Workplace Heterogeneity and the Rise of West German Wage Inequality

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Changes in wage structure

- Dramatic changes in the wage structure of several developed counties (U.S., Canada, U.K., and Germany).
- Timing differs but some basic facts in common:
  - Increase in *between group* inequality (College/HS wage gap).
  - Increase in *within group* inequality (Std of Mincer wage residual).

The consensus framework: S-D-I

- S-D: Market level Supply/Demand shifts
  - Technology (Bound and Johnson, 1992; Katz and Murphy, 1992; Autor, Levy, Murnane, 2003)
  - Demography (Freeman, 1979)
  - Education (Goldin and Katz, 2008)
- I: Institutions mediate market forces
  - Minimum wages (Lee, 1999)
  - Unions (Freeman, 1980)
  - Industry (Katz and Summers, 1989; Bound and Johnson, 1992)

What about frictions?

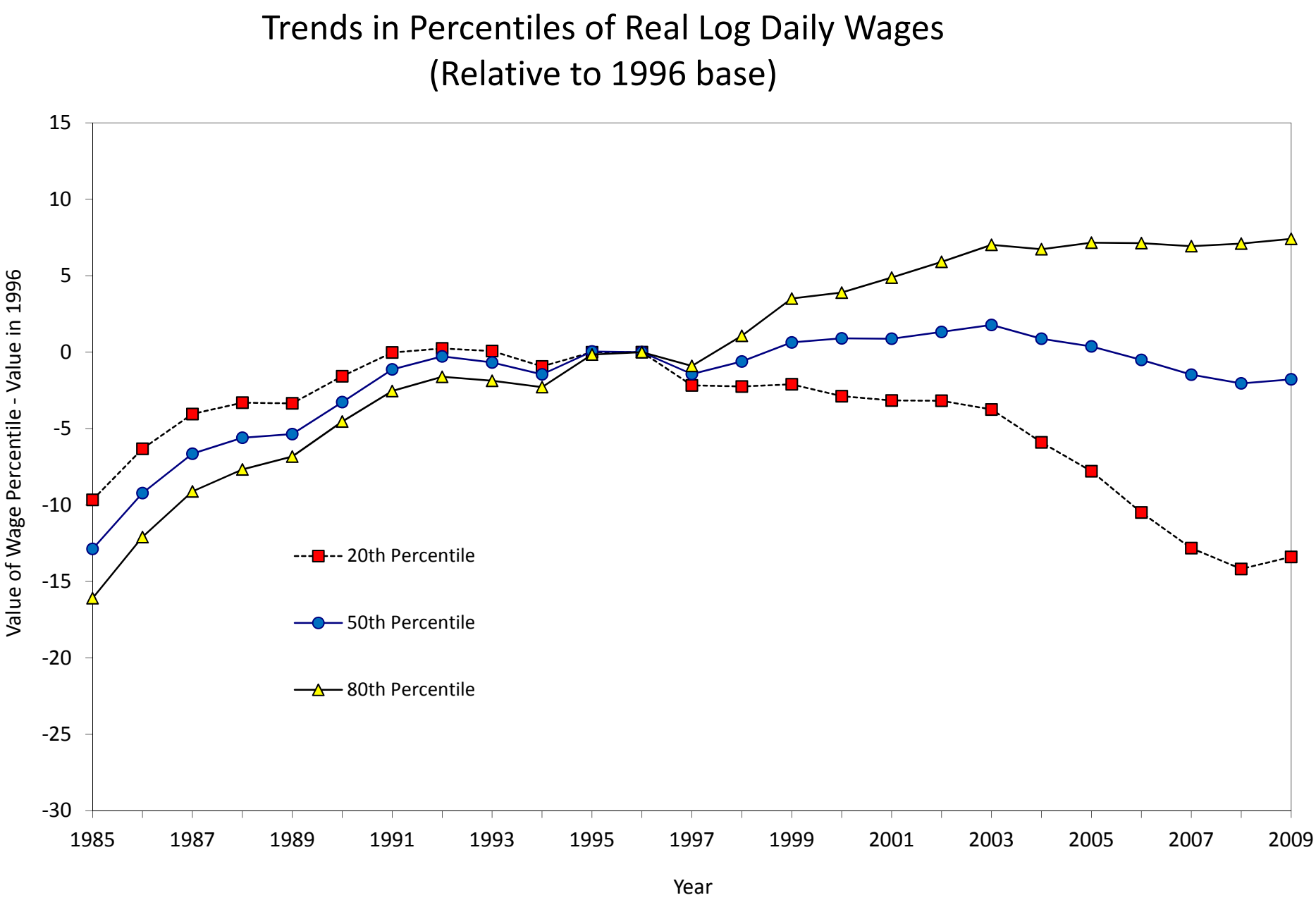
- Two sorts of wage dispersion:
  - Match effects (e.g. D-M-P): each job has a random productivity component and workers can get some share.
  - Firm effects / Wage posting (e.g. Burdett-Mortensen): firms pay high / low wages to all workers.
- Our focus: **firm component**. Has this component widened over time contributing to inequality?

Evidence

- Analysis of matched employer-employee data (e.g. Abowd, Kramarz, and Margolis, 1999 ; Postel-Vinay and Robin, 2002) typically finds large wage differences across firms after controlling for fixed worker heterogeneity.
- Few attempts (so far) to explore nonstationarity in these patterns.
- Ideal dataset would cover period before and after episode of dramatic change in wage structure.
  - Makes it difficult to study U.S.

Our study

- Analyze a large administrative linked employer-employee dataset of German wages over period 1985-2009 (IAB social security records).
- German wage changes in the mid 90's-00's ≈ U.S. in the 80's-90's (Dustmann, Ludsteck, and Schonberg, 2009).
- Provides an opportunity to carefully examine period of dramatic change along with pre-period.


Trends in Percentiles of Real Log Daily Wages
(Relative to 1996 base)
Value of Wage Percentile - Value in 1996
15
10
5
0
-5
-10
-15
-20
-25
-30
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
Year
20th Percentile
50th Percentile
80th Percentile

Methodology

- Estimate model of person, establishment, and match effects separately over four intervals.
- Account for nonrandom sorting of workers to firms via variant of methods in Abowd, Kramarz, and Margolis (1999).
- Examine patterns of nonstationarity in estimates.

4 new facts

- **Fact #1:** Firm effects very important for rise in wage dispersion. Match effects small and stable over time.
- **Fact #2:** Positive and rising correlation between establishment and person effects.
- **Fact #3:** Most of increase in returns to schooling attributable to establishment effects.
- **Fact #4:** Newer (post-1995) establishments have more unequal establishment effects.

Data: Integrated Employment Biographies (universe of social security records)

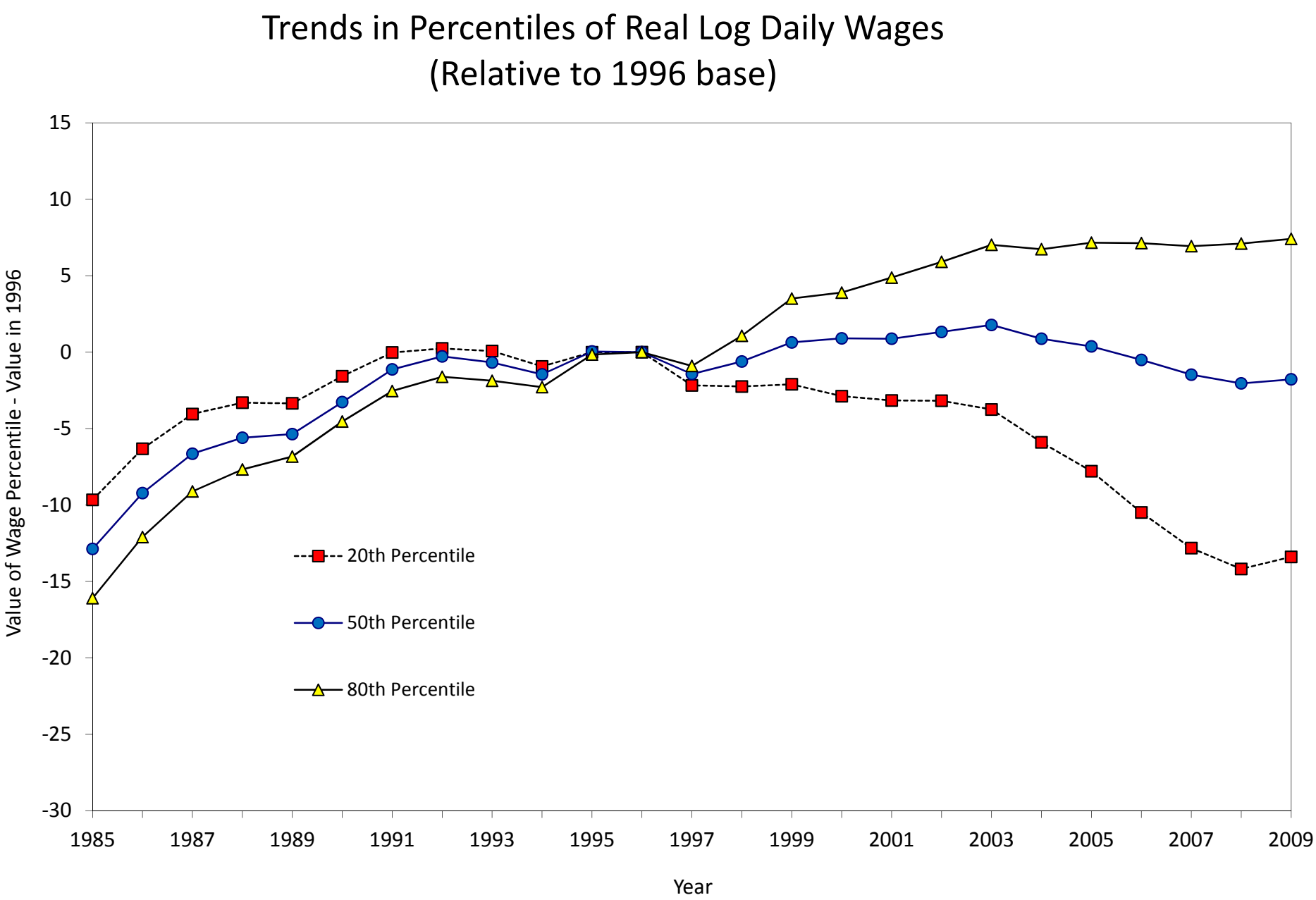
- Info on average daily wage, establishment id (EID), and educational attainment.
- Assign workers a single job each year, based on EID that paid most.
- EID assigned based on ownership, industry, and municipality.
  - Two fast food outlets in same city w/ same owner → same EID
  - Steel foundry and fabrication plant w/ same owner → two separate EIDs.

Sample restrictions

- Analyze period 1985-2009 during which inequality rises most dramatically.
- Focus on full time employed *West* German men ages 20-60 working at non-marginal jobs.
- Daily wage > 10 euro/day (in 2001 euros).

Problem: Top Coding (85th pctile)

- Impute upper tail assuming log-normality
  - Estimate Tobit by year/age/education group.
- Use additional panel regressors to predict wage including:
  - Average wage in other periods; fraction of other year observations that are censored.
  - Average wage of coworkers, fraction of coworkers topcoded.
- High Pseudo-R2's (>70%)
- **Robustness**: Apprentice-only sample.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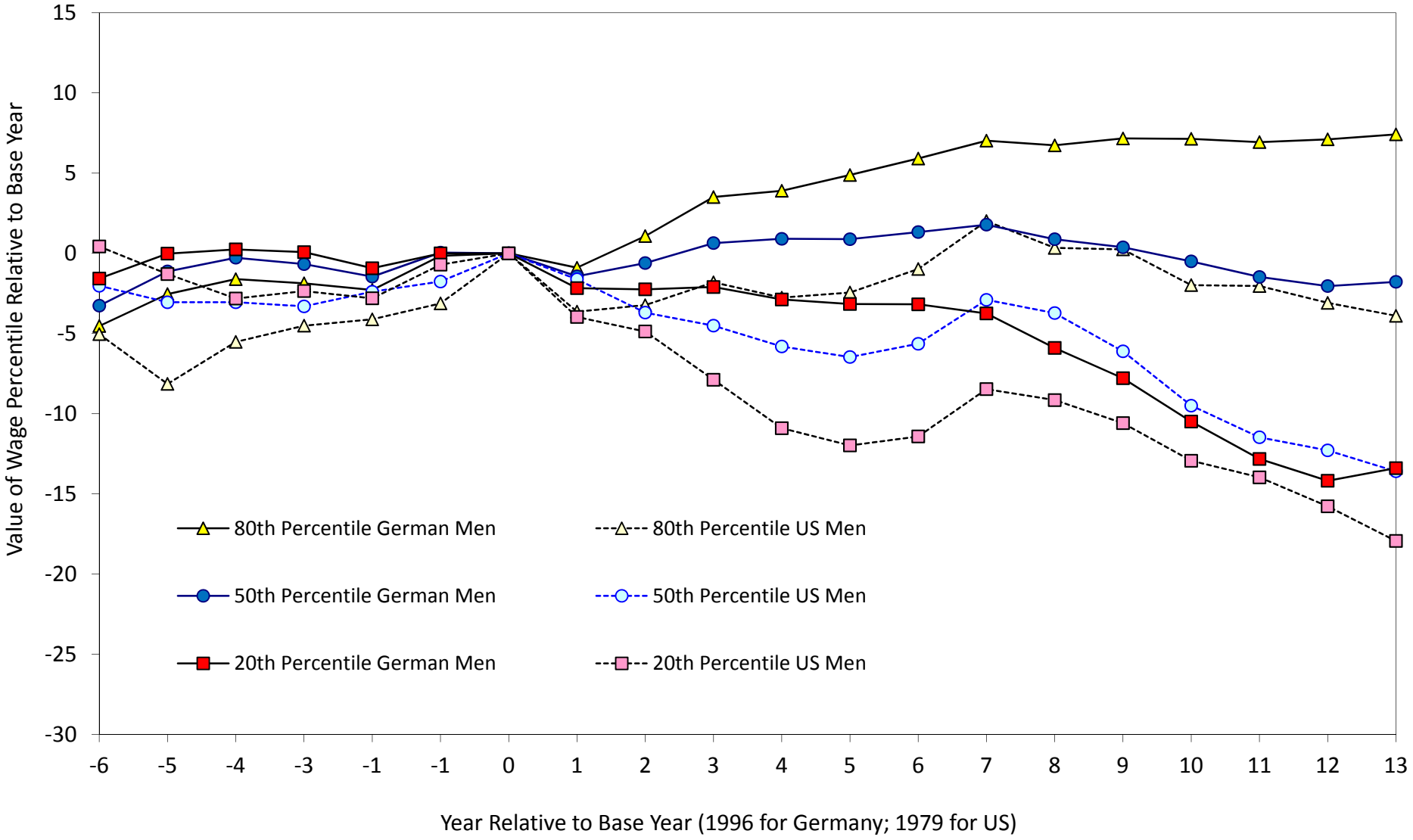
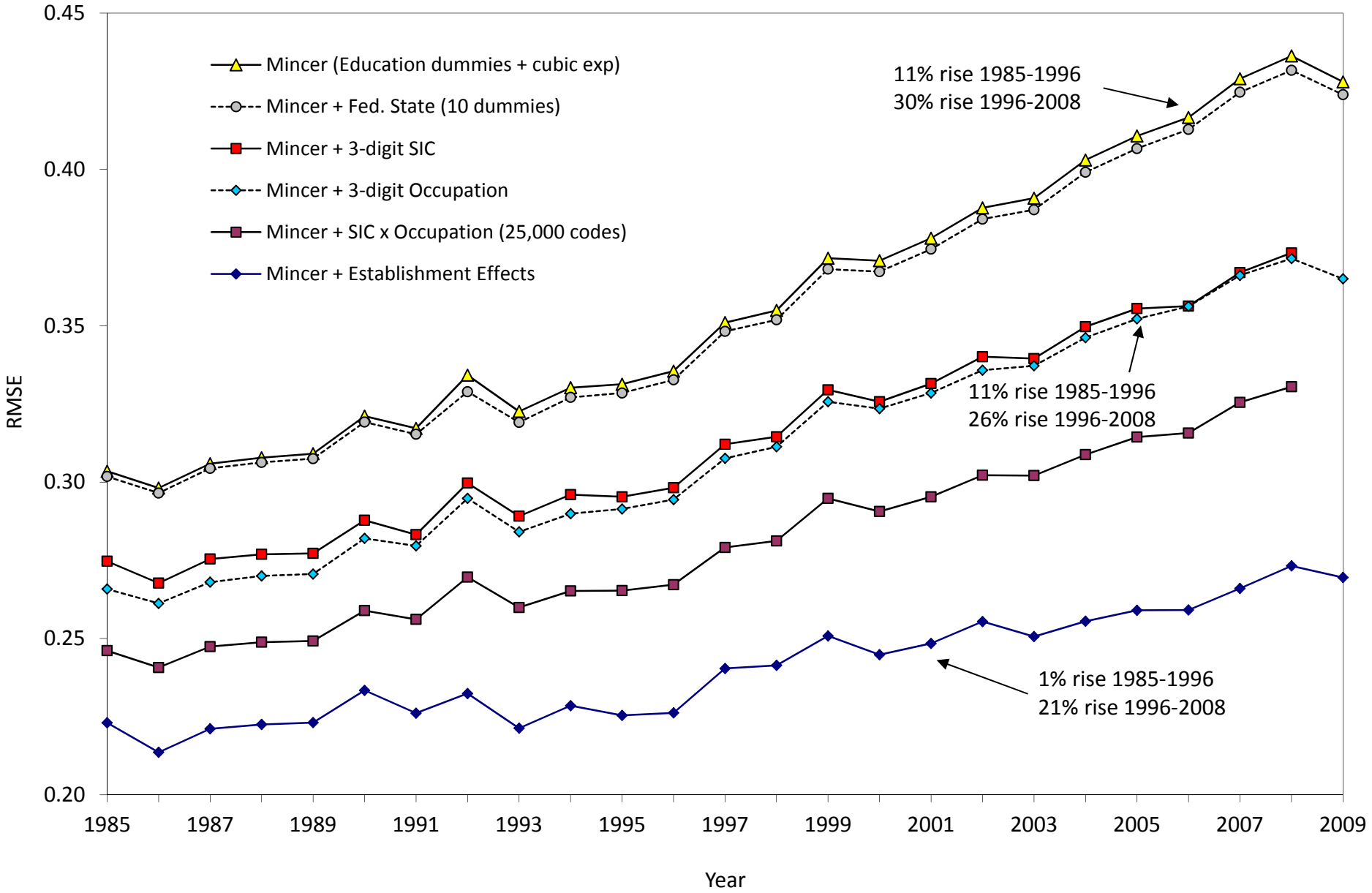
1997
1999
2001
2003
2005
2007
2009
Year
20th Percentile
50th Percentile
80th Percentile

Figure 1c: Trends in Percentiles of Real Log Daily Wage
Germany (1996=0) vs. US (1979=0)

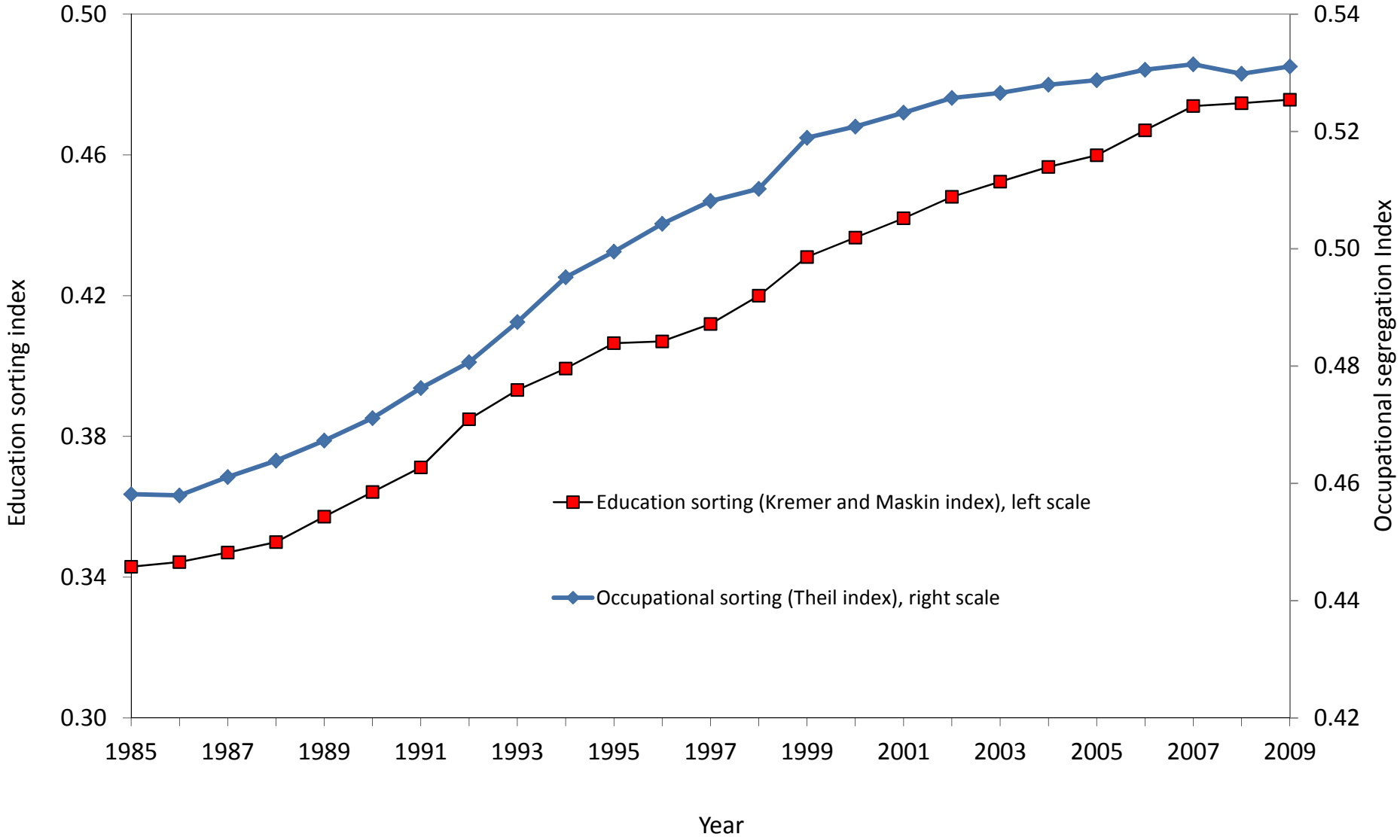


How much inequality can we explain?

Root Mean Squared Error from Alternative Wage Models



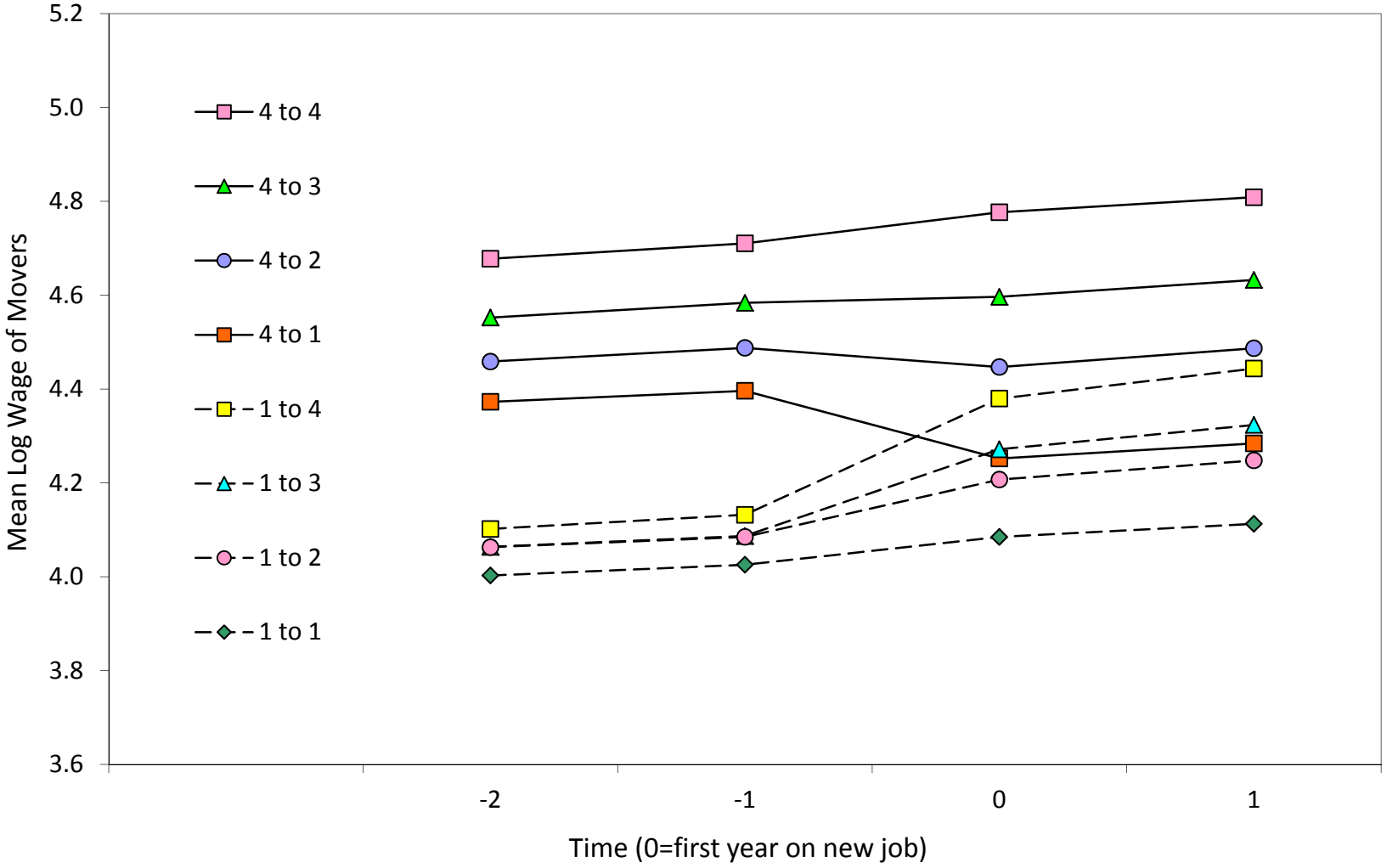
Sorting of Workers in Different Education and Occupation Groups Across Establishments



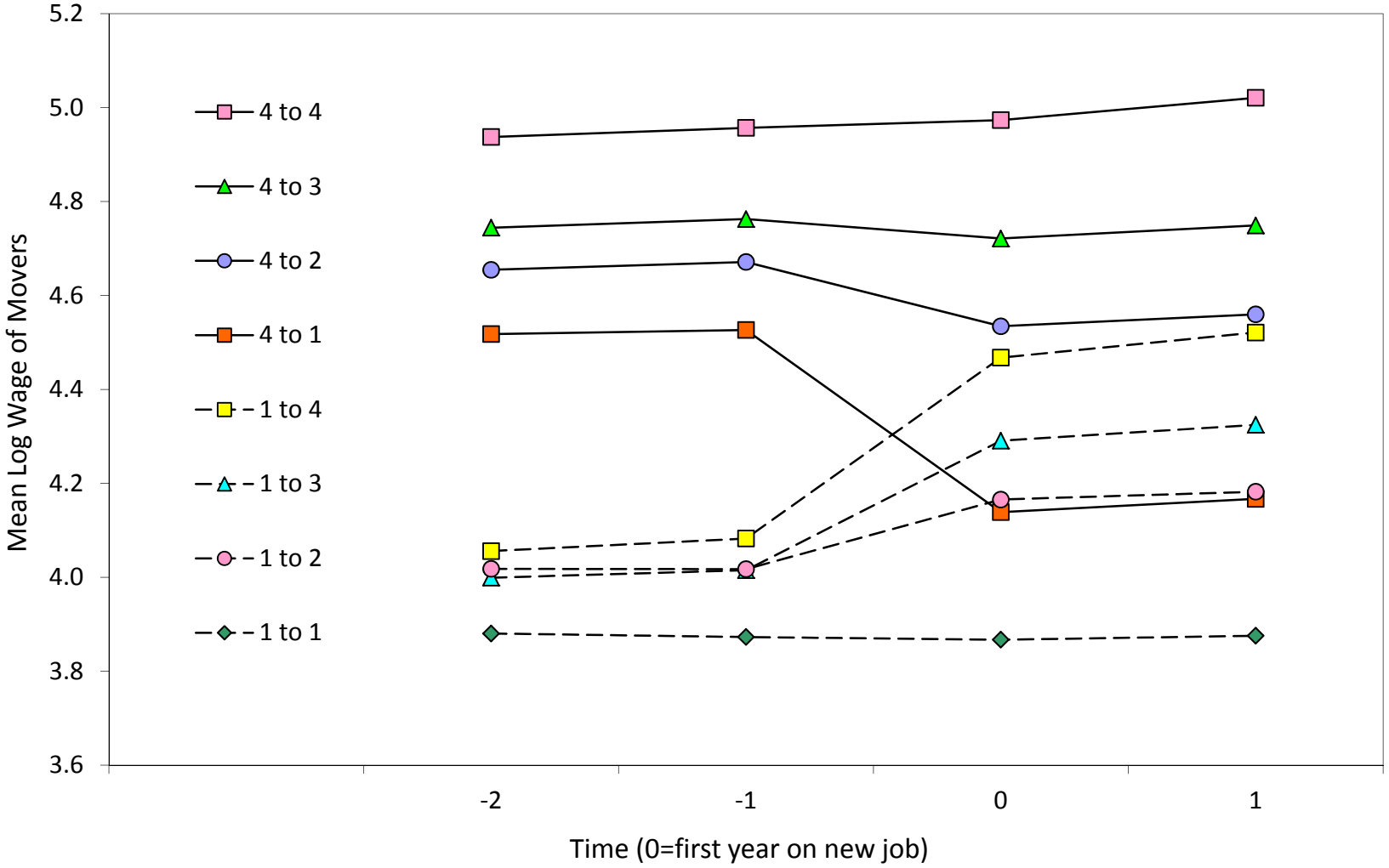
Event Study

- Classify all jobs in a year by average wage of coworkers (into 4 quartiles).
- Select workers who change establishments; classify each change by quartile of co-worker wages in last year of old job/first year of new job.
- Workers with 2+ years pre-change and post-change (at least 1 co-worker pre and post).
- Conduct separately for early years (1985/91) and later years (2002-2009).

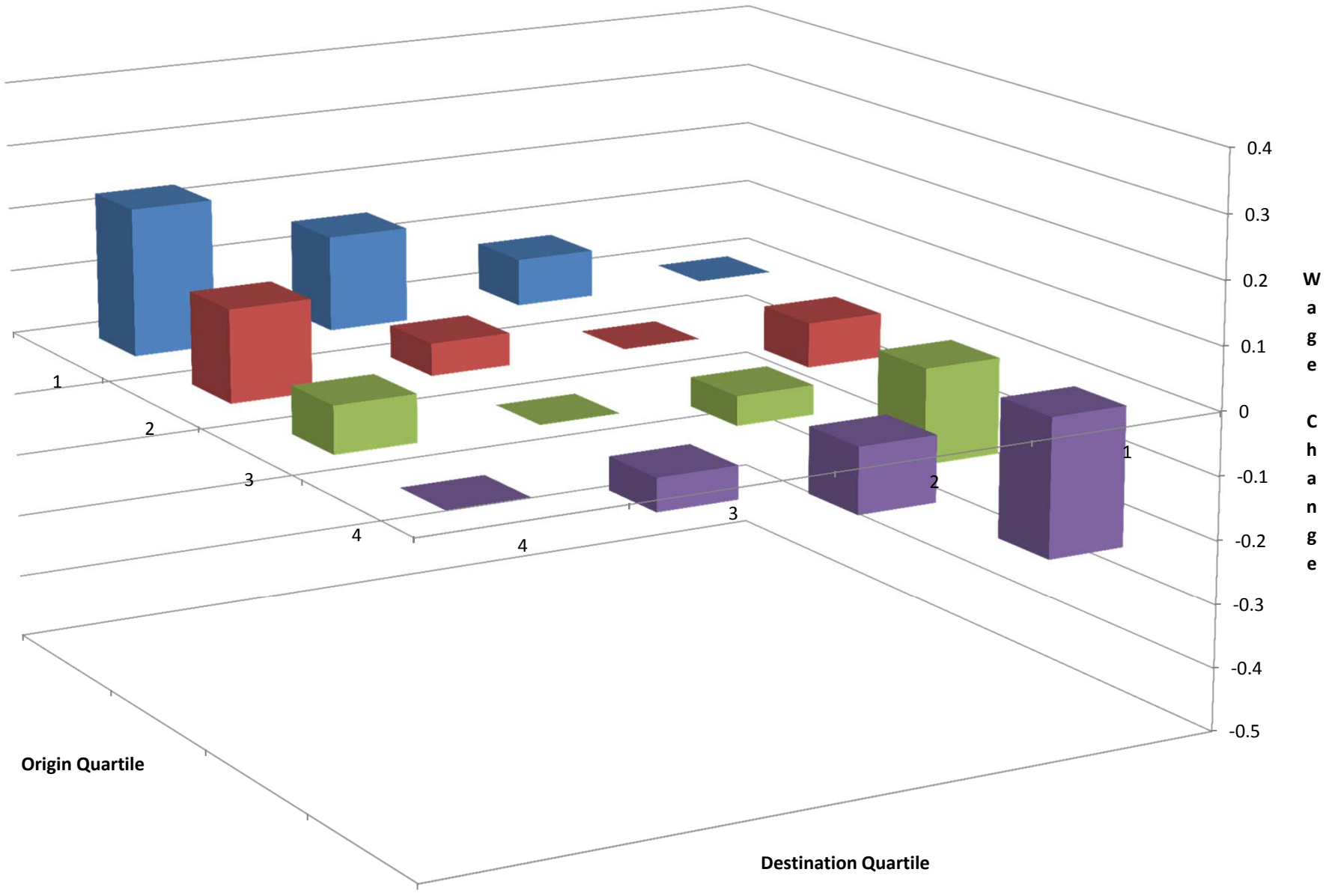
Mean Wages of Movers, Classified by Quartile of Mean Wage of Co-Workers at Origin and Destination, (Interval 1, 1985-1991)



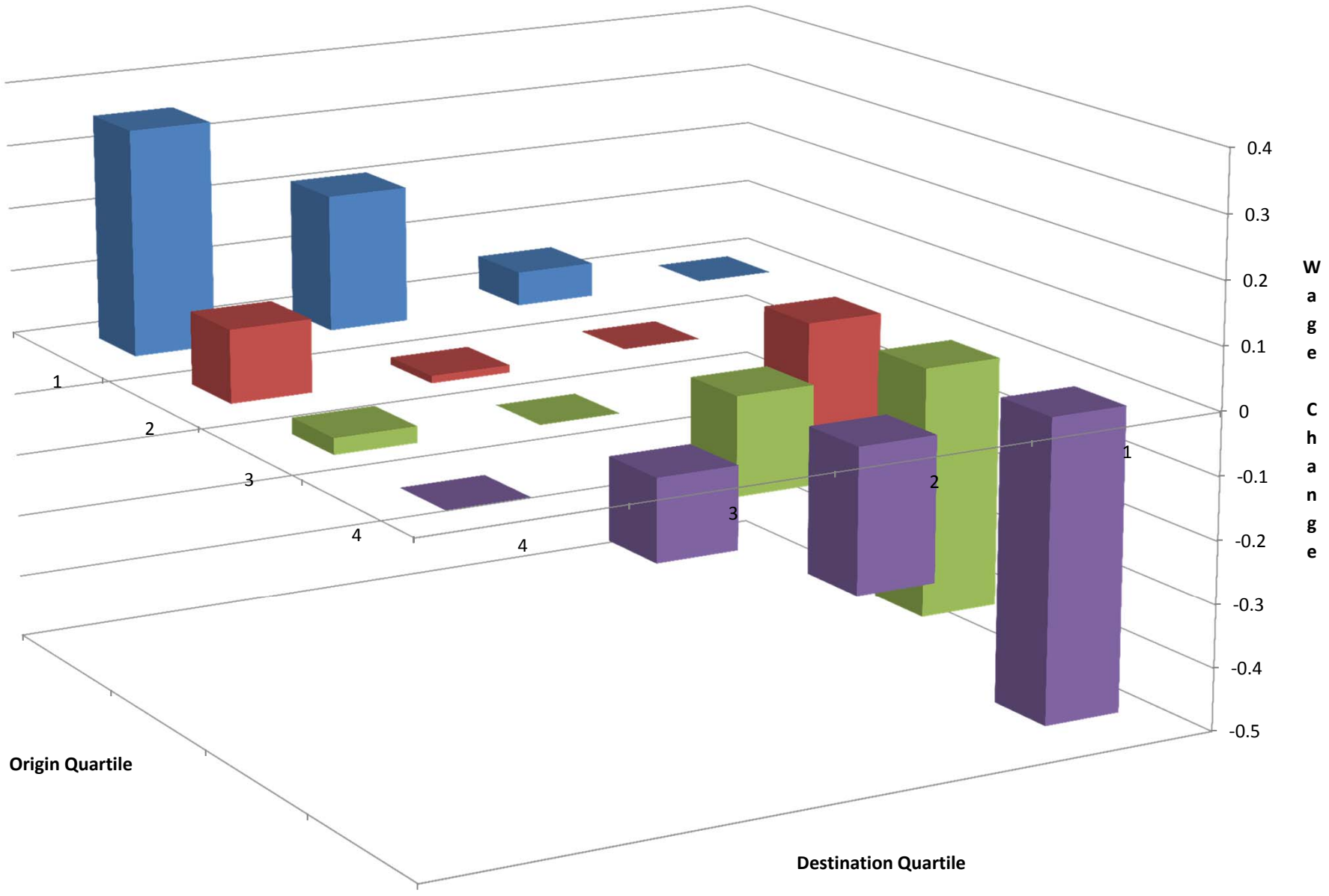
Mean Wages of Movers, Classified by Quartile of Mean Wage of Co-Workers at Origin and Destination, (Interval 4, 2002-2009)



Trend Adjusted Wage Changes Between Co-Worker Quartiles (interval 1)

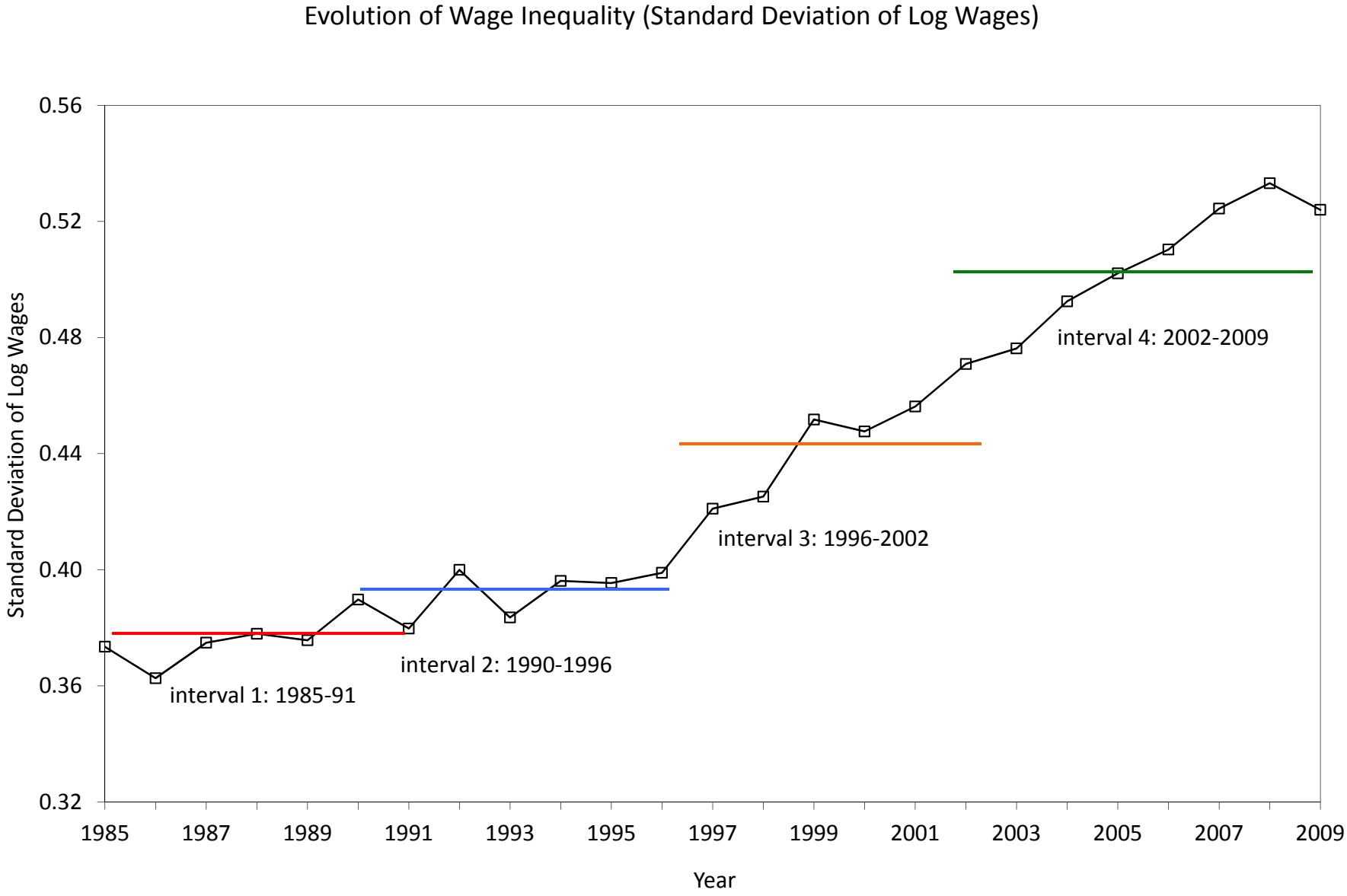


Trend Adjusted Wage Changes Between Co-Worker Quartiles (interval 4)



Roadmap

- Discuss Abowd, Kramarz, and Margolis (AKM, 1999) model.
- Estimate it locally over four intervals.
- Examine non-stationarity in estimates.
- Assess goodness of fit.
- Decompose between-group patterns of inequality.


Evolution of Wage Inequality (Standard Deviation of Log Wages)
Standard Deviation of Log Wages
0.56
0.52
0.48
0.44
0.40
0.36
0.32
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
Year
interval 1: 1985-91
interval 2: 1990-1996
interval 3: 1996-2002
interval 4: 2002-2009

Some notation

$$y_{it} = \underbrace{\alpha_i}_{\text{person effect}} + \underbrace{\psi_{\boldsymbol{J}(i,t)}}_{\text{establishment effect}} + \underbrace{x'_{it}\beta}_{\text{time varying controls}} + \underbrace{\eta_{i\boldsymbol{J}(i,t)}}_{\text{match effect}} + \underbrace{\zeta_{it}}_{\text{drift}} + \underbrace{\varepsilon_{it}}_{\text{transitory error}}$$

Fixed effects | *Random Effects*

- **Person effect**: "portable" component of earnings power.
- **Establishment effect**: employer-specific component of earnings power.
- **Time varying controls**: education x year dummies and age cubic interacted with education (linear term omitted)
- **Match effect:** treatment effect heterogeneity

Exogenous Assignment

- A sufficient condition for identification:

$$P(\boldsymbol{J}(i,t) = j|r) = P(\boldsymbol{J}(i,t) = j)$$
$$= G_{jt}(\alpha_i, \psi_1, ..., \psi_j)$$

- Good variation comes from:
  - Workers switching to higher firm effect employers
  - Lower quality workers being laid off from high paying firms
  - Sorting based upon nonwage characteristics of firm (e.g. recruiting effort, commute time, amenities).

Threat to Validity: Selection on transitory component

- Firm has a bad year, wages stagnate, and people leave the following year.
  - Overstates the establishment effect at destination and understates it at origin.
- But should see an Ashenfelter (1978) style dip in event study.
- Also: shocks at each firm should eventually average out to zero as T grows large.

Threat to Validity: Selection on match component

- Possible if lots of scope for comparative advantage *and* worker has bargaining power.
- But transitions in both directions should usually be associated with wage increases.

$$E\left[y_{it} - y_{it-1} | 1 \rightarrow 2\right] = -\psi_1 + E[\eta_{i2} - \eta_{i1} | 1 \rightarrow 2]$$

$$E\left[y_{it} - y_{it-1} | 2 \rightarrow 1\right] = \psi_1 + E[\eta_{i1} - \eta_{i2} | 2 \rightarrow 1]$$

- And unrestricted match effects model should fit much better than person + establishment.

Threat to Validity: Selection on drift component

- Possible if firms learn rapidly about workers and learning associated with job to job mobility (Gibbons and Katz, 1992).
- But, learning takes years (Lange, 2007).
  - Ought to see an increasing trend in event study before upward transitions and decreasing trend before downward transitions.
- Offer shopping (e.g. Postel-Vinay and Robin, 2002)
  - Difficulty explaining symmetry in event study.

Identification

- Establishment effect contrasts only identified within "connected set" of establishments.
  - Set of establishments connected (either directly or indirectly) via worker transitions.
  - Adjacency matrix representation (connected components).
- We only consider the largest connected set of establishments (roughly 90% of establishments, 96% of workers).
  - Depth First Search (DFS) algorithm to find connected set quickly.
  - Normalization: set one firm effect to zero in connected set.

Table 1: Summary Statistics for Overall Sample and Individuals in Largest Connected Set

	All full time men, age 20-60				Individuals in Largest Connected Set			
			Log Real Daily Wage				Log Real Daily Wage	
Interval	Number person/yr. obs.	Number Individuals	Mean	Std. Dev.	Number person/yr. obs.	Number Individuals	Mean	Std. Dev.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1985-1991	86,230,097	17,021,779	4.344	0.379	84,185,730	16,295,106	4.351	0.370
largest connected/all					***97.6***	***95.7***	***100.2***	***97.7***
1990-1996	90,742,309	17,885,361	4.391	0.392	88,662,398	17,223,290	4.398	0.384
largest connected/all					***97.7***	***96.3***	***100.2***	***97.9***
1996-2002	85,853,626	17,094,254	4.397	0.439	83,699,582	16,384,815	4.405	0.432
largest connected/all					***97.5***	***95.8***	***100.2***	***98.3***
2002-2009	93,037,963	16,553,835	4.387	0.505	90,615,841	15,834,602	4.397	0.499
largest connected/all					***97.4***	***95.7***	***100.2***	***98.8***
Change from first to last interval			**0.043**	**0.126**			**0.045**	**0.128**

Table 2: Estimation Results for AKM Model, Fit by Interval

	Interval 1 1985-1991 (1)	Interval 2 1990-1996 (2)	Interval 3 1996-2002 (3)	Interval 4 2002-2009 (4)
Dimensions / Summary Stats:				
Number person effects	**16,295,106**	**17,223,290**	**16,384,815**	**15,834,602**
Number establishment effects	**1,221,098**	**1,357,824**	**1,476,705**	**1,504,095**
Sample size (person-year obs)	**84,185,730**	**88,662,398**	**83,699,582**	**90,615,841**
Std. Dev. Log Wages	0.370	0.384	0.432	0.499
Summary of Parameter Estimates:				
Std. dev. of person effects	0.289	0.304	0.327	0.357
Std. dev. of establ. effects	0.159	0.172	0.194	0.230
Std. dev. of Xb	0.121	0.088	0.093	0.084
Correlation of person/establ. effects (across person-year obs.)	0.034	0.097	0.169	0.249
RMSE of AKM residual	0.119	0.121	0.130	0.135
(degrees of freedom)	66,669,487	70,081,245	65,838,023	73,277,100
Adjusted R-squared	0.896	0.901	0.909	0.927
Comparison Match Model				
RMSE of Match model	0.103	0.105	0.108	0.112
Adjusted R-squared	0.922	0.925	0.937	0.949
Std. Dev. of Match Effect*	0.060	0.060	0.072	0.075

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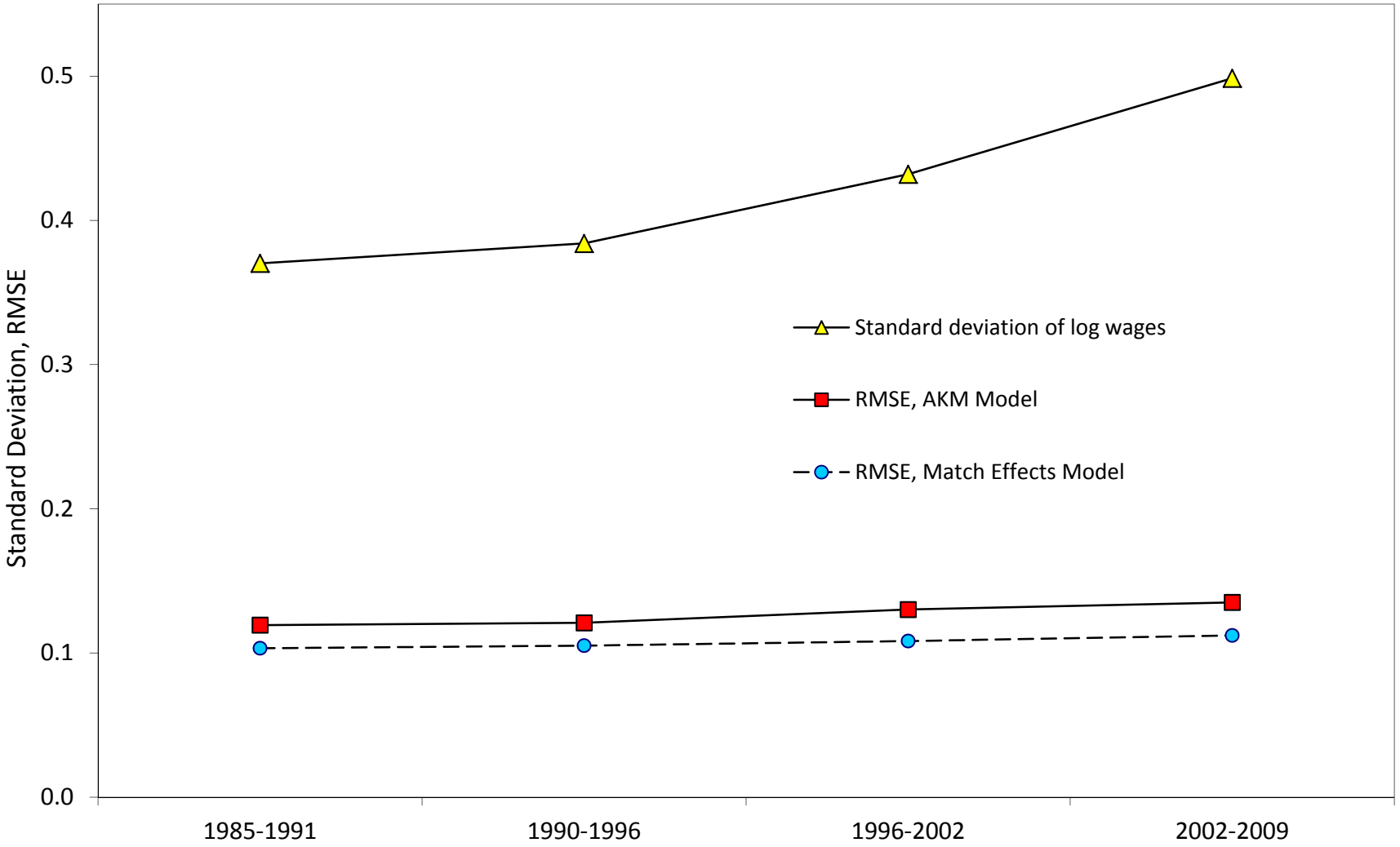
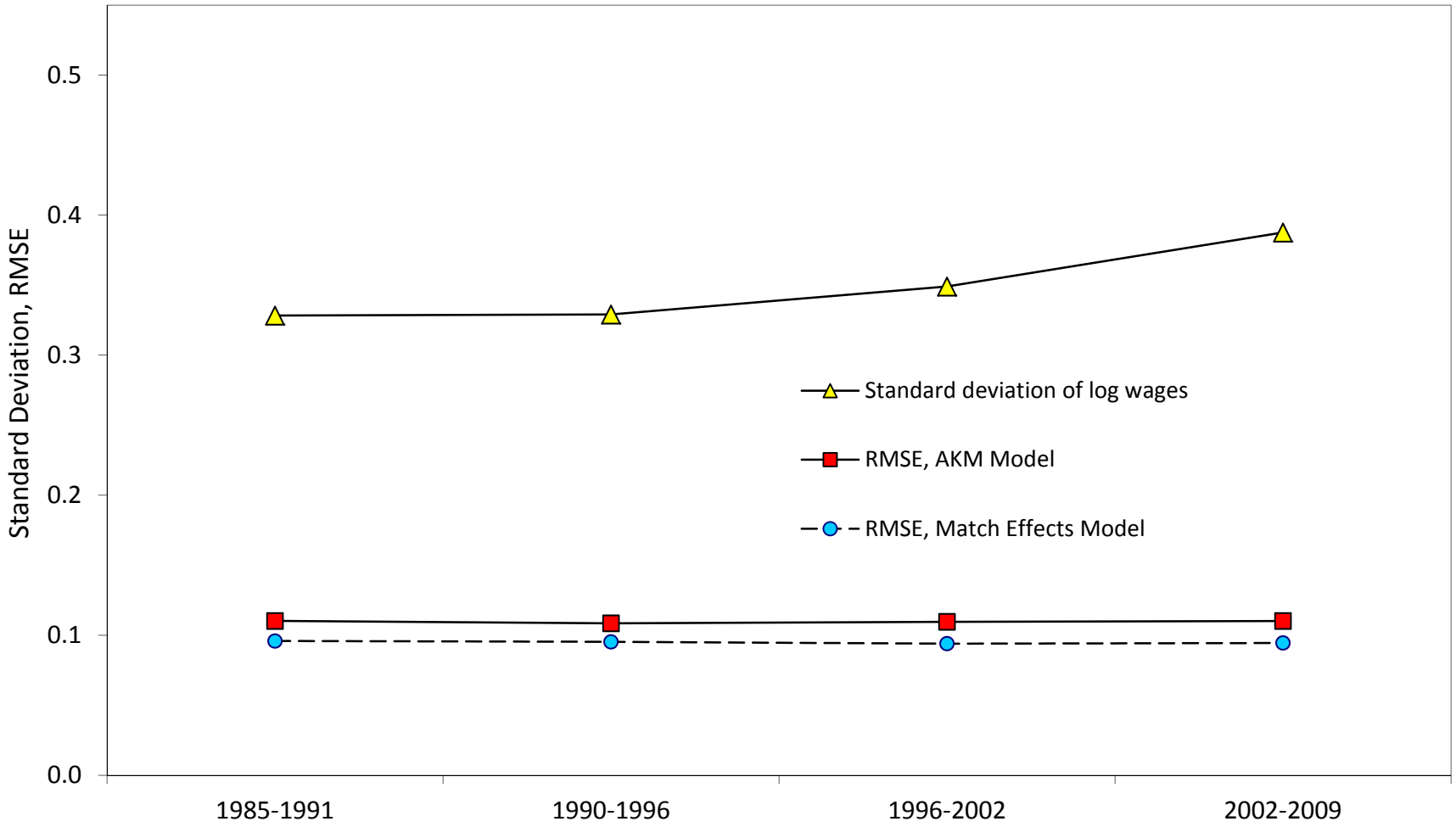
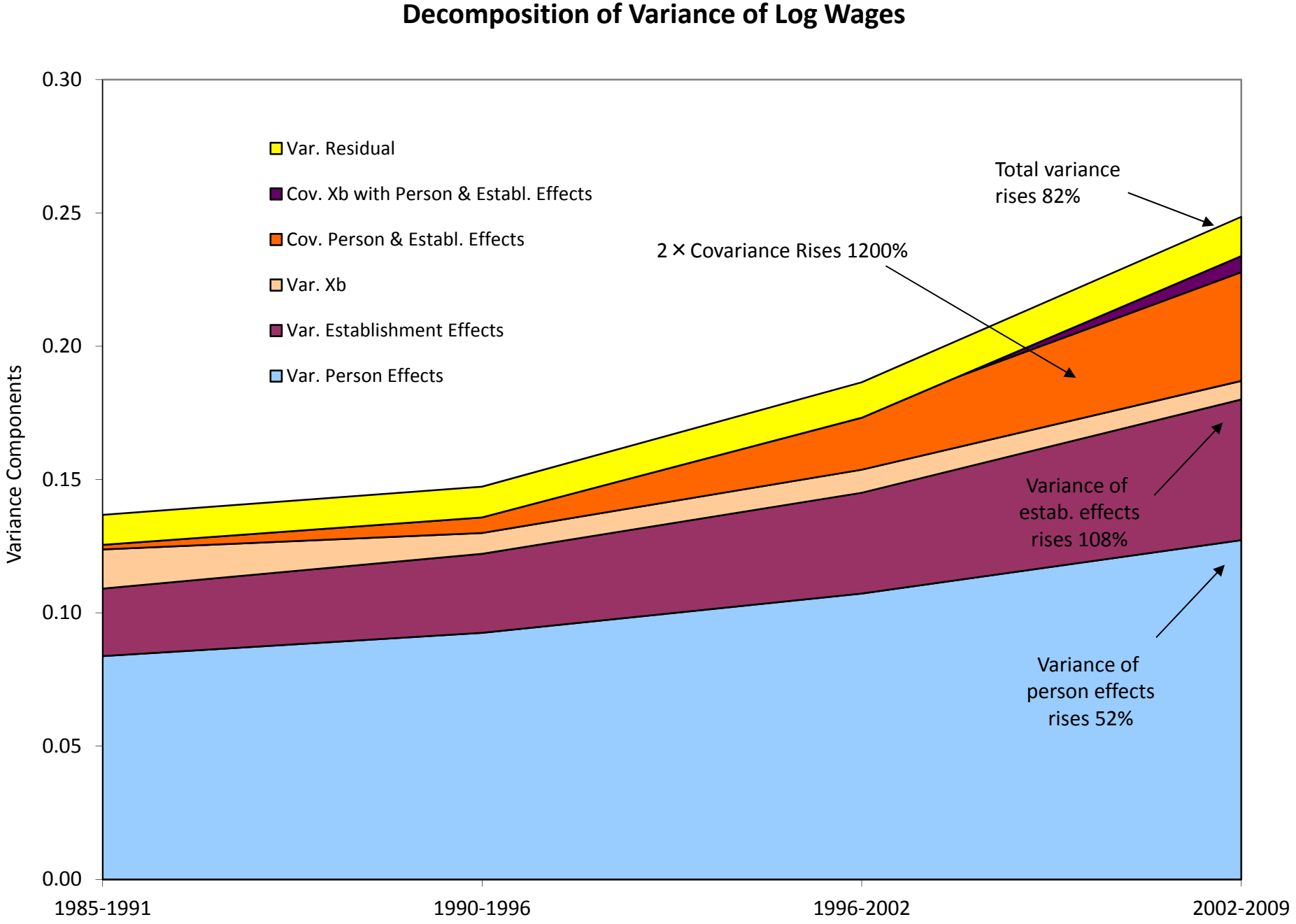
AKM explains nearly all of the rise in wage inequality

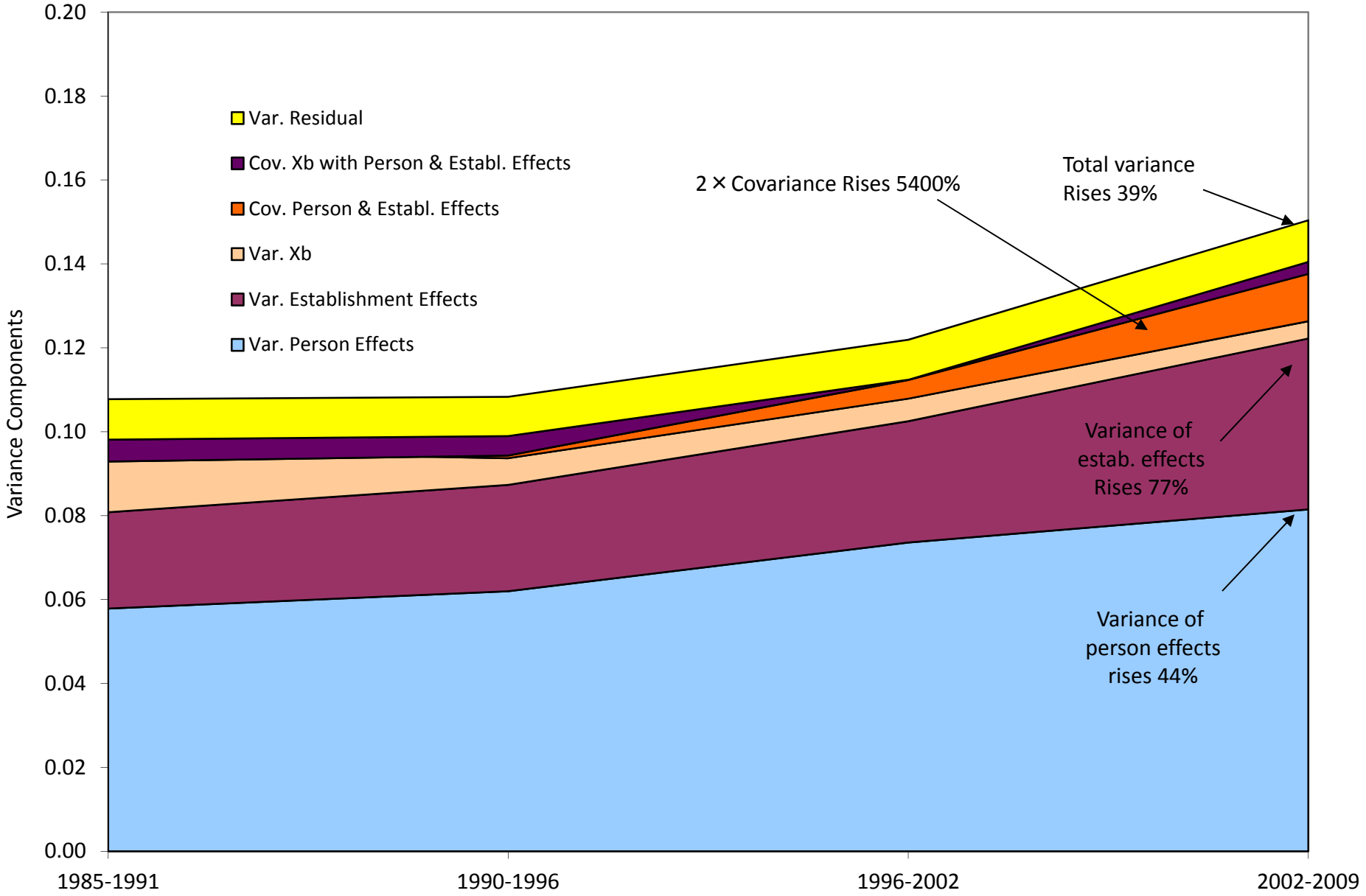


Same for apprentice only sample

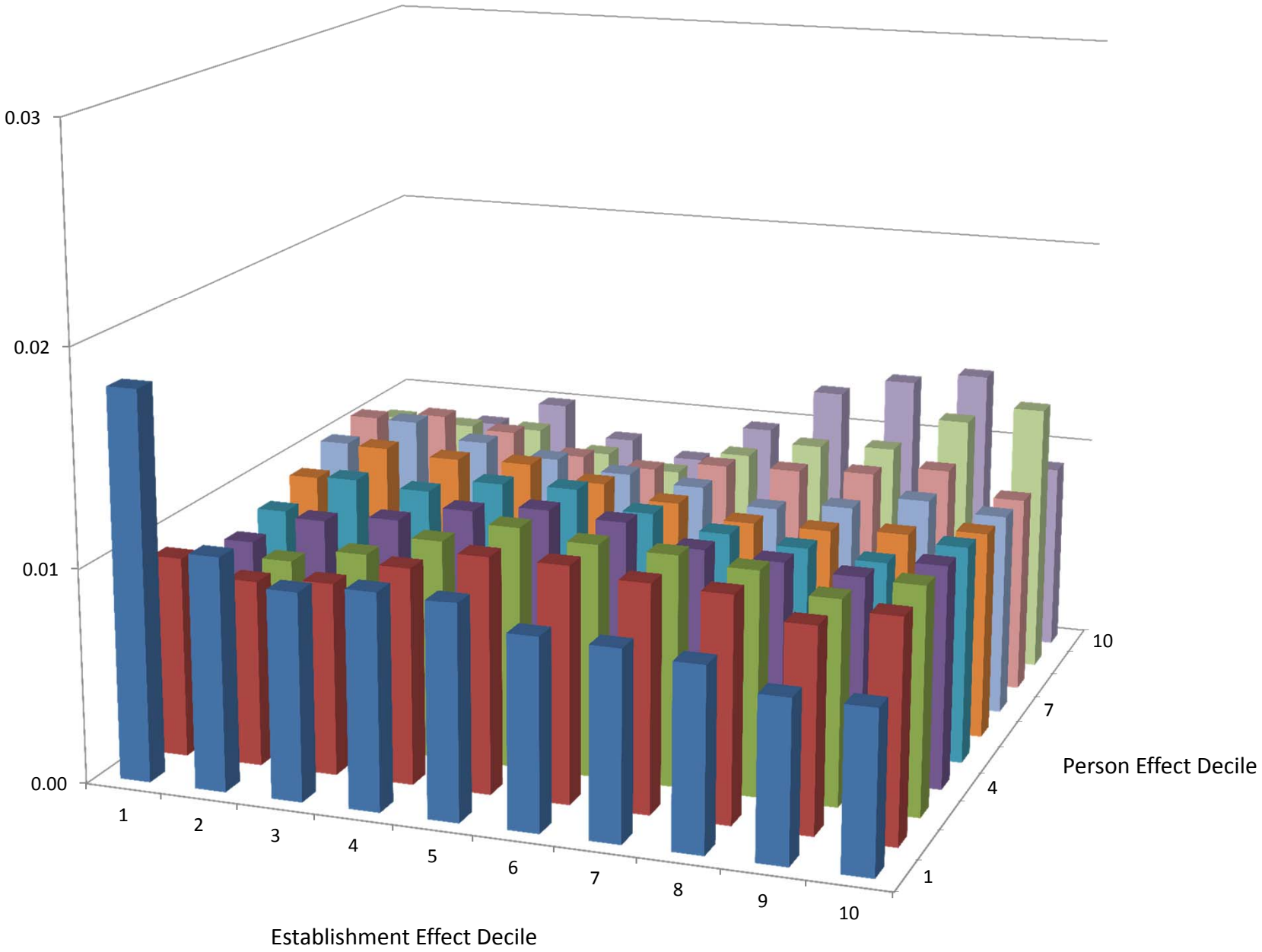



Decomposition of Variance of Log Wages
Variance Components
0.30
0.25
0.20
0.15
0.10
0.05
0.00
1985-1991
1990-1996
1996-2002
2002-2009
Var. Residual
Cov. Xb with Person & Establ. Effects
Cov. Person & Establ. Effects
Var. Xb
Var. Establishment Effects
Var. Person Effects
Total variance rises 82%
2 × Covariance Rises 1200%
Variance of estab. effects rises 108%
Variance of person effects rises 52%

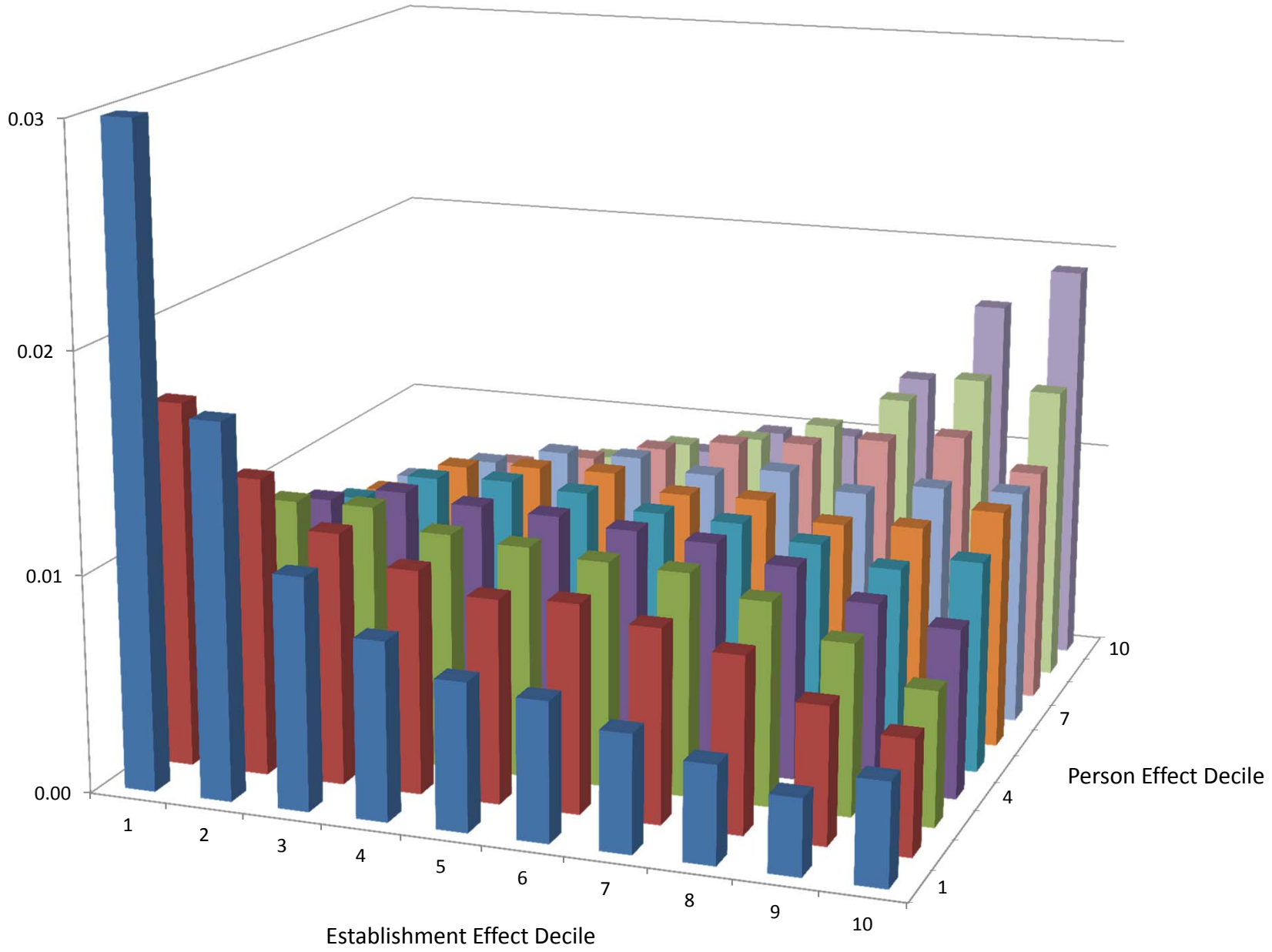
Decomposition of Variance of Log Wages, Apprentices Only



Joint Distribution of Person and Establishment Effects, Interval 1

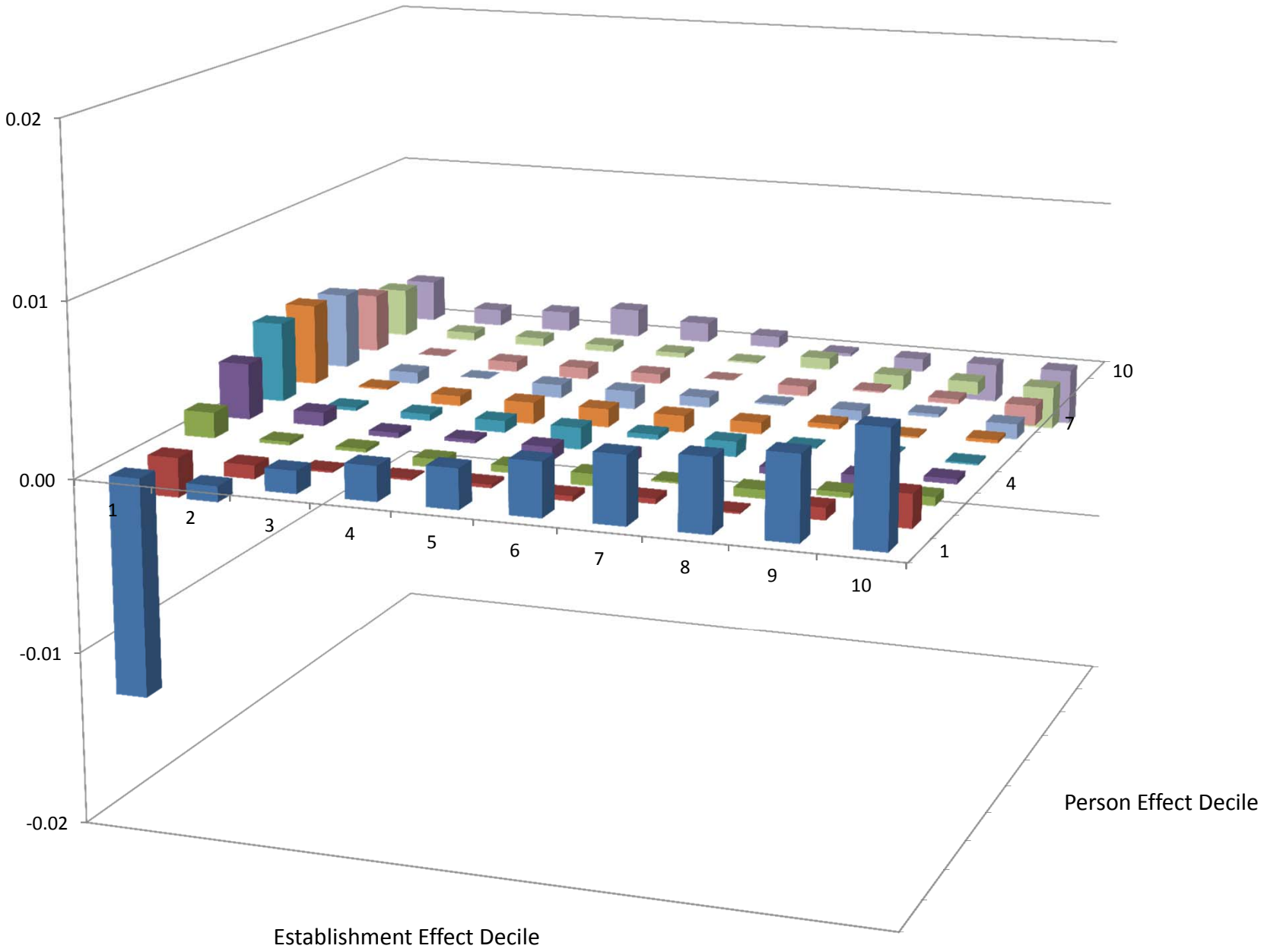


Joint Distribution of Person and Establishment Effects, Interval 4

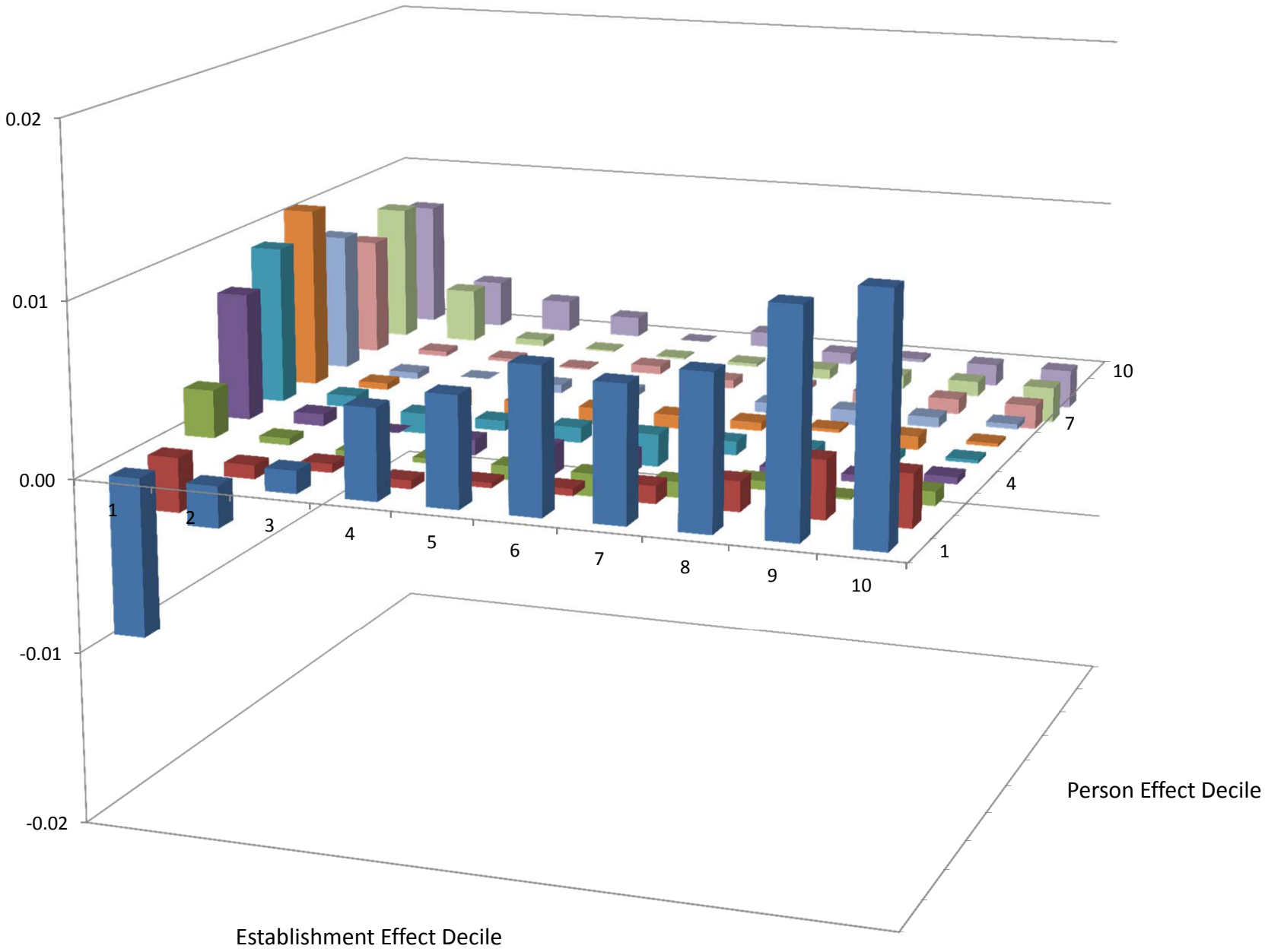


Some tests of specification

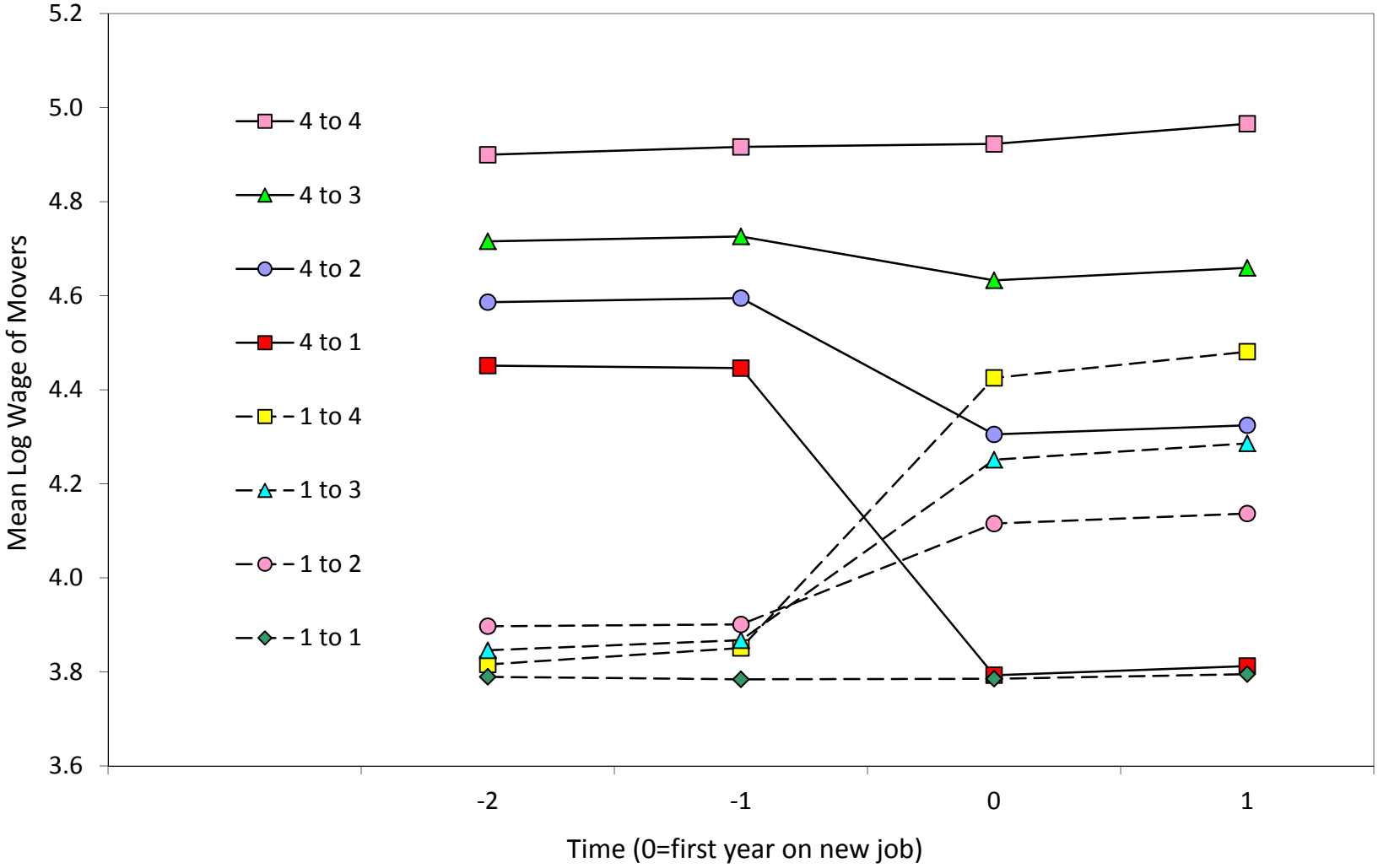
Mean Residual by Person/Establishment Deciles, Interval 1



Mean Residual by Person/Establishment Deciles, Interval 4



Mean Wages of Movers, Classified by Quartile of Establishment Effects for Origin and Destination Firms



Decomposing Between Group Variation

Rise in Wage Inequality Across Education Groups

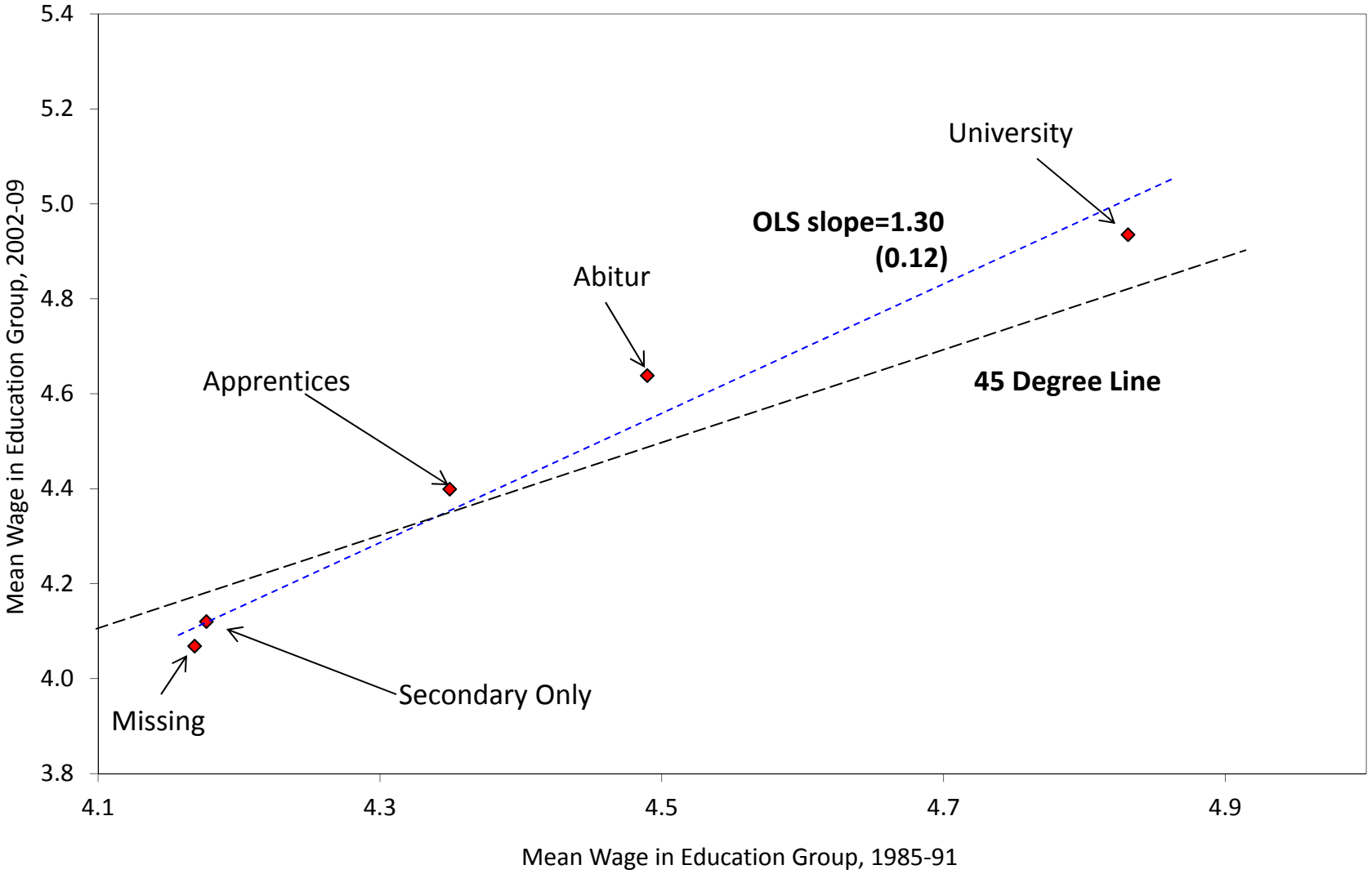
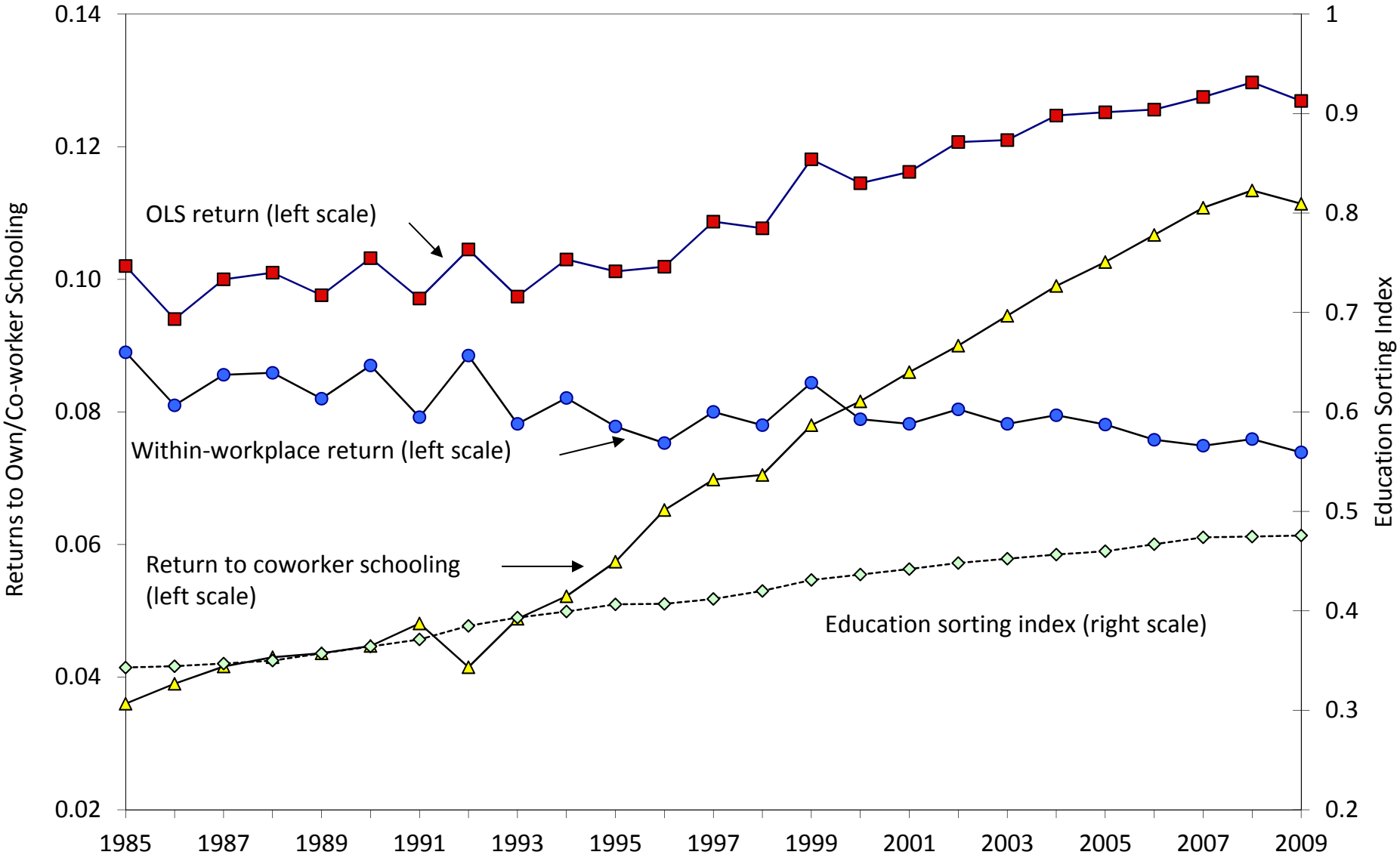


Table 4: Decomposition of Changes in Relative Wages by Education Level

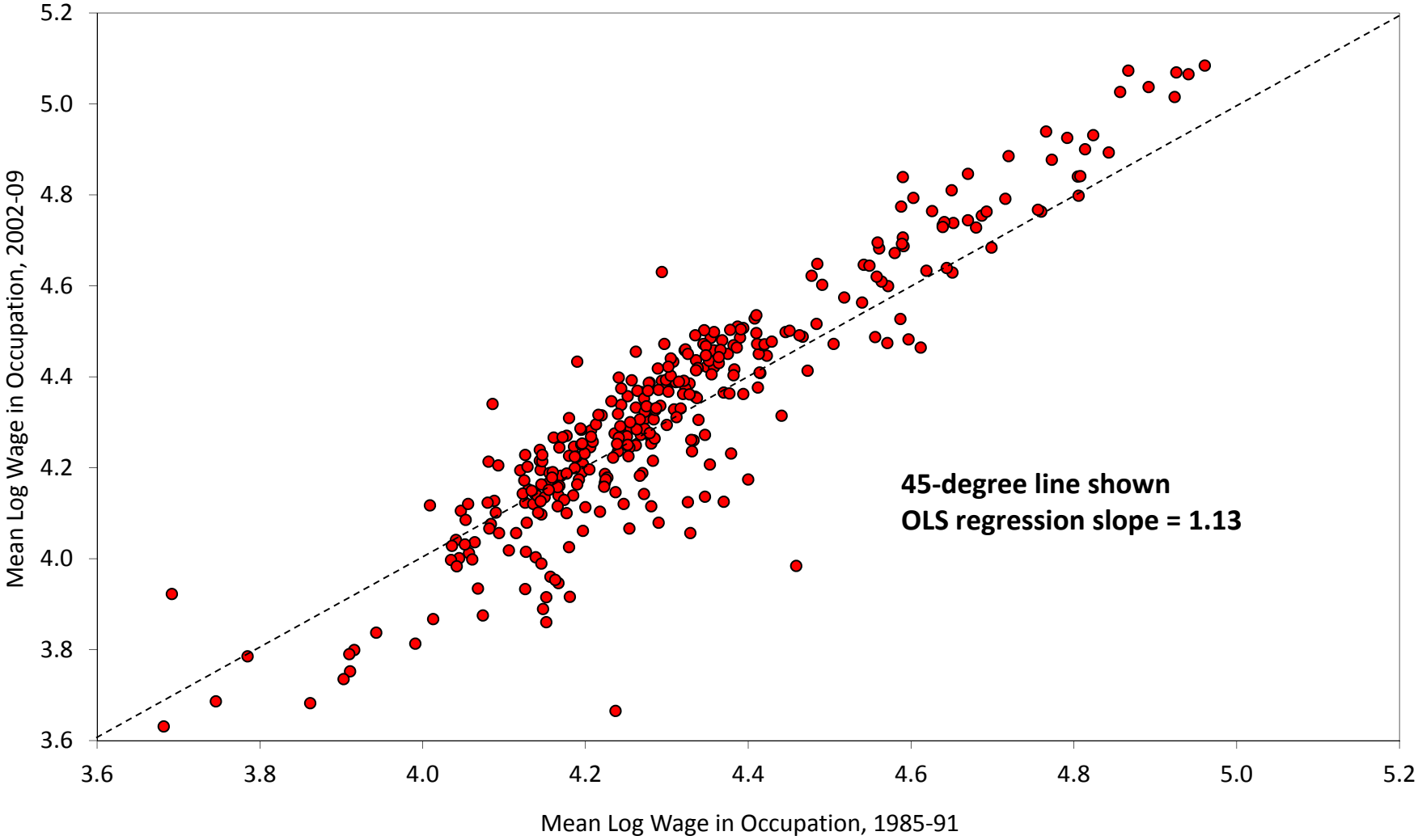
	Change Relative to Apprentices in:			
	Mean Log Wage	Person Effect	Establishment Effect	Remainder
	(1)	(2)	(3)	(4)
Highest Education Qualification:				
1. Missing/none	**-14.9**	**1.8**	**-12.2**	-4.2
2. Lower Secondary or less	**-10.5**	**-0.1**	**-6.3**	-4.1
3. Apprentices	**0.0**	**0.0**	**0.0**	0.0
4. Abitur	**10.1**	**0.0**	**2.6**	7.5
5. University or more	**5.7**	**1.5**	**3.9**	0.3

Notes: Wage changes are measured from 1985-1991 to 2002-2009. Remainder (column 4) represents changing relative contribution of Xb component.

Cross-Check: Mundlak (1978) Decomposition of Return to Education



Mean Real Wages by Occupation: 2002-09 vs 1985-91



Contribution of Person and Establishment Effects to Wage Variation Across Occupations and Industries

	Interval 1	Interval 2	Interval 3	Interval 4	Change in Variance (Int. 1 to Int 4)	
	1985-1991	1990-1996	1996-2002	2002-2009	Change	Share
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Between Occupations (342 3-digit occupations)						
Std. dev. of mean log wages	**0.217**	**0.221**	**0.246**	**0.279**	**0.031**	**100**
Std. dev. of mean person effects	0.183	0.195	0.195	0.207	0.009	31
Std. dev. of mean estbl. effects	0.089	0.094	0.102	0.126	0.008	26
Corr. mean person/establ. effects	0.082	0.111	0.284	0.296	0.013	42
Panel B: Between Industries (96 2-digit industries)						
Std. dev. of mean log wages	0.173	0.184	0.203	0.224	0.020	100
Std. dev. of mean person effects	0.103	0.114	0.128	0.140	0.009	44
Std. dev. of mean estbl. effects	0.104	0.110	0.108	0.121	0.004	19
Corr. mean person/establ. effects	0.242	0.301	0.422	0.403	0.008	42

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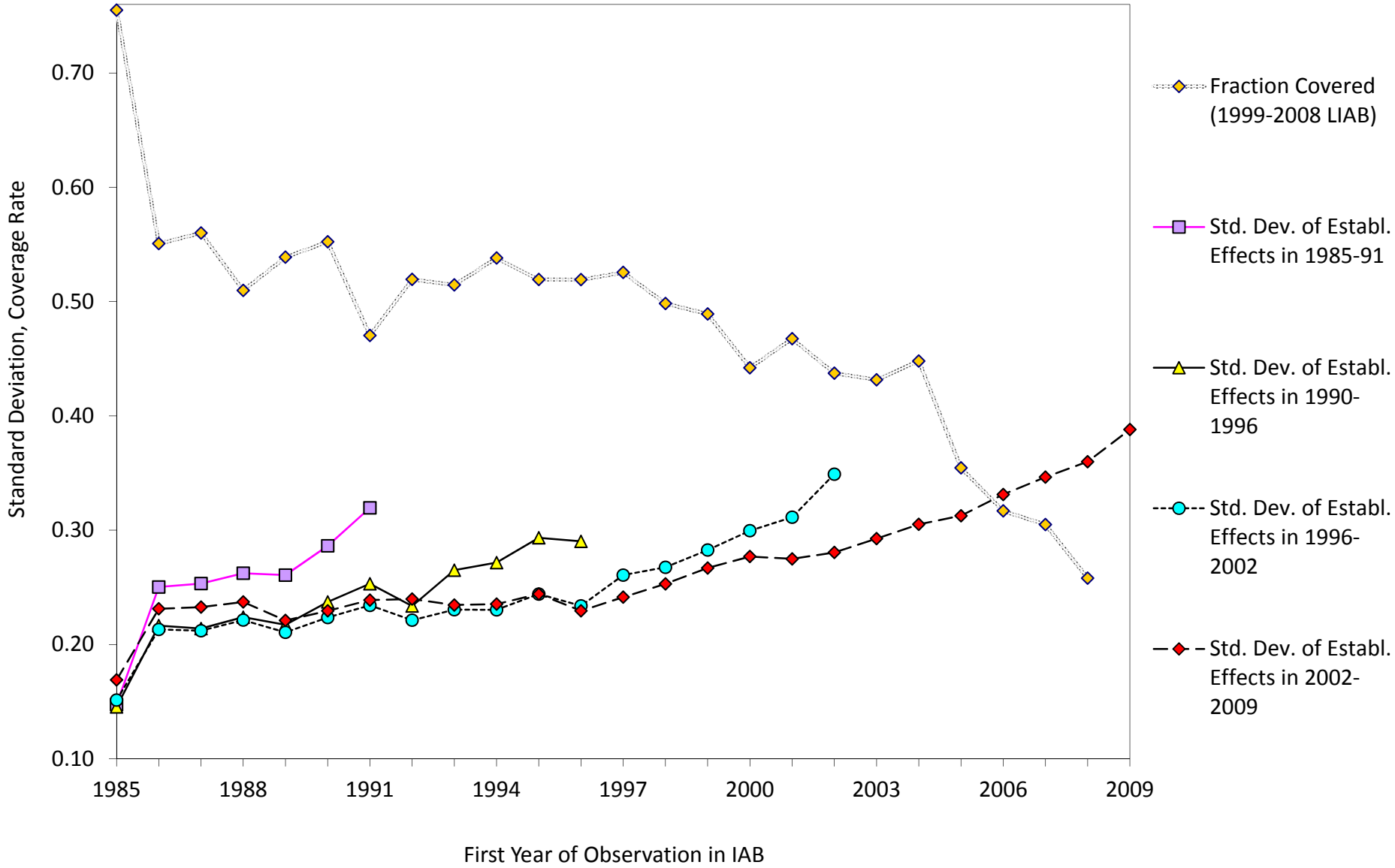
Why is dispersion in estab effects rising so fast after 1996?

- First show a “birth cohort” effect – firms born after 1996 have more variable establishment effects.

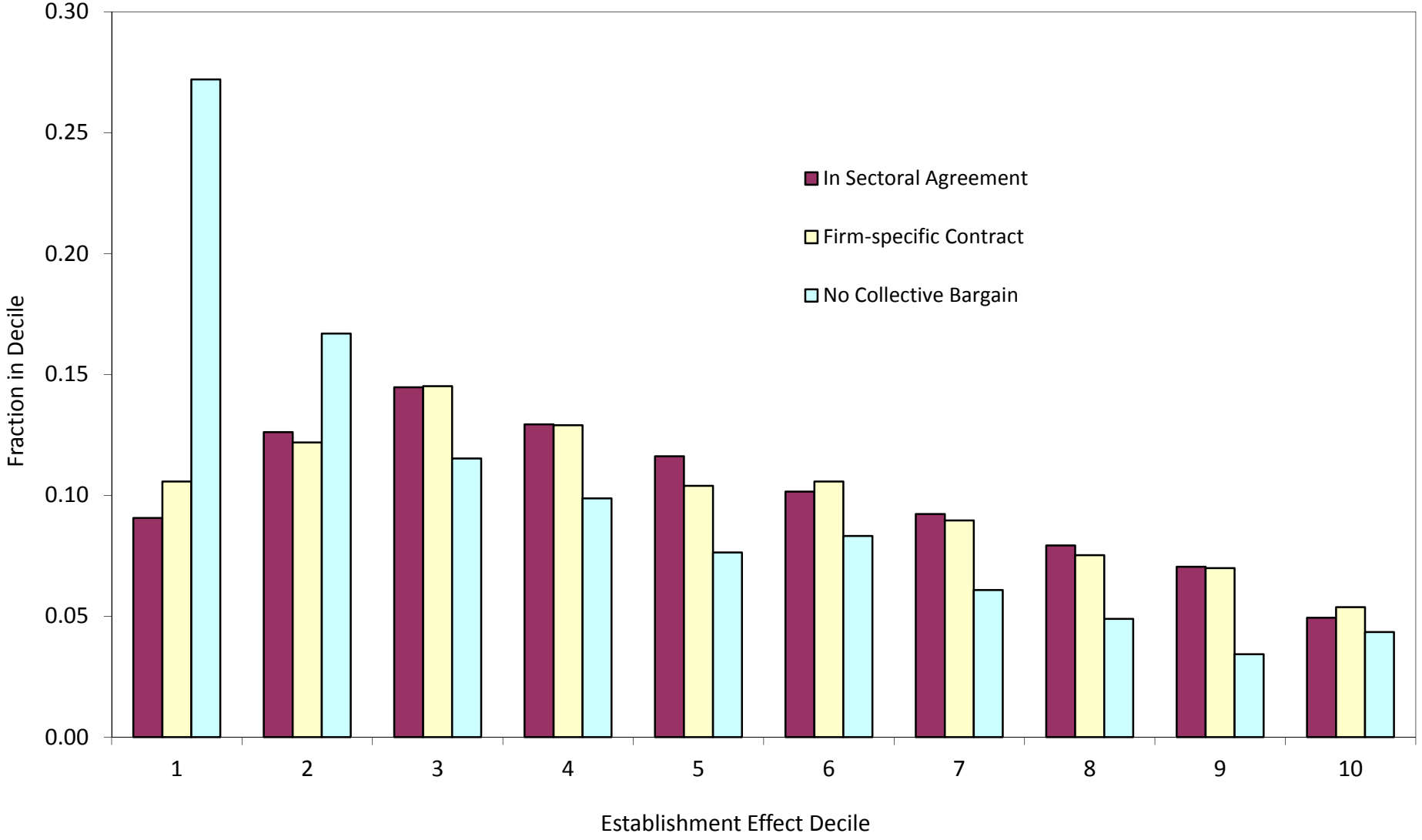
- Then show that firms not in sectoral contract have more variable (and skewed) effects.

- Connection?

Figure 15: Standard Deviation of Establishment Effects and Fraction Covered by Collective Agreements, by Birth Year of Establishment

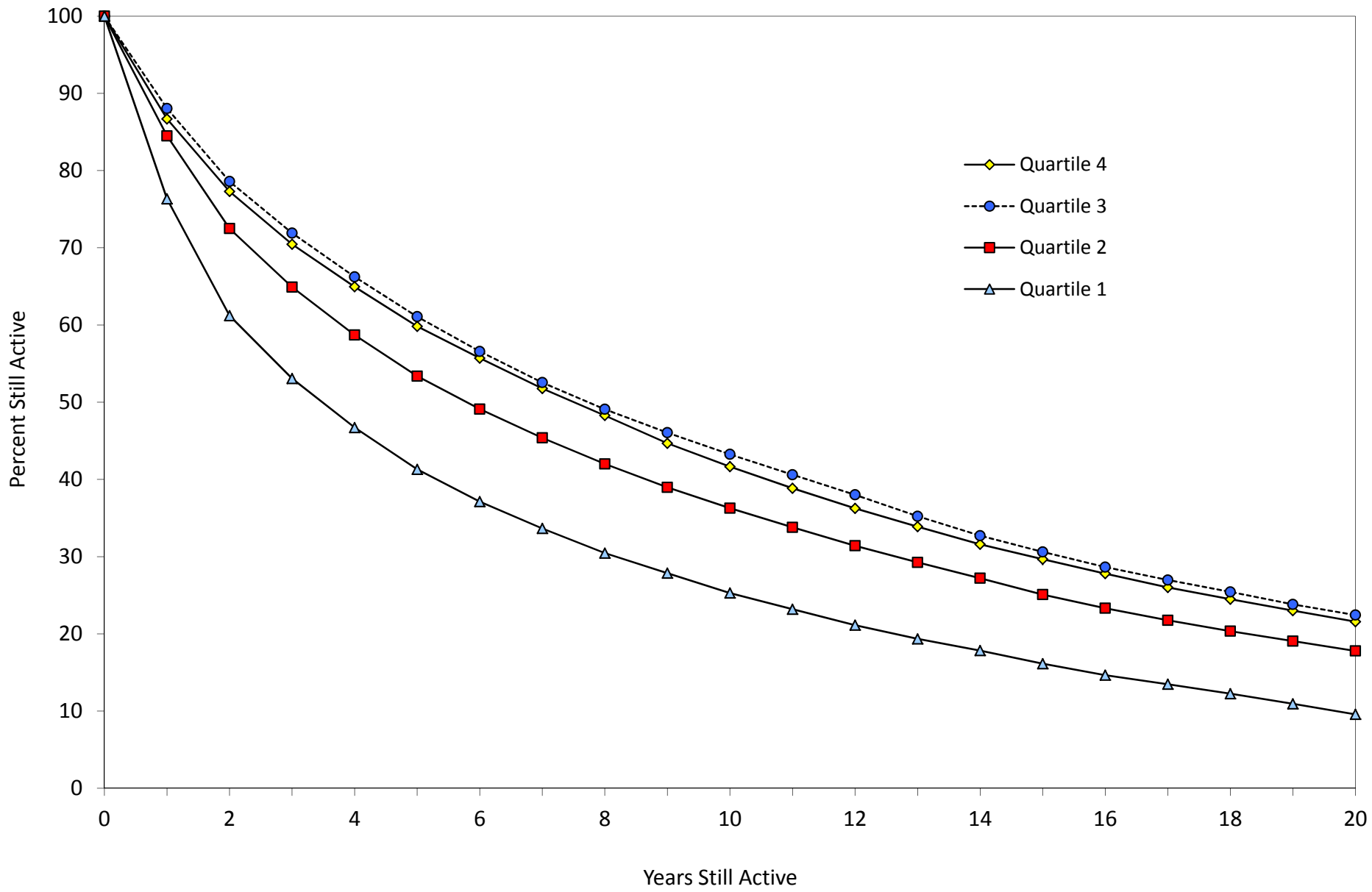


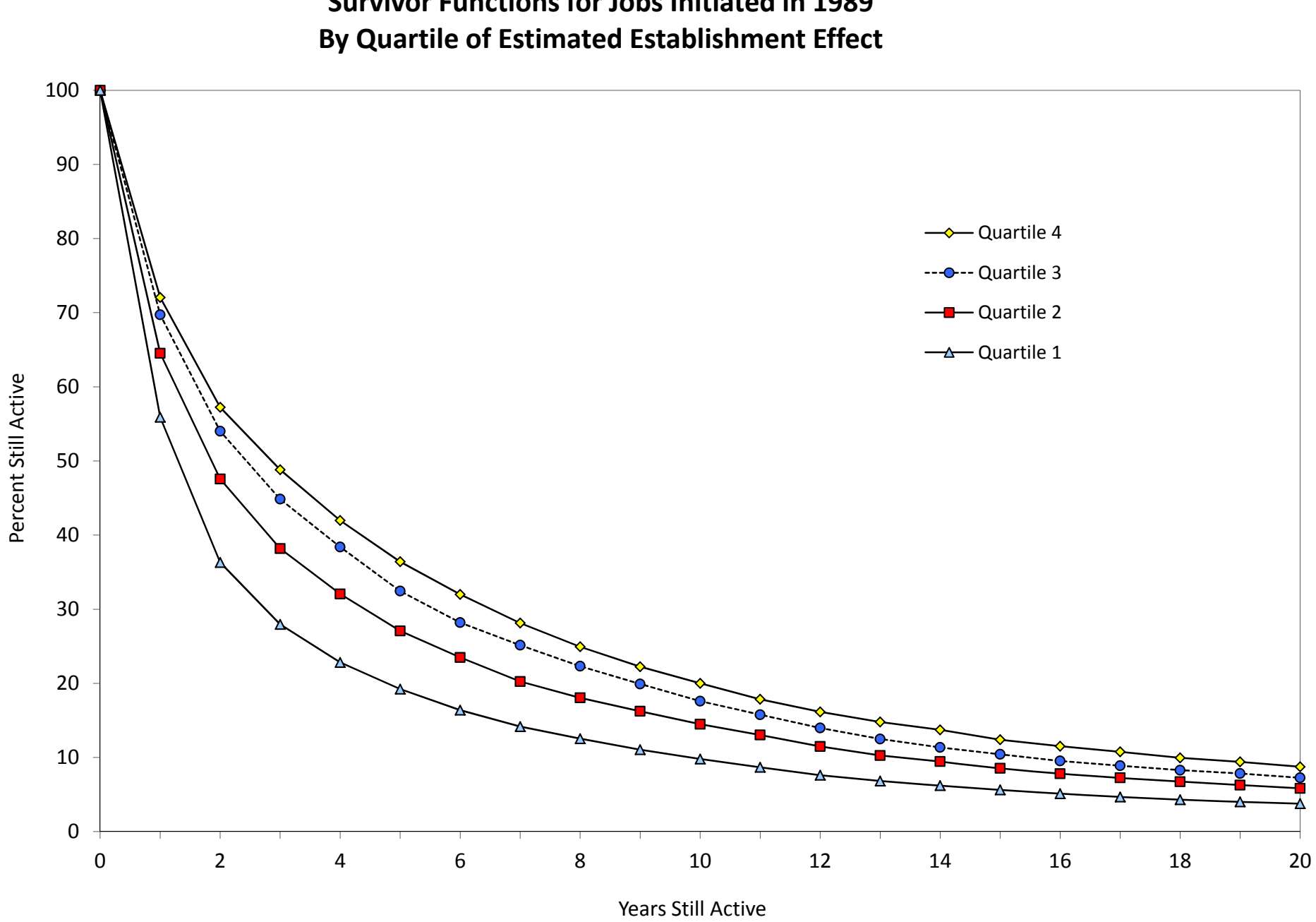
Distribution of Establishment Effects by Collective Bargaining Status
(Based on Establishment Effects for 1996-2002, Bargaining Status in 2000 LIAB)



note: sample includes 7,080 establishments in 2000 Wave of LIAB that can be linked to IAB

Are High Wage Establishments Eventually Driven Out of the Market?


Survivor Functions for Establishments First Observed in 1989
By Quartile of Estimated Establishment Effect
Percent Still Active
Years Still Active
Quartile 4
Quartile 3
Quartile 2
Quartile 1
0
10
20
30
40
50
60
70
80
90
100
0
2
4
6
8
10
12
14
16
18
20


Survivor Functions for Jobs Initiated in 1989
By Quartile of Estimated Establishment Effect
Percent Still Active
100
90
80
70
60
50
40
30
20
10
0
0
2
4
6
8
10
12
14
16
18
20
Years Still Active
Quartile 4
Quartile 3
Quartile 2
Quartile 1

Conclusions

- Establishment component is rising share of wage variation
  - Working for a “high wage” firm more important than ever.
- Rising assortative matching
  - The best paid workers are increasingly concentrated at the best paying establishments.
- Establishment cohort effects in wage setting
  - Newer establishments more unequal.

Questions

- Are these patterns specific to Germany?

- Proximate vs. ultimate sources of change
  - Technology
  - Decreasing adherence to sectoral contracts
  - Outsourcing and fragmentation of firms
  - Trade

- The economics of employer heterogeneity
  - How much of plant wage variation due to productivity?
  - How do workers get matched to firms? (networks, schooling, recruiting)
  - How best to capture w-f interactions?