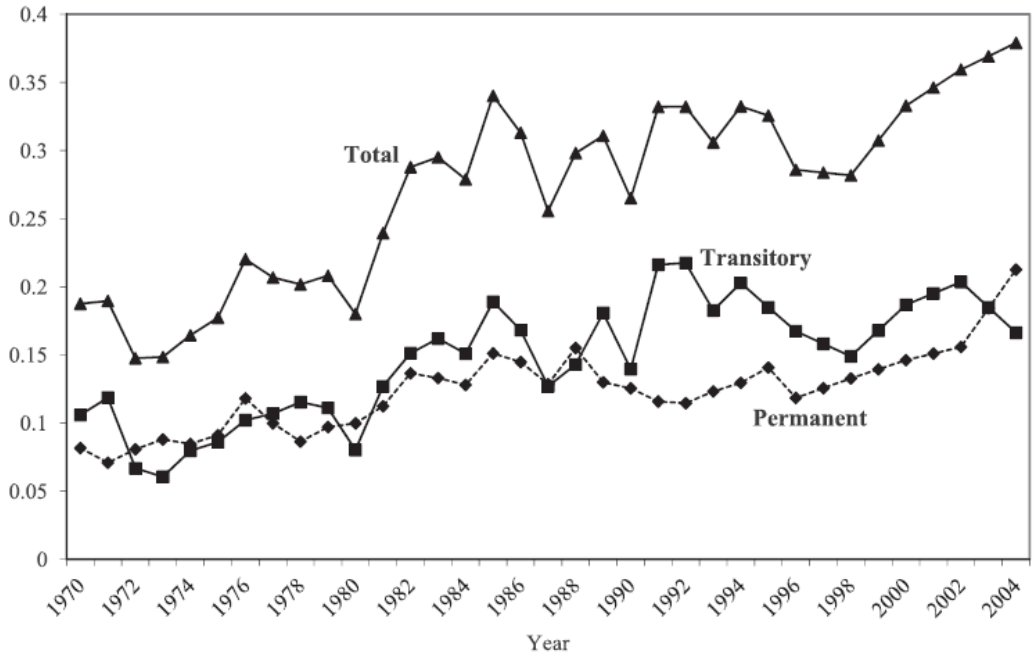


Figure 3
Fitted Permanent, Transitory, and Total Variances of Log Earnings Residuals, Age 30–59 (EC Model)

Wage Inequality and Firms

- A parallel literature has looked at firms' effect in wage inequality

- Is it the worker or the firm? Do identical workers earn differently in different firms?
  - Rents
  - Efficiency wages

- Is it really a firm effect or do high-wage workers work in high-wage firms (sorting)?

Wage Inequality and Firms

- In competitive labor markets the workplace does not matter for wages
- Given individual characteristics, any firm-specific premium would be wiped out by equalizing forces of competition
- Firm effects represent violations of the 'law of one price'
- Testing for violations
  - Rent sharing literature: regress individual wages on measures of employers' profitability or rents (Guiso, Pistaferri, Schivardi 2005; Card, Devicienti and Maida, 2014)
  - Firm switching literature: estimate wage change associated to changing firm holding constant individual unobservables (Abowd Kramarz Margolis, 1999, and their followers)

Wage Inequality and Firms

- Abowd, Kramarz, Margolis (AKM 1999) pioneered the use of two-way fixed effects to separate workers' and firms' variance components
  - Emphasise need of (nearly) population data

- Card, Heining and Kline (2013) spurred renewed interest in the question

- A burgeoning literature: Card et al. (2016; 2017), Guevenen, Bloom and von Wachter (2016), Moretti et al (2017), Devicienti, Fanfani and Maida (2017)

Wage Inequality and Firms: AKM specification

- Typical model

$$w_{ijt} = \beta' X_{ijt} + \lambda_i + \phi_j + \mu_{ij} + \varepsilon_{ijt}$$

$j = J(i,t)$ i's employer in period t
ϕ_j firm-specific wage premium/penalty
μ_{ij} match effect
X_{ijt} time varying controls

- Estimable from matched employer employee data (population)
- Typically: collapse match and transitory, and use 2-way FE regression
- Estimate sorting post-regression as $\text{cov}(\widehat{\lambda_i}\widehat{\phi_j})$
- $var(\widehat{\phi_j}) > 0$ rejects the competitive model

Wage Inequality and Firms: AKM specification

- Issues
  - No dynamics
  - Does not estimate match effects
  - Card et al (2013) recover time trends estimating by sub-panels of 6 years: short panel issue?
  - Negative estimates of sorting

Wage Inequality and Firms: Card et al QJE 2013

TABLE IV

DECOMPOSITION OF THE RISE IN WAGE INEQUALITY

	Interval 1 (1985–1991)		Interval 4 (2002–2009)		Change from interval 1 to 4	
	(1) Var. component	(2) Share of total	(3) Var. component	(4) Share of total	(5) Var. component	(6) Share of total
Total variance of log wages	0.137	100.0	0.249	100.0	0.112	100
Components of variance:						
Variance of person effect	0.084	61.3	0.127	51.2	0.043	39
Variance of establ. effect	0.025	18.5	0.053	21.2	0.027	25
Variance of Xb	0.015	10.7	0.007	2.8	–0.008	–7
Variance of residual	0.011	8.2	0.015	5.9	0.003	3
2cov(person, establ.)	0.003	2.3	0.041	16.4	0.038	34
2cov(Xb, person + establ.)	–0.001	–1.0	0.006	2.4	0.007	7
Counterfactuals for variance of log wages*						
1. No rise in correl. of person/estab. effects	0.137		0.213		0.077	69
2. No rise in var. of estab. effect	0.137		0.209		0.072	64
3. Both 1 and 2	0.137		0.184		0.047	42

Notes. See notes to Table II for sample composition. Calculations based on estimated AKM models summarized in Table III. Entry in column (5) is change in variance component from interval 1 to interval 4. Entry in column (6) is ratio of the change in the variance component to the total change in variance of wages reported in first row of table (as a percentage).

*Counterfactual 1 computes the counterfactual rise in variance assuming the correlation between the person and establishment effects remains at its interval 1 value—that is, imposing the restriction that $\text{Cov}_4(\text{person, establ.}) = \rho_1 \text{Var}_4(\text{person})^{1/2} \times \text{Var}_4(\text{establ.})^{1/2}$ where the subscript 4 refers to the interval 4 value of the statistic and ρ_1 is the correlation between the person and establishment effects in interval 1. Counterfactual 2 assumes that the variance of establishment effects remains at its interval 1 level. Counterfactual 3 imposes both restrictions.

Bridging between Life-Cycle and Firm Effects in Wage Inequality

- These two literatures may gain from talking to each other: new research questions

    1. Do firms impact on wage trajectories?
    2. Does inequality grows more within or between matches?
    3. Does the timing of matches matter?
        - Early employers may extract information on workers' ability that is useful also for later employers, with persistent effects on the wage distribution

- Policy implications: reducing young workers' mismatch may have long term impacts on wage inequality

An Intermediate Step: Wage Inequality and Tenure

- A group of papers used longitudinal samples of workers to study tenure effects on wage inequality (employer learning)
  - Blundell, Pistaferri and Preston (2010);
  - Altonji, Smith and Vindangos (2013);
  - Cappellari and Leonardi (2016)

- These studies use workers' sample and cannot identify firm heterogeneity or worker-firm sorting
  - Estimates may reflect unobserved firm attributes rather than tenure effects

Workers, Firms and Wage Dynamics

A small literature using population data on workers and firms

- Friedrich, Laun, Meghir and Pistaferri (mimeo 2016): use Swedish register to model employment transitions, job to job mobility and firm effects in wage over time
  - Structural approach, distributional assumptions
  - No distinction of life cycle from business cycle
  - No sorting

This Paper

Contributes to the literature on firms effects in life-cycle wages by:

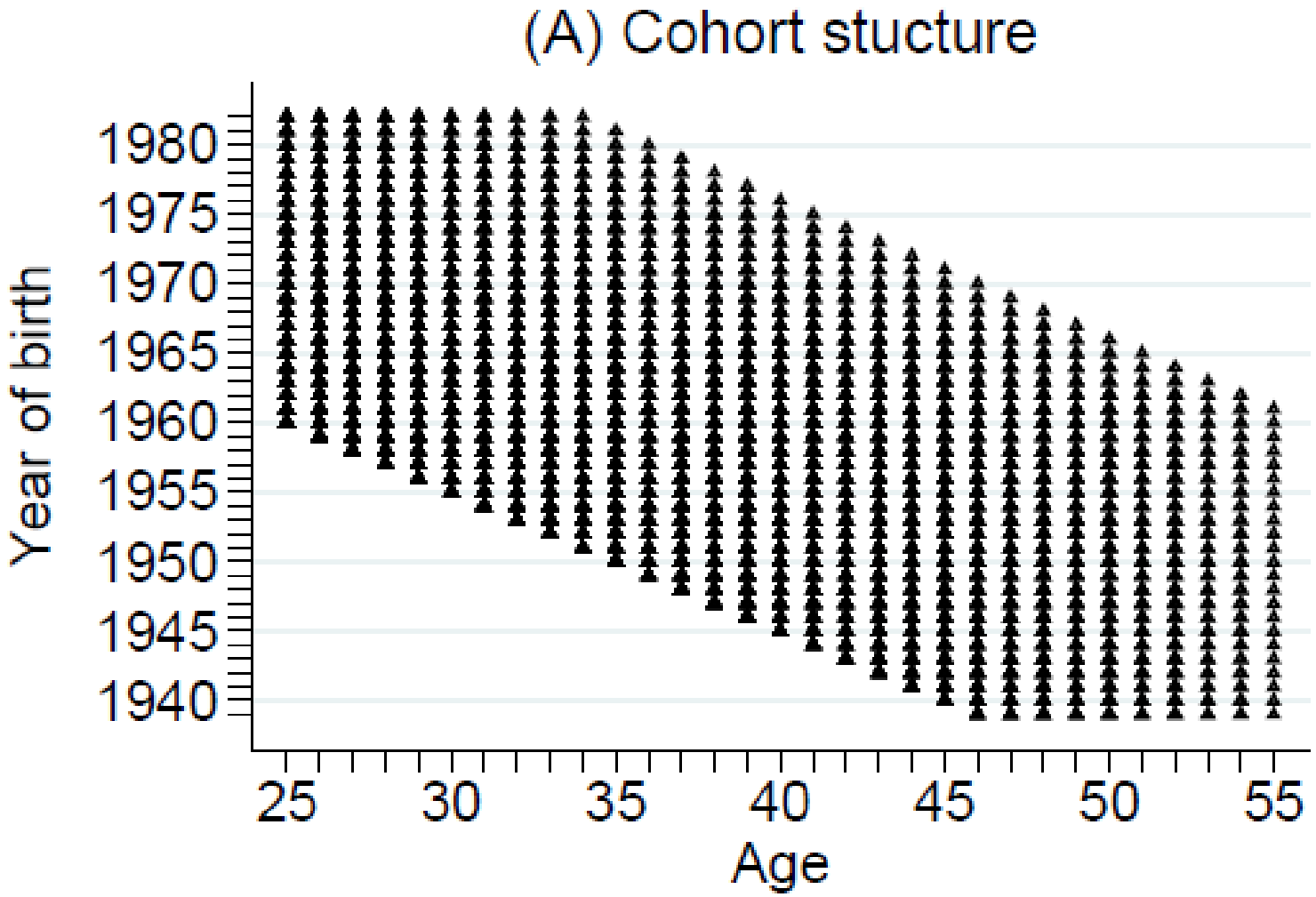
1. Introducing life-cycle dynamics in wage shocks between and within matches: timing of shocks
2. Accounting for firm-workers sorting over the life-cycle (age-based sorting)
3. Isolating life-cycle from historical trends in wage inequality
4. Proposing a novel identification strategy that exploits information on the wage covariance structure of co-workers

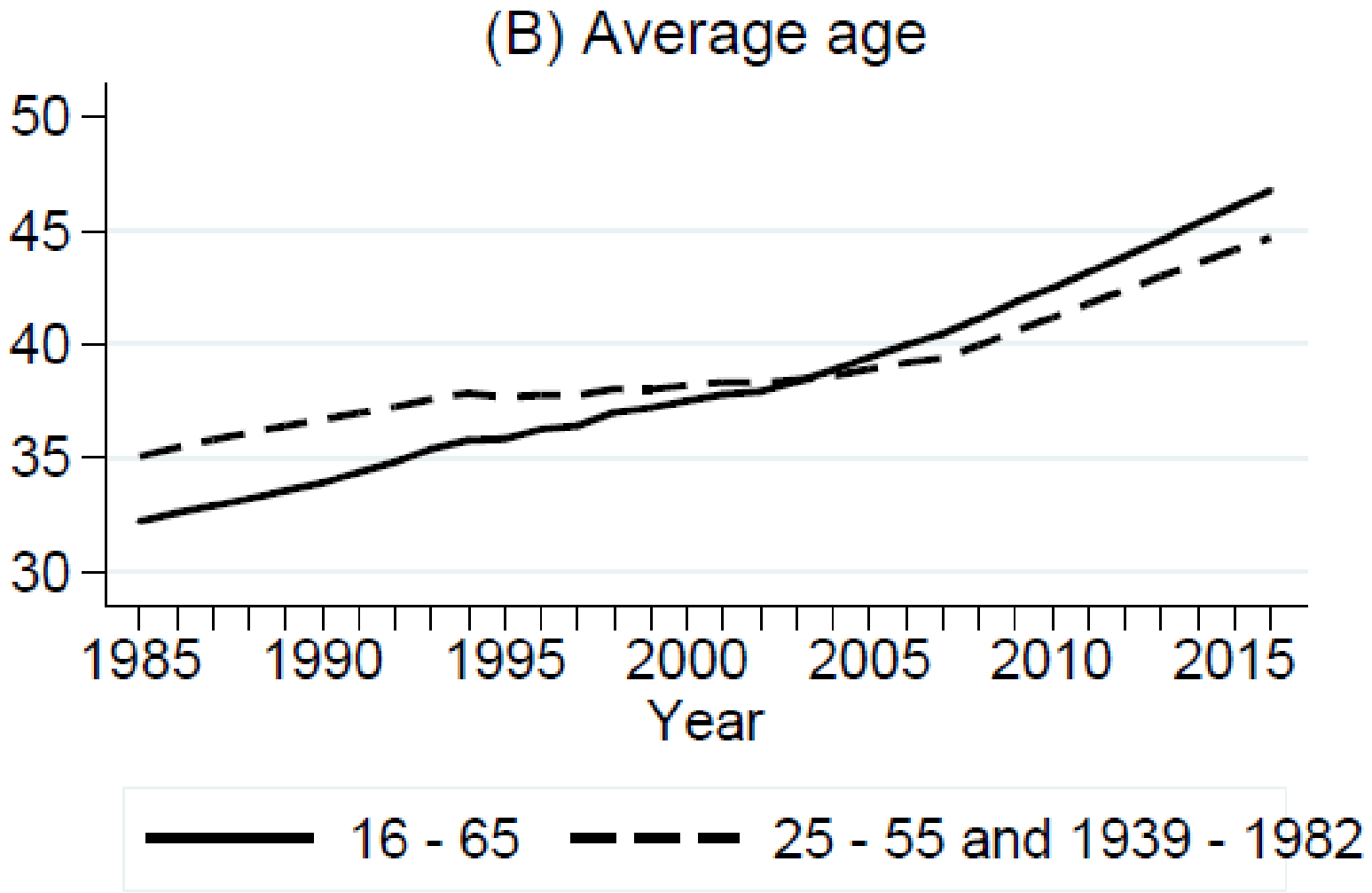
Structure of Talk

- Data
- Model
- Identification
- Empirical Covariance Structure
- Main results
- Robustness and heterogeneity
- Wrapping Up

Data

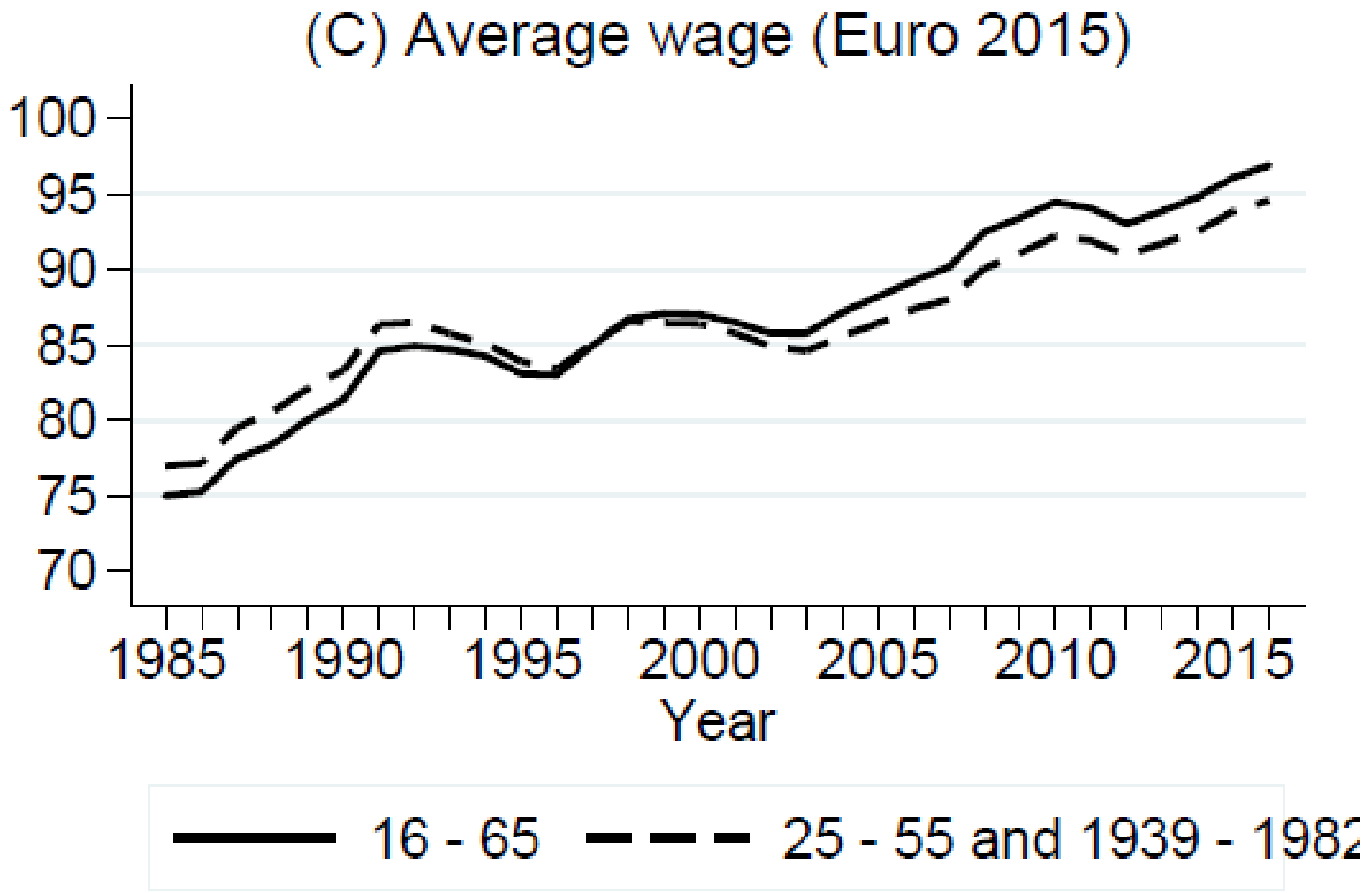
- VisitINPS: Population of job spells in the private non-agricultural sector of the Italian economy, 1985 – 2016
- Fresh spells since February 1974
- Men aged 25-55, excluding apprenticeships (0.5%) and managers (1.5%)
- At least 10 potential individual observations: birth cohorts 1939-1982
- At least 5 consecutive individual observations
- At least 8 full-time equivalent (FTE) working weeks per year
- Subpopulation of N=12.3 millions men and K=3 millions firms, with TxN=152 millions data points on wages

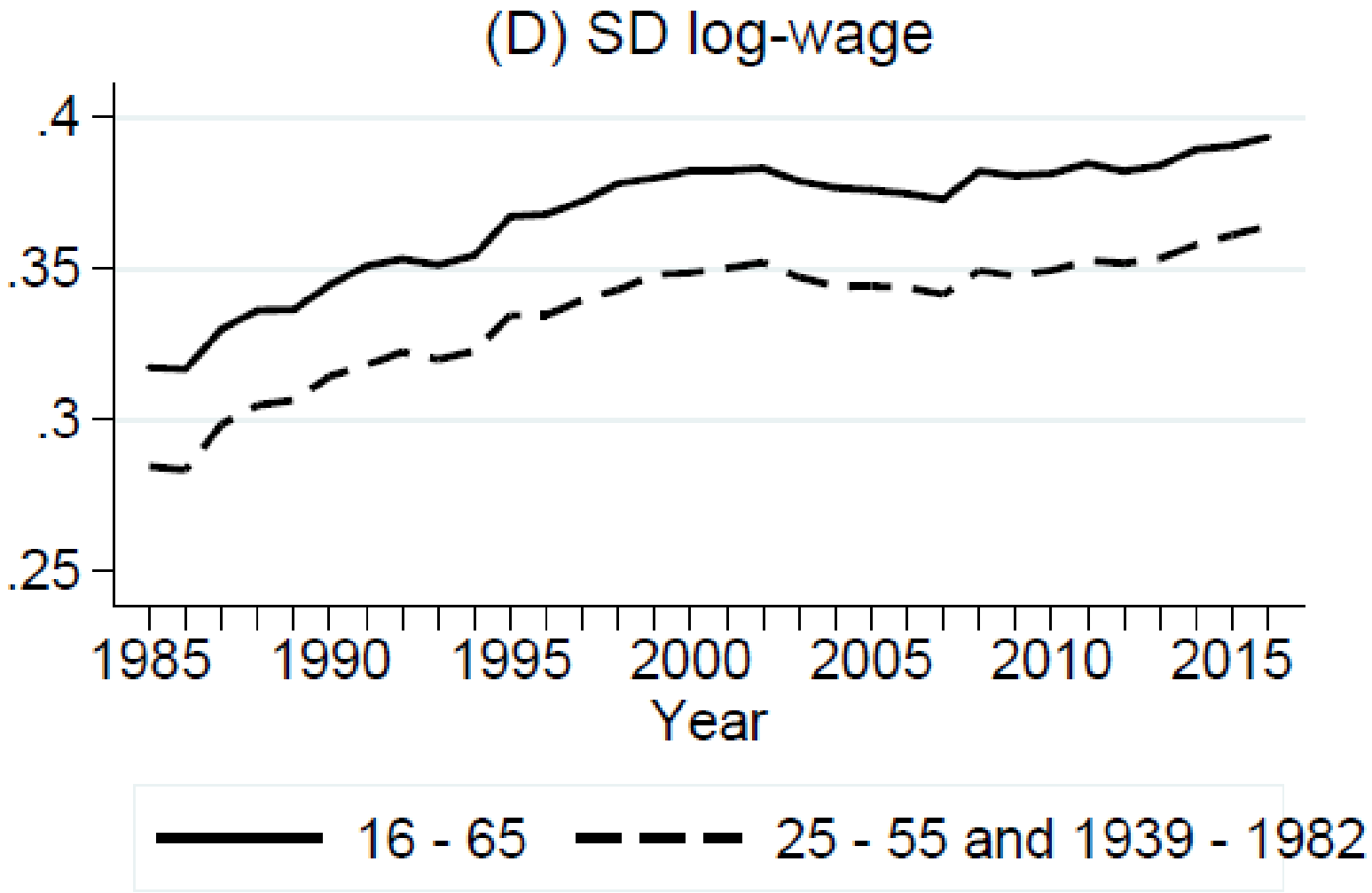

(A) Cohort stucture
Year of birth
1980
1975
1970
1965
1960
1955
1950
1945
1940
25
30
35
40
45
50
55
Age


(B) Average age
50
45
40
35
30
1985
1990
1995
2000
2005
2010
2015
Year
16 - 65
25 - 55 and 1939 - 1982

Data: Wages

- Collapse multiple spells at the same firm within the year
- Prevalent firm: yearly maximum of FTE weeks
- Daily wages: gross annual earnings at the firm/(FTE days)
- Winsorize at 0.5% of each tail each year


(C) Average wage (Euro 2015)
100
95
90
85
80
75
70
1985
1990
1995
2000
2005
2010
2015
Year
16 - 65
25 - 55 and 1939 - 198


(D) SD log-wage
.4
.35
.3
.25
1985
1990
1995
2000
2005
2010
2015
Year
16 - 65
25 - 55 and 1939 - 1982

Econometric Model

- Characterization consistent with both human capital and search/matching mechanisms, plus non-competitive labor market that induce dynamic firm effects

- Wages as a cumulative process evolving through the arrival of shocks
  - Permanent vs transitory shocks
  - Individual- vs Firm- specific shocks
  - Individual dynamics within and between firms

Econometric Model

$$w_{ijt} = \alpha_t(\lambda_{it} + \mu_{ijt}) + \delta_t\phi_{jt} + \gamma_t(\varepsilon_{it} + \xi_{jt})$$

- w_{ijt}: residualized log of daily wages
- $j = J(it)$: firm in which *i* is employed in year t (prevalent employer)
- α, δ and γ: time shifters

Individual Dynamics between Firms

- General human capital/Mobility between firms

$$\lambda_{it} = \lambda_{i(t-1)} + u_{it} = \lambda_{i(c+25)} + \sum_{k=c+26}^{t} u_{ik}$$

(c is year of birth)

$$\lambda_{i(c+25)} \sim \left(0, \sigma_{\lambda}^{2}\right);\ u_{it} \sim \left(0, \sigma_{u(t-c)}^{2}\right)$$

- Life-cycle shocks drawn from age-specific distributions

Individual Dynamics within Firms: Match Effects

- Firm-specific human capital/Employer learning

$$\mu_{ijt} = S_{i(t,t-1)}\mu_{ij(t-1)} + v_{ijt} = \sum_{k=t-\tau}^{t} v_{ijk}$$

$$S_{i(t,t-1)} = 1[J(i,t) = J(i,t-1)]$$

(accumulation in tenure)

$$v_{ijt} \sim (0, \sigma^2_{v(t-c)})$$

- Match-specific shocks drawn from age-specific distribution

Firm Effects

- Firm effects are shared among co-workers and therefore do not depend on their age

- These effects may be time-varying:
  - firm ability to impact wages may vary over its life-course
  - surviving firms may have more market power

- We model them as permanent shocks drawn from firm age specific distributions

$$\phi_{jt} \sim \left(0, \sigma^2_{\phi(t-d)}\right) \qquad E\left(\phi_{jt}\phi_{jt'}\right) = \sigma_{\phi\phi(t-d)(t'-d)}$$

Transitory Shocks

- Purely transitory (White Noise): the model is too rich to allow additional structure such as AR or ARMA

- Individual specific and firm specific

- Drawn from age-specific distributions

$$\varepsilon_{it} \sim \left(0, \sigma^2_{\varepsilon(t-c)}\right) \qquad \xi_{jt} \sim \left(0, \sigma^2_{\xi(t-d)}\right)$$

Assumptions

- Match effects and transitory shocks are orthogonal between themselves and with anything else

- Life-cycle and firm effects are correlated: sorting (do high wage workers work in high wage firms?)

$$E\left(\lambda_{i(c+25)}, \phi_{jt}\right) = \rho_{\phi 25} \qquad E\left(u_{it}, \phi_{jt}\right) = \rho_{\phi(t-c)}$$

Moment Restrictions and Identification

- Comparing variances and covariances identifies transitory shocks
- Individual covariances reflect all sources of variation= Individual+Match+Firm+Sorting
- If we could isolate Firm+Sorting , then changes of individual covariances with age and tenure separate Individual from Match…
- …but there is no way of isolating Firm+Sorting relying only on individual covariances

Moment Restrictions and Identification

- We need additional moment restrictions: Co-workers covariance structure

- Co-workers covariances= Firm+Sorting.
  - Separable, because sorting is age-specific.
  - Non separable at age 25

- Future co-workers aged 25 (not currently working in the same firm, but meeting in the future) = Sorting at 25

Empirical Moments: Individuals

- Estimated by averaging the cross products of residualized log-wages across individuals:

$$m^{I}_{tt'} = \frac{\sum_i \omega_{ijt}\omega_{ij't'}}{\sum_i d_{ijt}d_{ijt'}}$$

d is a dummy for valid wage observations

- By birth cohort to separate time and age (10,582 empirical moments)

Empirical Moments: Co-workers

- Firm-specific covariance uses all pairwise matches across co-workers born in the same year
- Firm-specific covariances averaged across firms using the square root of the number of pairwise matches as weight (Page and Solon 2003 for neighborhoods)
- Use all co-workers if < 200 individuals, otherwise a random sample of 200 co-workers stratified by occupation (10,582 empirical moments)

$$m^{C}_{tt'} = \sum_j \theta_j \frac{\sum_i \sum_{h>i} \omega_{ijt}\omega_{hjt'}}{\sum_i \sum_{h>i} d_{ijt}d_{hjt'}}$$

$$\theta_j = \sqrt{\sum_i \sum_{h>i} d_{ijt}d_{hjt'}} \Big/ \sum_j \sqrt{\sum_i \sum_{h>i} d_{ijt}d_{hjt'}}$$

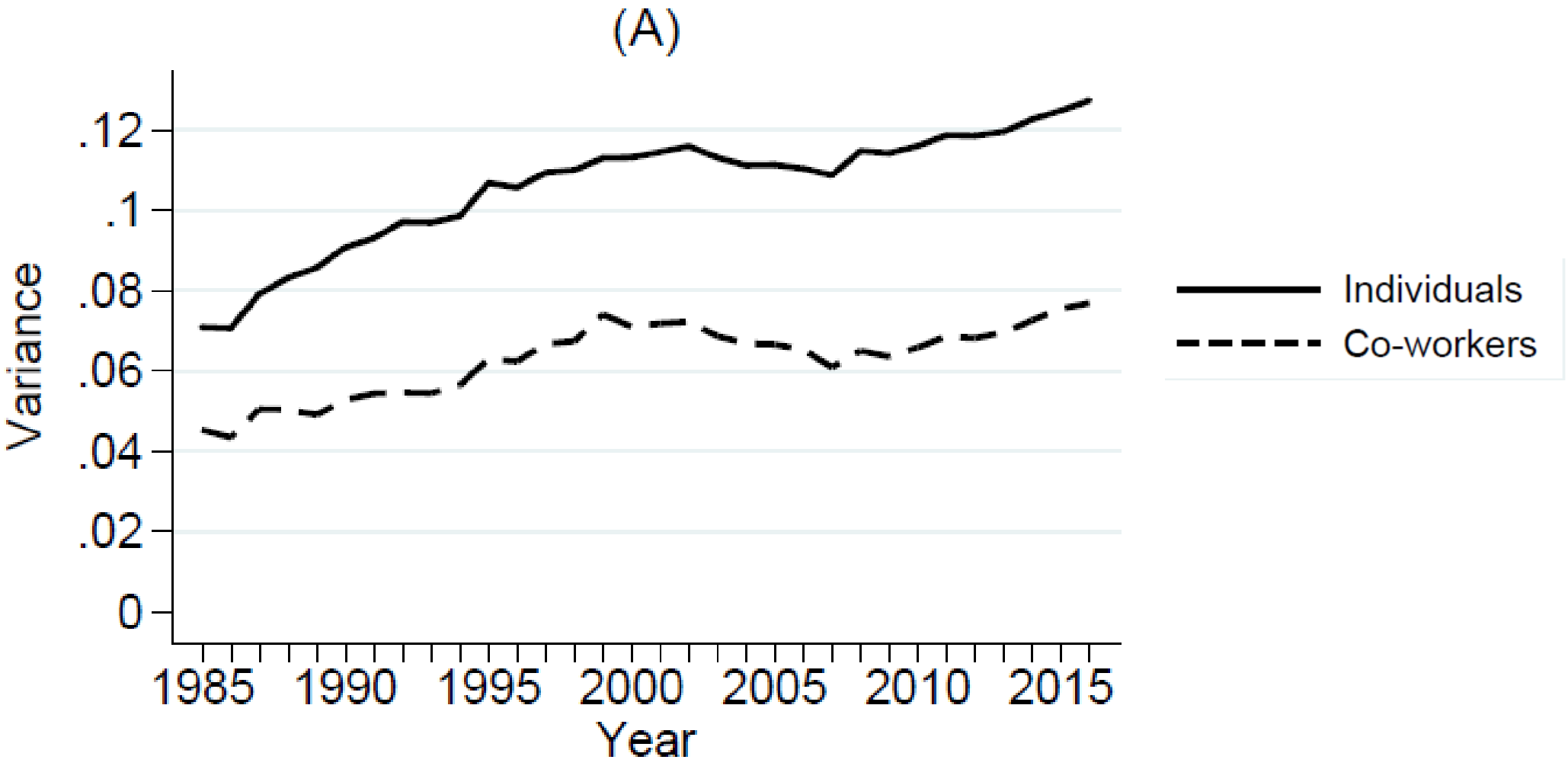
Empirical Moments: Future Co-workers aged 25

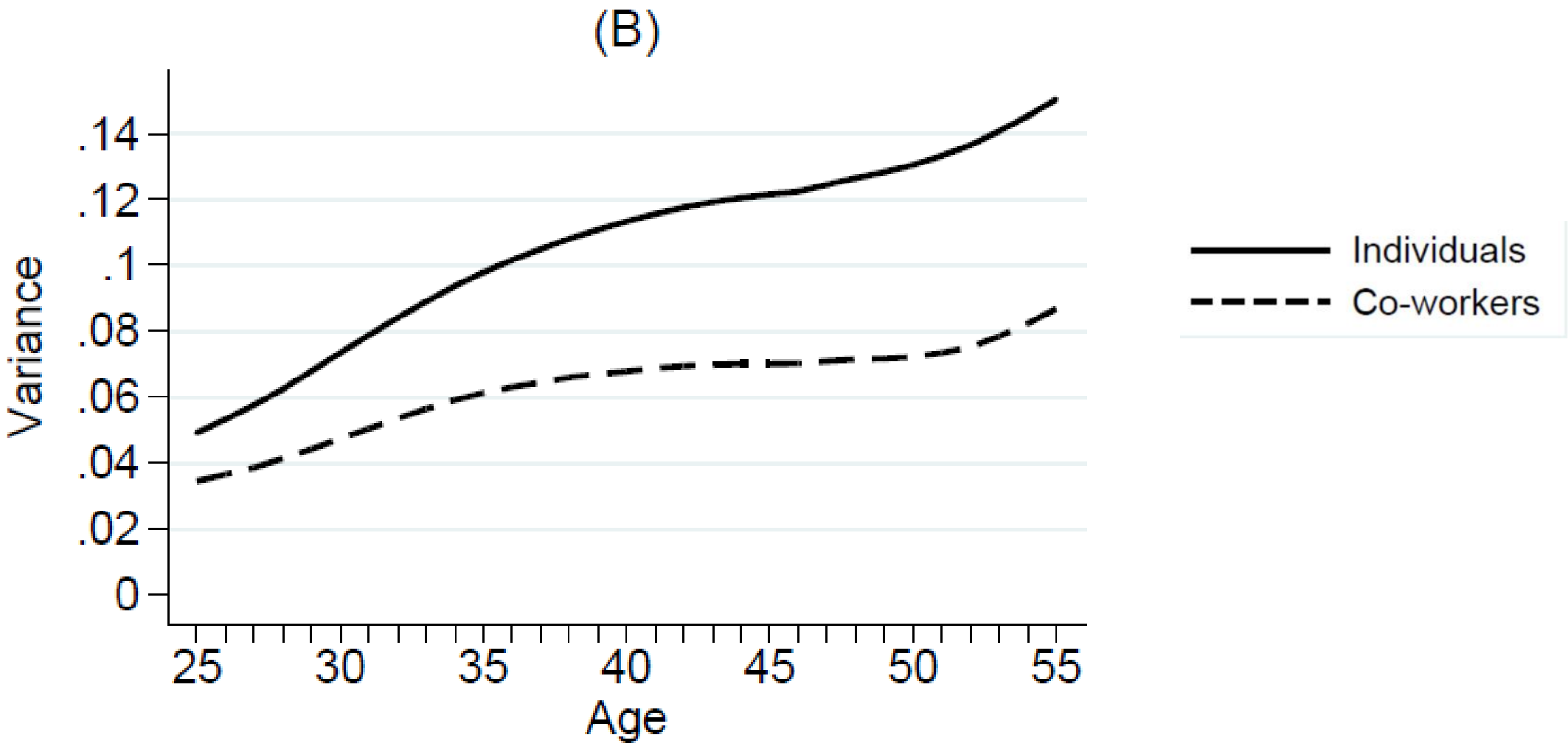
25 years old employees and their future co-workers (138 empirical moments)

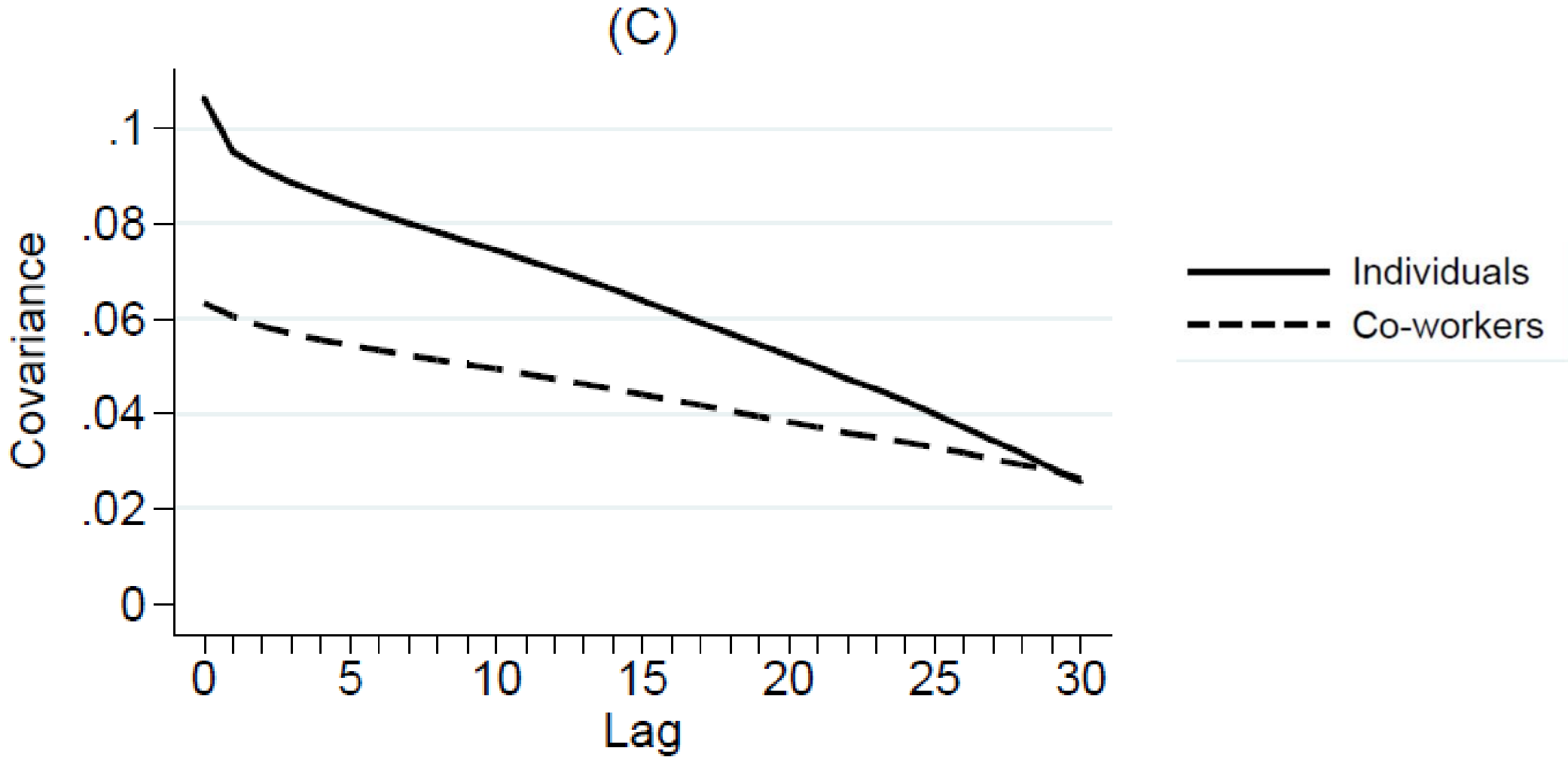
- i.e. the employees of the firm they will join in two years since the year of observation
- for which they have not been working for in the two years prior to the period of observation
- born in the same year

$$m^F_{tt'} = \sum_i \frac{\frac{\sum_{h \neq i} \omega_{ixt} \omega_{hjt'}}{\sum_{h \neq i} d_{hjt'}}}{d_{ixt}}$$

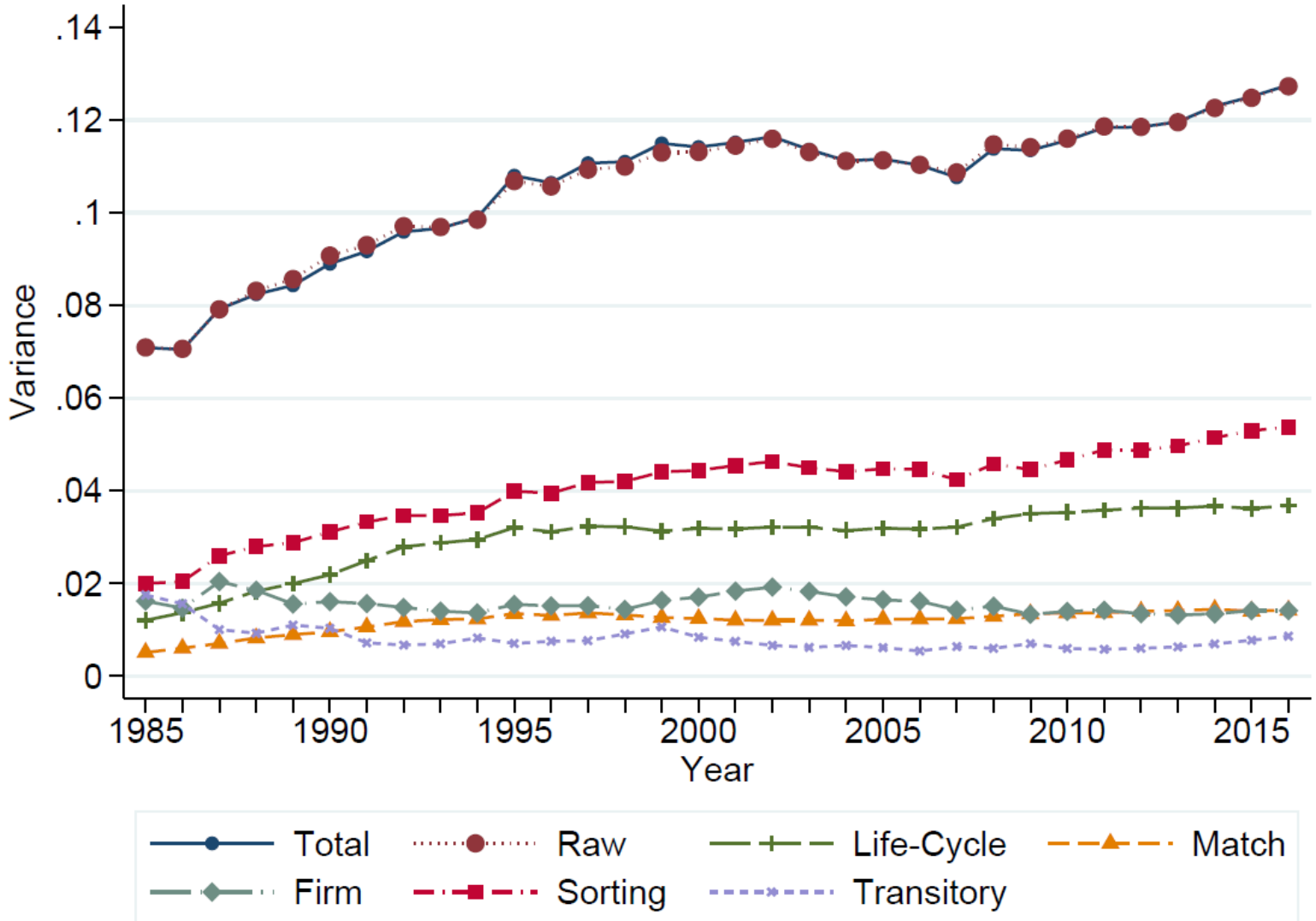
$$\forall i: J(i, t+2) = j, J(i, t+s) \neq j, (t-c) = 25, s = -2, \dots 1$$


(A)
Variance
.12
.1
.08
.06
.04
.02
0
1985
1990
1995
2000
2005
2010
2015
Year
Individuals
Co-workers


(B)
Variance
.14
.12
.1
.08
.06
.04
.02
0
25
30
35
40
45
50
55
Age
Individuals
Co-workers


(C)
Covariance
.1
.08
.06
.04
.02
0
0
5
10
15
20
25
30
Lag
Individuals
Co-workers

Results

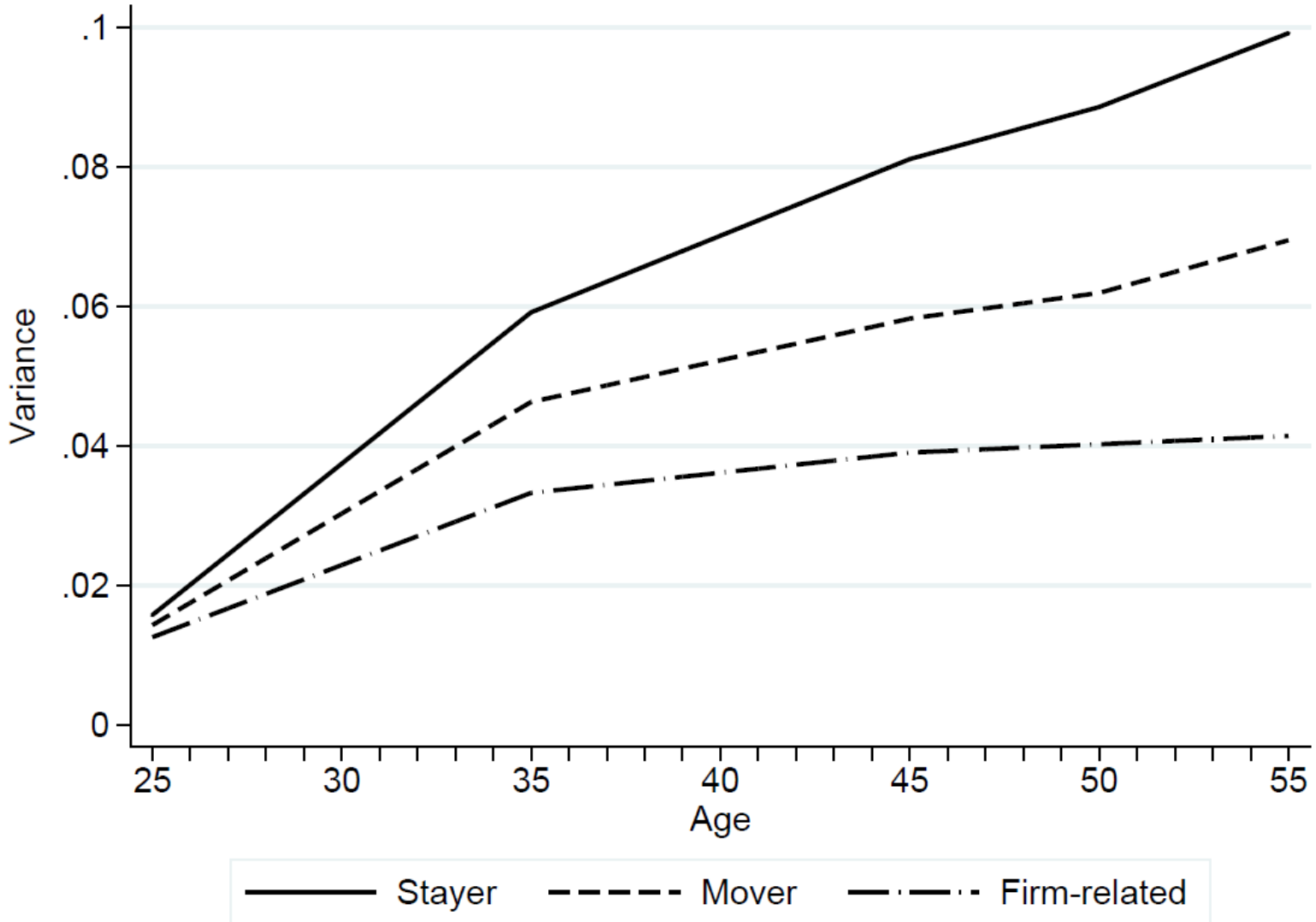

.14
.12
.1
.08
.06
.04
.02
0
Variance
1985
1990
1995
2000
2005
2010
2015
Year
Total
Raw
Life-Cycle
Match
Firm
Sorting
Transitory

	Coeff.	S.E.x10
	A) Life-cycle	
σ_{λ}^{2}	0.0017	0.0006
σ_{u26-35}^{2}	0.0011	0.0001
σ_{u36-45}^{2}	0.0006	0.0001
σ_{u46-50}^{2}	0.0005	0.0002
σ_{u51-55}^{2}	0.0013	0.0002

	Coeff.	S.E.x10
	B) Match	
σ^2_{v25}	0.0015	0.0002
σ^2_{v26-35}	0.0011	0.0002
σ^2_{v36-45}	0.0010	0.0002
σ^2_{v46-50}	0.0008	0.0002
σ^2_{v51-55}	0.0006	0.0002

	Coeff.	S.E.x10
	C) Firm	
$\sigma^2_{\phi young}$	0.0162	0.0011
$\sigma^2_{\phi middle}$	0.0098	0.0010
$\sigma^2_{\phi old}$	0.0074	0.0010
$\sigma_{\phi\phi young\ -middle}$	0.0045	0.0008
$\sigma_{\phi\phi young\ -old}$	0.0105	0.0009
$\sigma_{\phi\phi middle\ -old}$	0.0060	0.0008

	Coeff.	S.E.x10
	D) Sorting	
$\rho_{\phi 25}$	0.0014	0.0003
$\rho_{\phi 26-35}$	0.0010	0.00003
$\rho_{\phi 36-45}$	0.0003	0.00003
$\rho_{\phi 46-55}$	0.0001	0.00004

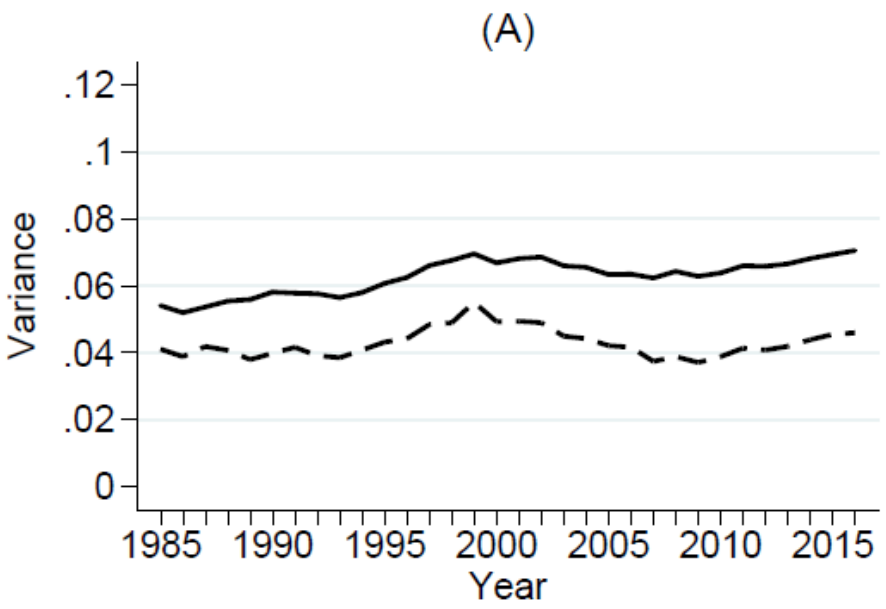

.1
.08
.06
.04
.02
0
Variance
25
30
35
40
45
50
55
Age
Stayer
Mover
Firm-related

Comparison with AKM

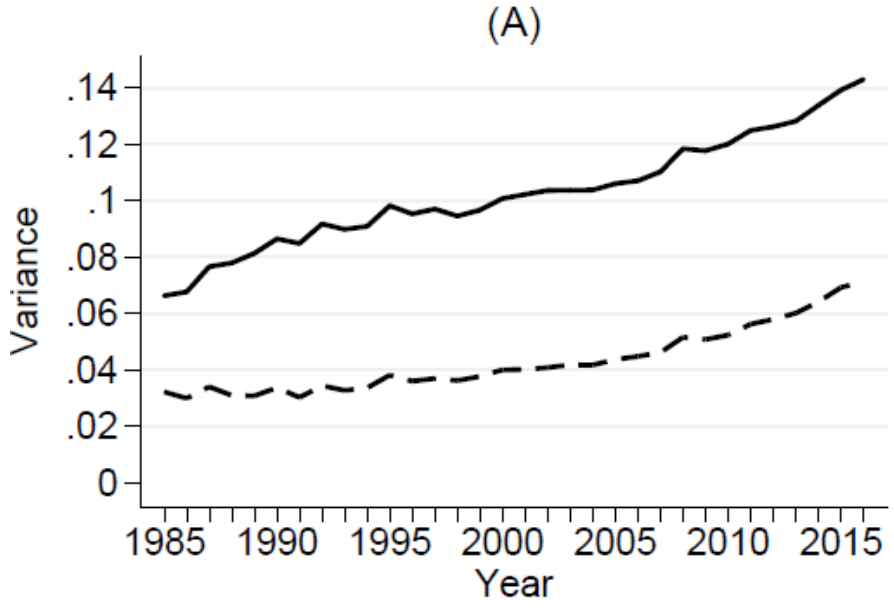
	(1) Baseline		(2) AKM	
	Var. of logs	Share of total	Var. of logs	Share of total
Life-Cycle	0.030	28.04	0.025	22.35
Match	0.012	11.23	0.032	28.58
Firm	0.016	14.72	0.038	33.97
Sorting	0.041	38.36	0.013	11.37
Transitory	0.008	7.64	0.004	3.73
Total	0.106	100.00	0.113	100.00

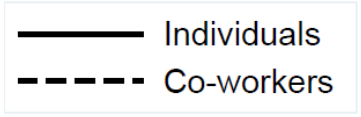
Heterogeneity by Occupation

Blue collars



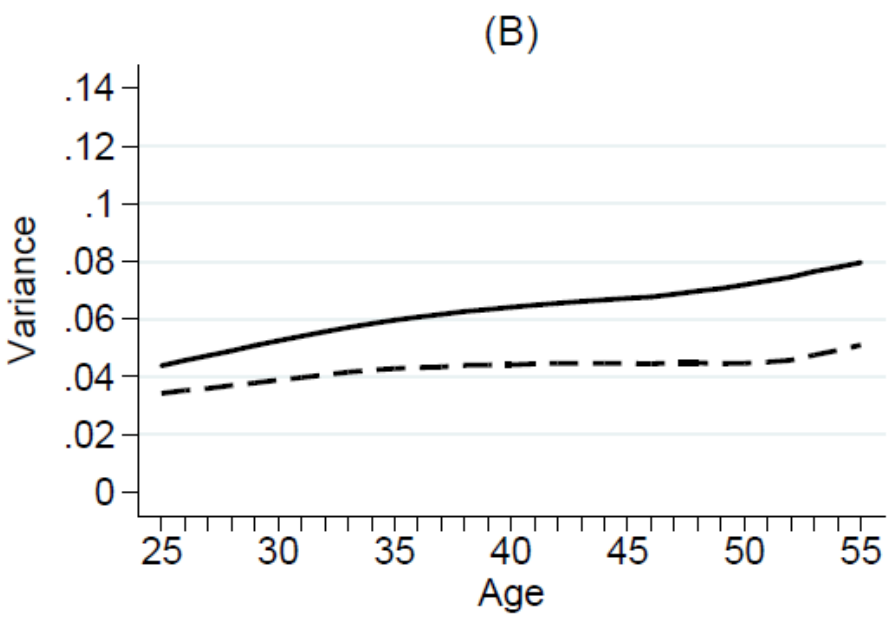
White collars



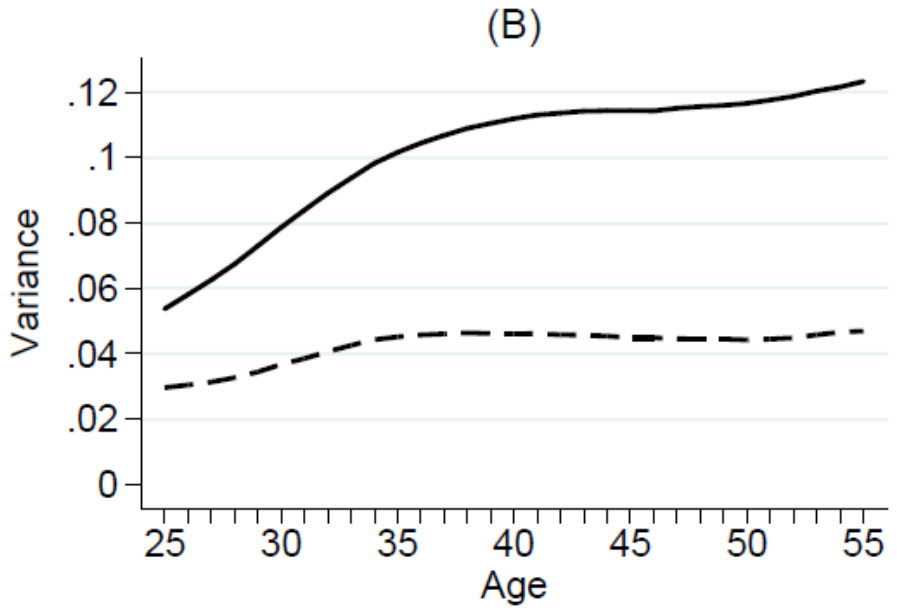


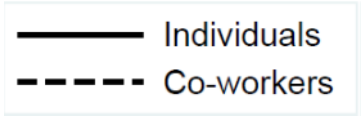
Heterogeneity by Occupation

Blue collars



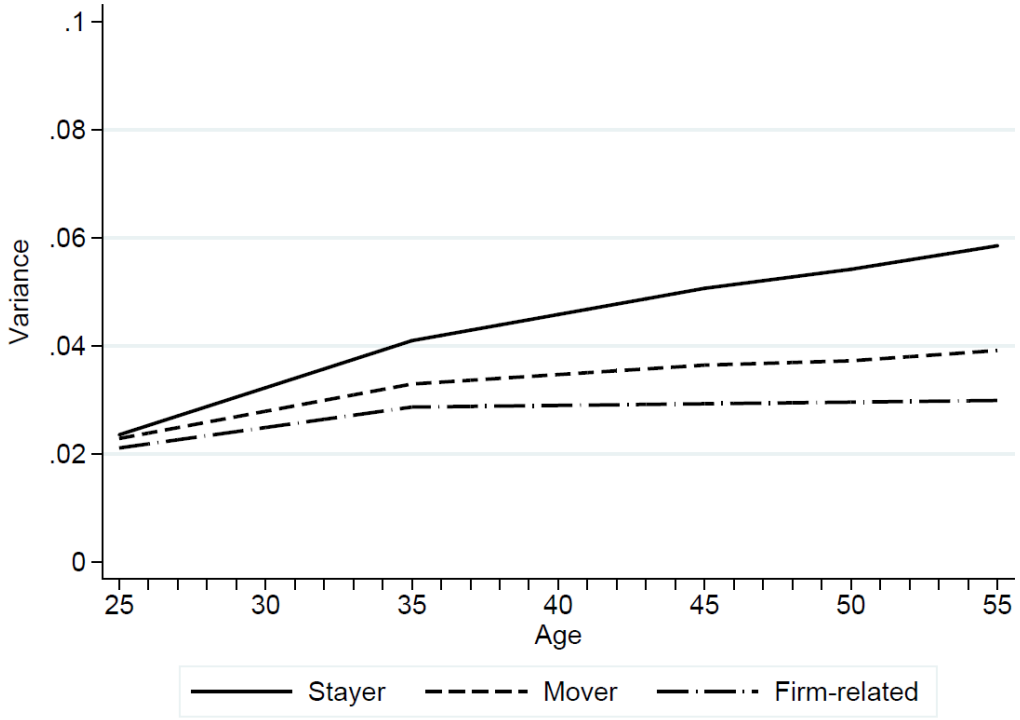
White collars



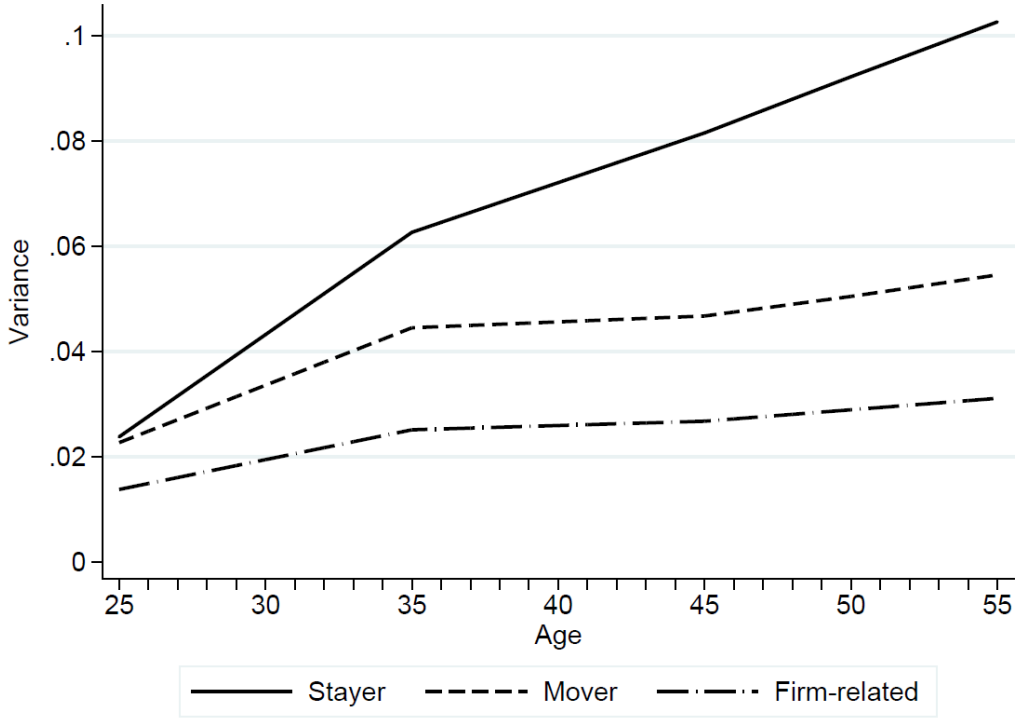


Heterogeneity by Occupation

Blue collars



White collars



Heterogeneity by Occupation

	Blue collar workers		White collar workers	
	Var. of logs	Share of total	Var. of logs	Share of total
Life-Cycle	0.011	18.31	0.034	32.23
Match	0.008	13.11	0.021	19.76
Firm	0.024	39.12	0.021	19.99
Sorting	0.011	17.41	0.023	21.46
Transitory	0.008	12.06	0.007	6.59
Total	0.062		0.105	

Wrapping Up

- When workers are young, inequality grows substantially both within and between job spells
- At older ages, within-match inequality growth slows down (and virtually stops at 45), while inequality keeps on growing between matches
- Sorting of workers in firms accounts for a relevant share of overall inequality, especially for young workers
- Firms are the main source of inequality for blue collar workers. Individual ability contributes to wage inequality mostly within white collar workers