Automation and Occupational Wage Trends: What Role for Unions and Collective Bargaining?

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Background

Routine-biased Technological Change:

- Technological advancements generate declining demand for routine tasks (Autor & Dorn; Acemoglu & Autor; Goos, Manning, Salomons)

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1. **Employment shares:** decline of high "routine task intensive" occupations
    - Manufacturers, Office Clerks
    - Middle of wage distribution
    - Job polarization: decline of automatable jobs + increase in low-pay and high-pay jobs

Background

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2. **Occupational wages:**
    - Declining demand = a possibility for declining relative wage growth
    - Occupational wage polarization? In the U.S. (1990s)
    - In many European countries, automatable occupations still experiencing greater wage growth relative to less automatable service-sector jobs

Background

But:

- Primarily focused on a single country (U.S.)
- Little understanding of how labour market institutions affect variance in relative wage growth of automatable occupations

Background

Labour Market Institutions

- Greater union coverage and collective bargaining coverage:
  - Lower in-work poverty rates (Brady et al., 2013)
  - Lower levels of wage inequality (Visser & Checchi, 2011)
  - Higher wage premiums for routine occupations (Denice & Rosenfeld, 2018)

- Unions / bargaining coverage on the decline in many countries, especially the U.S., but not a universal trend.

Background

RQ: To what extent do changes in the levels of unionization and collective bargaining coverage within a country affect the relative wage growth of automatable occupations?

- **Sample 1:** 15 countries (OECD Member States)
- **Sample 2:** 50 United States
- Within-country variation, 1980 onward
- “Routine task intensity” of occupations
- Between-occupation wage growth

Hypotheses / Mechanisms

H1: Automatable occupations experience more favourable wage growth relative to less automatable occupations when levels of collective bargaining coverage within a country are stable or increasing.

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3. Bargaining coverage might **decline at a faster rate** among automatable occupations when bargaining coverage at the national level declines.

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$$W_h = M_h + (B_h * U_h) \qquad (2)$$

‘Competitive Wage’ + Bargaining Premium

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If $\frac{\overline{B_h}}{M_h} > \frac{\overline{B_l}}{M_l}$,

Then: decline in bargaining coverage *(U)* equally distributed across occupation types will contribute to relative decline in wages of high RTI occupations, all else constant.

$$\overline{W_h} = \overline{M_h} + \overline{(B_h * U_h)}$$

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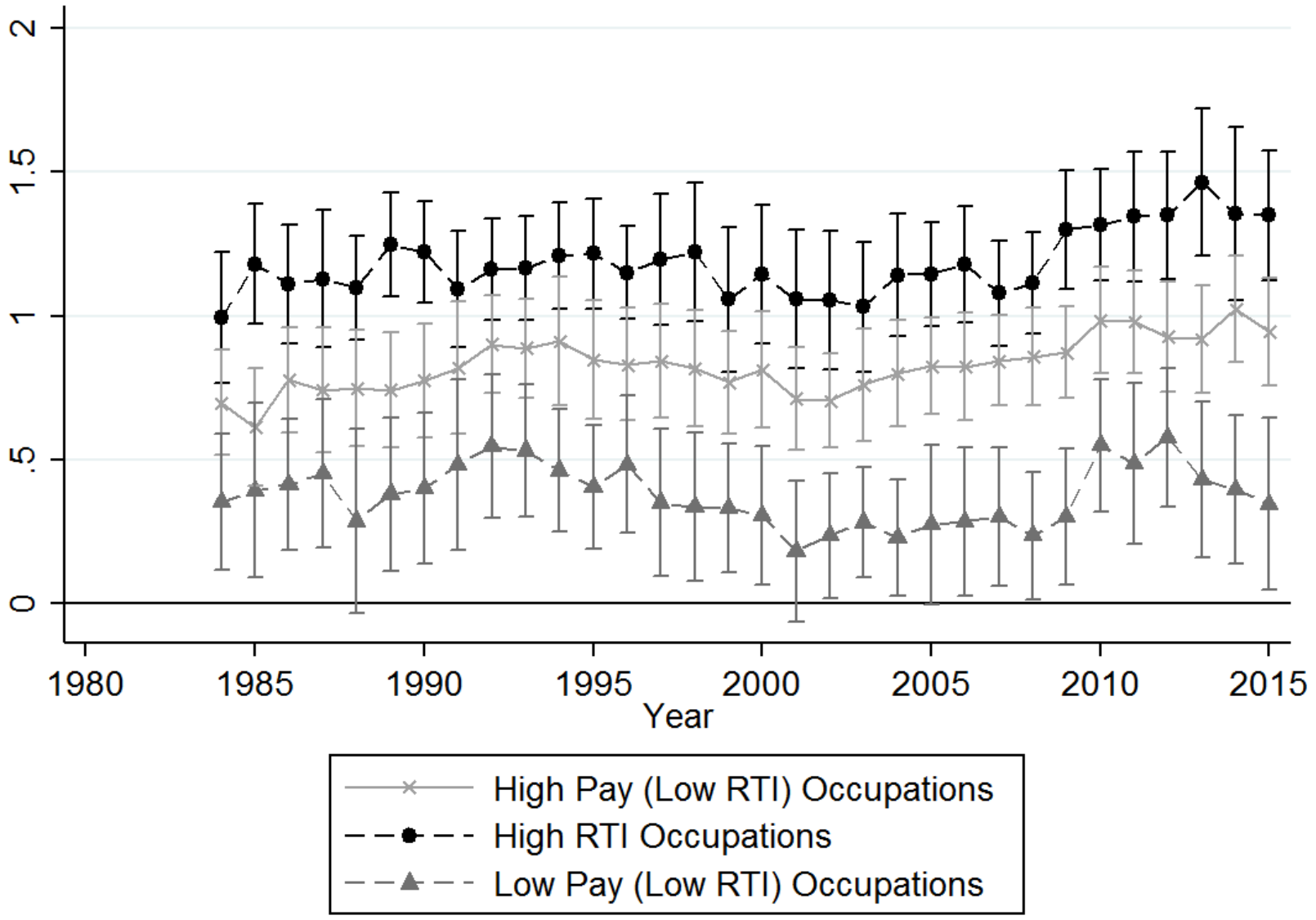
Figure A3: *Bargaining Premium in the U.S.:* Marginal Effect of State-Industry Union Coverage on Log Earnings of Low Pay and High RTI Occupations in the U.S. (50 United States)



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If $\overline{U_h}$ declines at a faster rate than $\overline{U_l}$,

Then: average high RTI occupation might experience relative decline in wages even if relative bargaining premiums are equal.

$$\overline{W_h} = \overline{M_h} + \overline{(B_h * U_h)}$$

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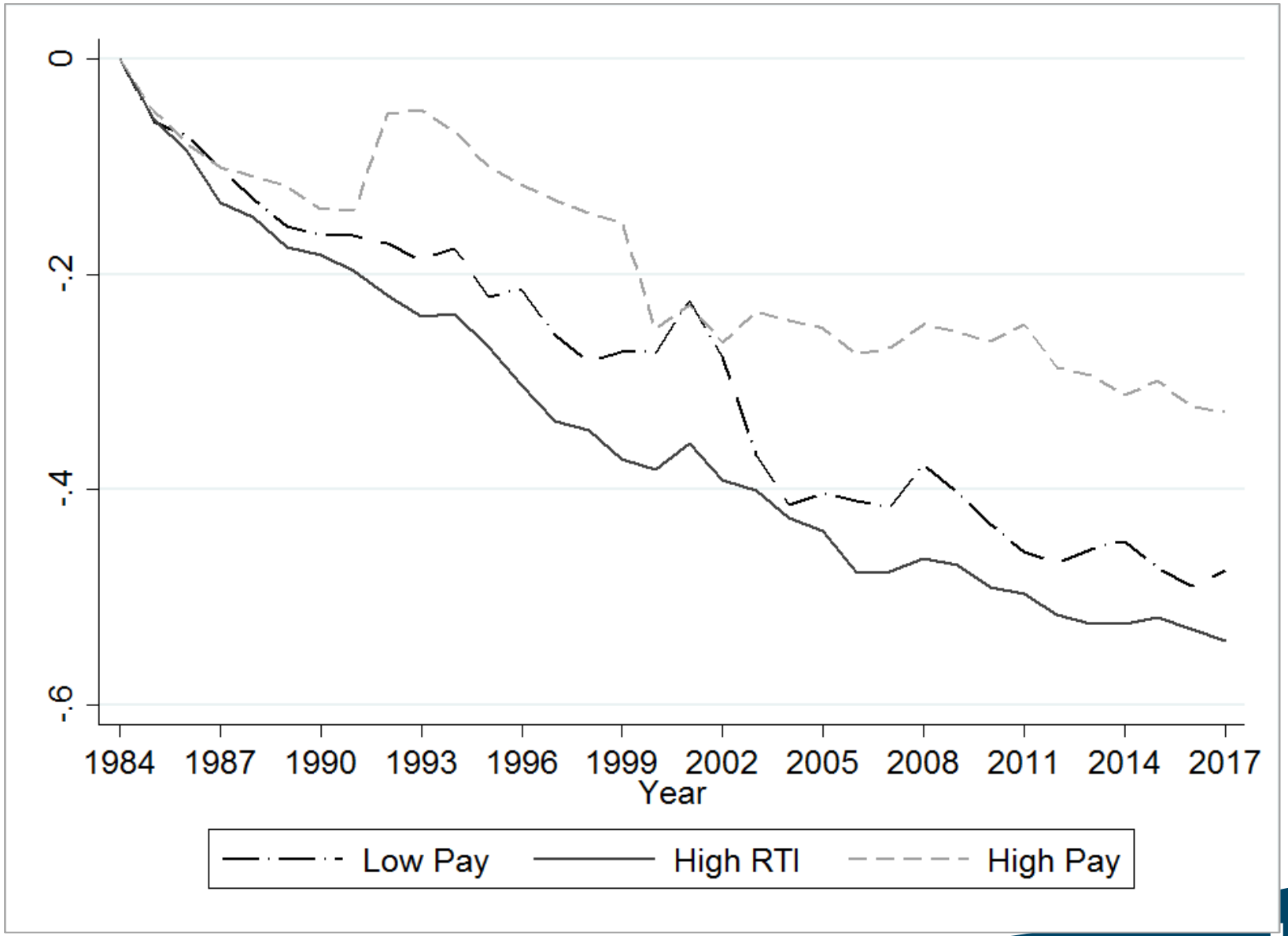
Figure A1: Percent Change in Union Coverage by Year & Occupation Type (United States)



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Hypotheses / Mechanisms

Employment effect:

H2: Increasing bargaining coverage within a country is associated with more rapid declines in employment shares among automatable occupations.

Dualization: automatable occupations can achieve wages above market value, but at expense of labour market outsiders (low skill, new LM entrants, jobseekers, etc.)

Hypotheses / Mechanisms

Investment effect:

H3: Increasing bargaining coverage within a country discourages employers from investing in productivity-enhancing technologies, slowing the shift in demand away from routine tasks.

Capital hold-up: higher bargaining coverage diverts returns from capital investments to workers, encouraging firms to under-invest (Card, Devicienti and Maida, 2014; Green and Sand, 2015)

Data & Methods

Sample 1: Luxembourg Income Study

- 15 advanced economies, 1979-2013
- Employed adults (n=1.4 million)
- Applying Autor & Dorn (2013) measures of “routine task intensity” for each occupation in dataset
- Bargaining coverage at national level

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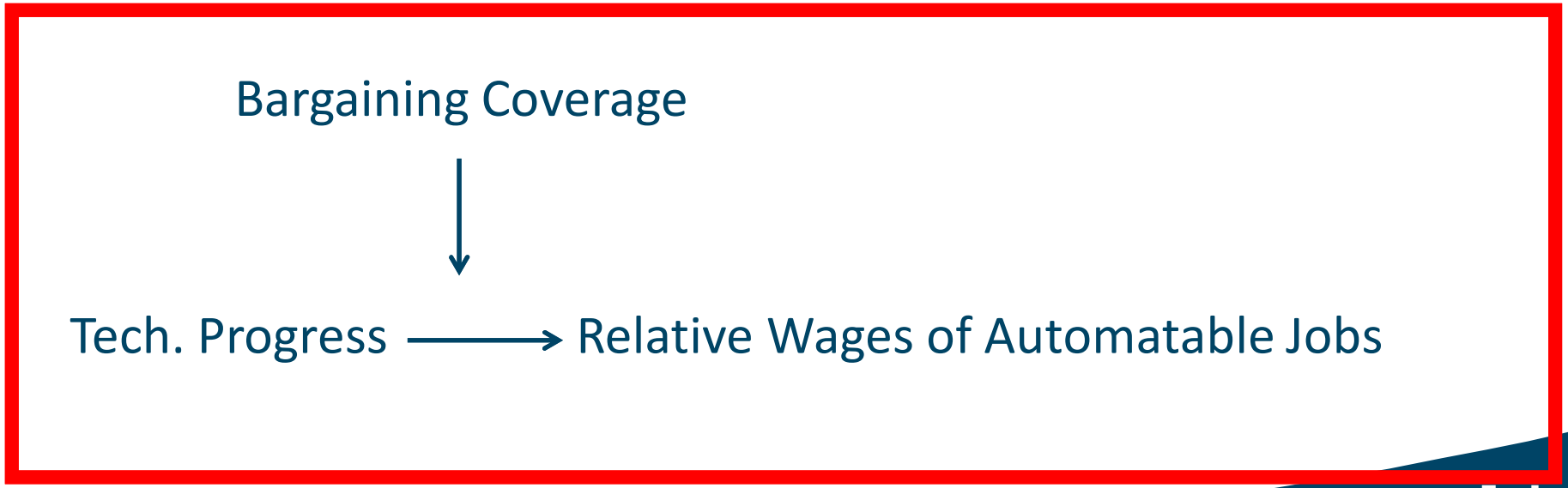

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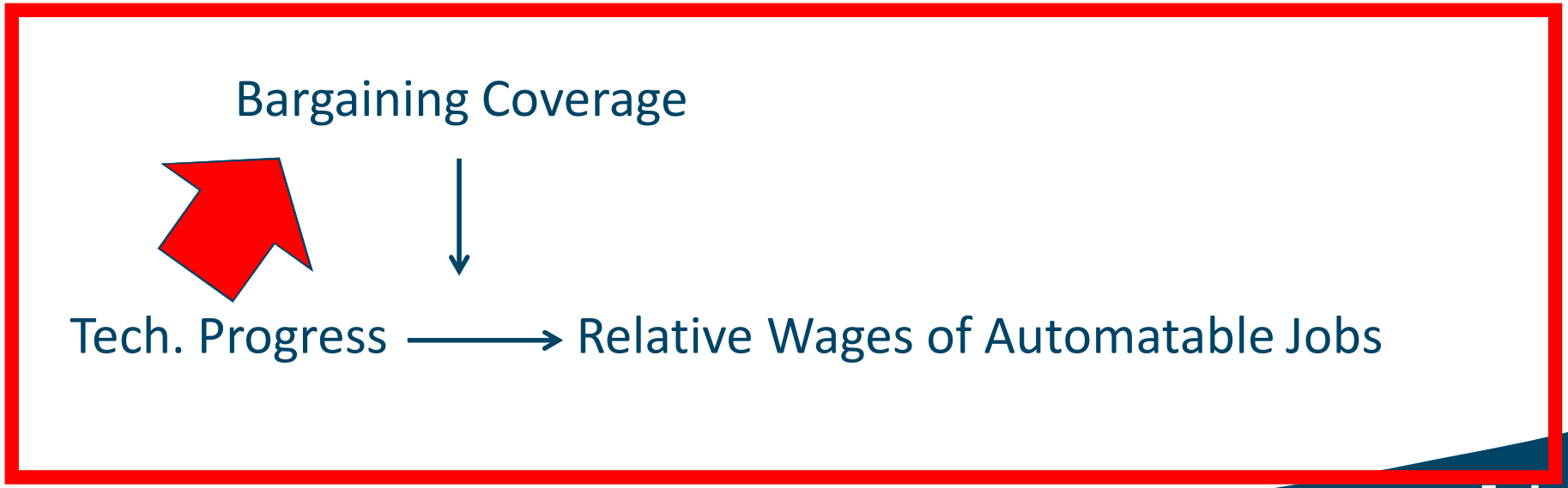


Data & Methods

Sample 2: 50 United States (CPS ASEC)

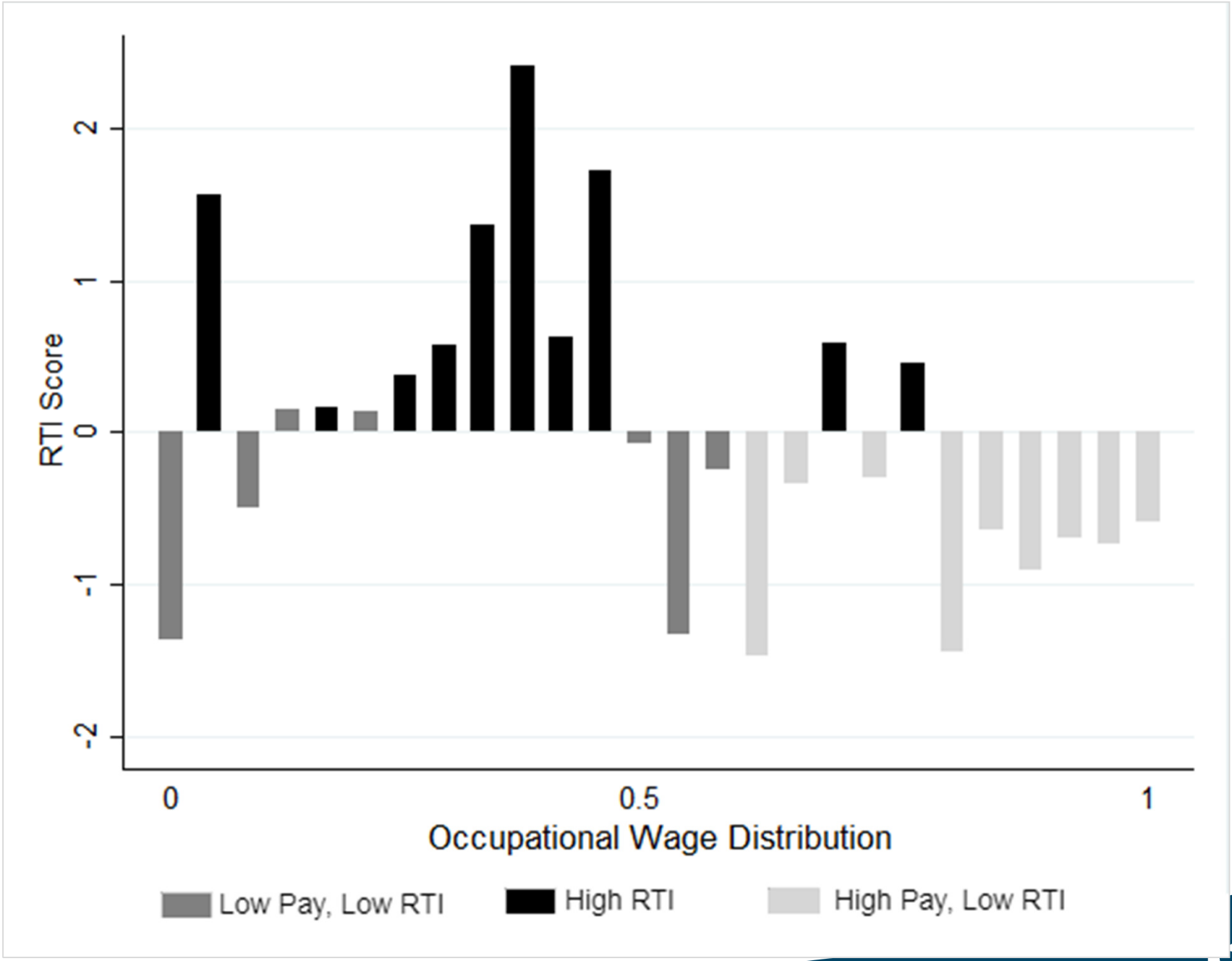
- 50 states, 1984-2015
- Employed adults (n=1.9 million)
- Applying Autor & Dorn (2013) measures of "routine task intensity" for each occupation in dataset
- **Bargaining coverage of automatable occupations in each state and industry**

Data & Methods

Three occupation groups:

1. **High Routine Task Intensity (RTI)**
   - Top third of RTI distribution
   - “Automatable occupations”
   - Ex: manufacturers, sales clerks
2. **Low RTI, Low Pay**
   - Lower RTI + below-average wages
   - Ex: service occupations
3. **Low RTI, High Pay**
   - Lower RTI + above-average wages
   - Ex: managers

High RTI Occupations			U.S.		Non-U.S. Countries	
ISCO-88 Code	Job Title	RTI Score	Wage / Median	Share of Employed	Wage / Median	Share of Employed
41	Office clerks	2.40	0.94	4.61	0.98	7.40
42	Customer services clerks	1.55	0.62	4.76	0.96	2.38
52	Sales workers	0.17	0.87	2.93	0.94	5.25
72	Metal, machinery and related trades workers	0.58	1.29	4.65	0.99	4.69
73	Precision, handicraft, printing and related trades workers	1.72	1.03	0.17	0.99	0.47
74	Other craft and related trade workers	1.36	0.77	0.75	0.97	1.55
81	Stationary plant and machine operators	0.45	1.46	0.47	0.99	0.37
82	Machine operators and assemblers	0.62	0.96	3.52	0.99	1.95
93	Labourers in mining, construction, manufacturing and transport	0.57	0.78	3.61	0.95	2.47
	Mean:	**1.05**	**0.97**	**2.83**	**0.98**	**2.95**


RTI Score
2
1
0
-1
-2
0
0.5
1
Occupational Wage Distribution
Low Pay, Low RTI
High RTI
High Pay, Low RTI

Estimation Strategy

1. Estimating wage trends of high RTI (automatable) occupations relative to low pay and high pay occupations

$$\log(Wage)_{jnst} = \beta_1 HighPay_j + \beta_2 LowPay_j + \beta_3 \left(HighPay_j \cdot Year_t\right) + \beta_4 \left(LowPay_j \cdot Year_t\right) + \beta_5 \mathrm{X}_j + [\alpha_s \cdot \alpha_n \cdot \alpha_t] + \varepsilon_{jnst}$$

DV: Log Wage (LIS PPPs)
IV: LowPay, HighPay dummies (reference: high RTI)
Controls: age, education, sex
Fixed Effects: Country*Industry*Year

Estimation Strategy

2. Do changes in collective bargaining coverage (CBC) within a country affect relative wage trends of high RTI (automatable) occupations?

$$\log(Wage)_{jnst} = \beta_1 HighPay_j + \beta_2 LowPay_j + \ldots + \beta_3 \left(HighPay_j \cdot Year_t\right) + \beta_4 \left(LowPay_j \cdot Year_t\right) + \beta_5 \left(LowPay_j \cdot Year_t \cdot CBC_{st}\right) + \beta_6 \left(HighPay_j \cdot Year_t \cdot CBC_{st}\right) + \beta_7 \mathrm{X}_j + [\alpha_s \cdot \alpha_n \cdot \alpha_t] + \varepsilon_{ist}$$

CBC: Collective Bargaining Coverage

- LIS Sample (cross-national): country-year
- US Sample (cross-state): industry-state-year among high RTI jobs

Descriptive Findings

Figure 3: Indexed wage growth of high RTI occupations relative to low pay and high pay occupations (countries experiencing decline in collective bargaining coverage)

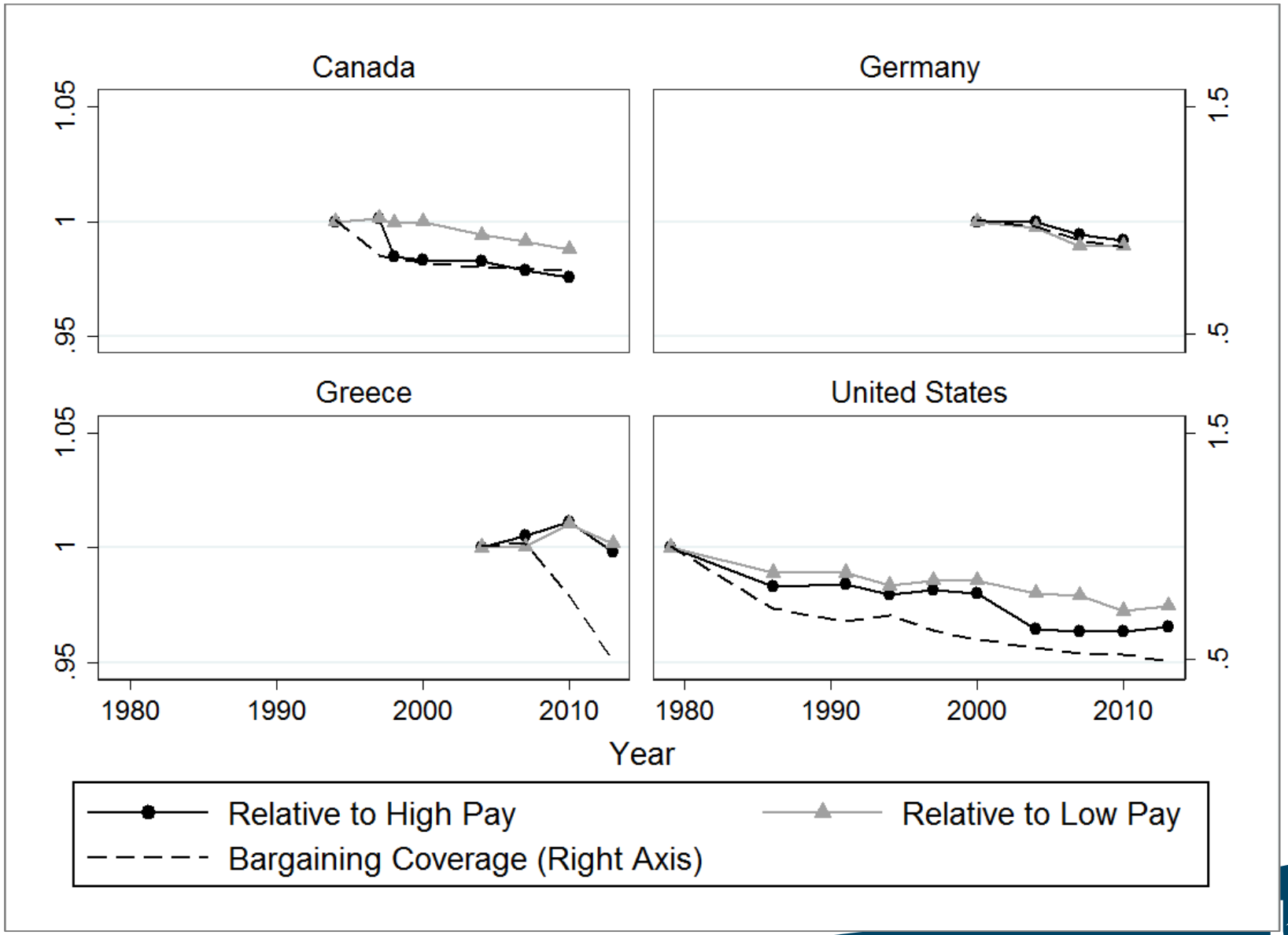


Figure 4: Indexed wage growth of high RTI occupations relative to low pay and high pay occupations

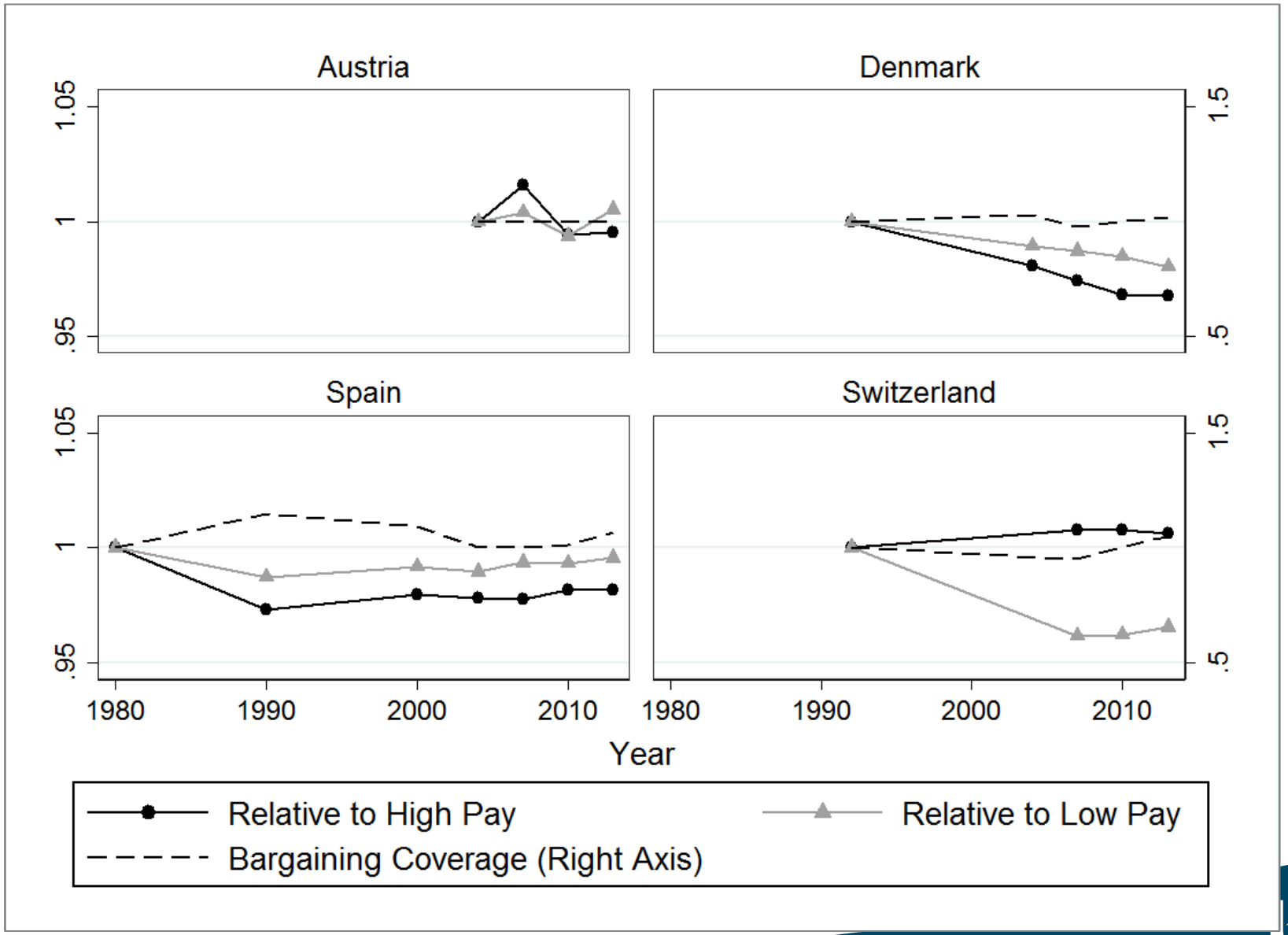
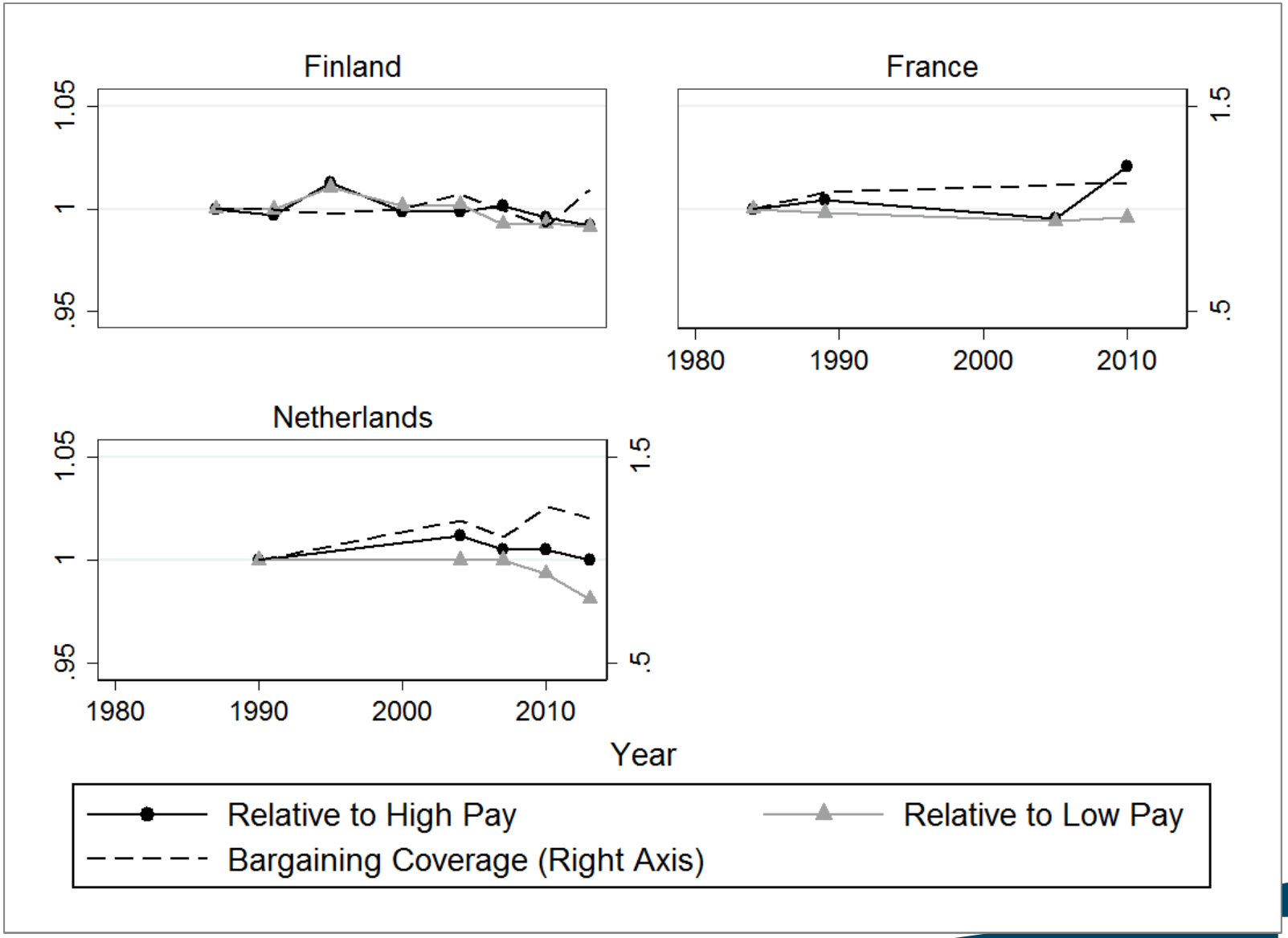


Figure 5: Indexed wage growth of high RTI occupations relative to low pay and high pay occupations (countries experiencing increases in levels of bargaining coverage)



Estimation Results

	15 OECD Member States	
	A1	A2
Low Pay *(Reference: High RTI)*	-.12*** (-4.84)	-.15*** (-8.63)
High Pay *(Reference: High RTI)*	.21** (3.74)	.23*** (7.45)
Low Pay # Year (Linear)	.003* (2.13)	.006** (4.00)
High Pay # Year (Linear)	.002 (0.89)	.005* (3.31)
Bargaining Coverage # Year (Linear)		.04*** (25.19)
Low Pay # Bargaining Coverage # Year (Linear)		-.004* (-2.37)
High Pay # Bargaining Coverage # Year (Linear)		.000 (0.43)
Observations	1,398,417	1,398,417

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(1) Are wages of high RTI occupations growing more slowly, on average, than low RTI occupations?

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(1) Are wages of high RTI occupations growing more slowly, on average, than low RTI occupations (net of controls)?

Yes and No:

- Low pay (low RTI) occupations gaining ground on high RTI occupations

- No significant difference in growth rates of high pay (low RTI) and high RTI

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(2) Do changes in collective bargaining coverage affect relative wage growth of automatable occupations?

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Low Pay *(Reference: High RTI)*	-.12*** (-4.84)	-.15*** (-8.63)
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Observations	1,398,417	1,398,417

(2) Do changes in collective bargaining coverage affect relative wage growth of automatable occupations?

Yes:

- Higher bargaining coverage within a country is associated with greater wage growth of automatable occupations relative to low RTI, low pay occupations.

- One SD decline in bargaining coverage = annual 0.4 log point decline in wages of high RTI occupations relative to low RTI, low pay jobs.

	50 United States	
	B1	B2
Low Pay *(Reference: High RTI)*	-.13*** (-17.4)	-.18*** (-19.4)
High Pay *(Reference: High RTI)*	.28*** (46.8)	.26*** (35.2)
Low Pay # Year (Linear)	-.000 (-0.76)	.001* (2.45)
High Pay # Year (Linear)	-.000 (4.03)	.000 (0.57)
Bargaining Coverage # Year (Linear)		.002*** (4.57)
Low Pay # Bargaining Coverage # Year (Linear)		-.003*** (-4.61)
High Pay # Bargaining Coverage # Year (Linear)		-.001*** (-5.89)
Observations	1,905,150	1,905,150

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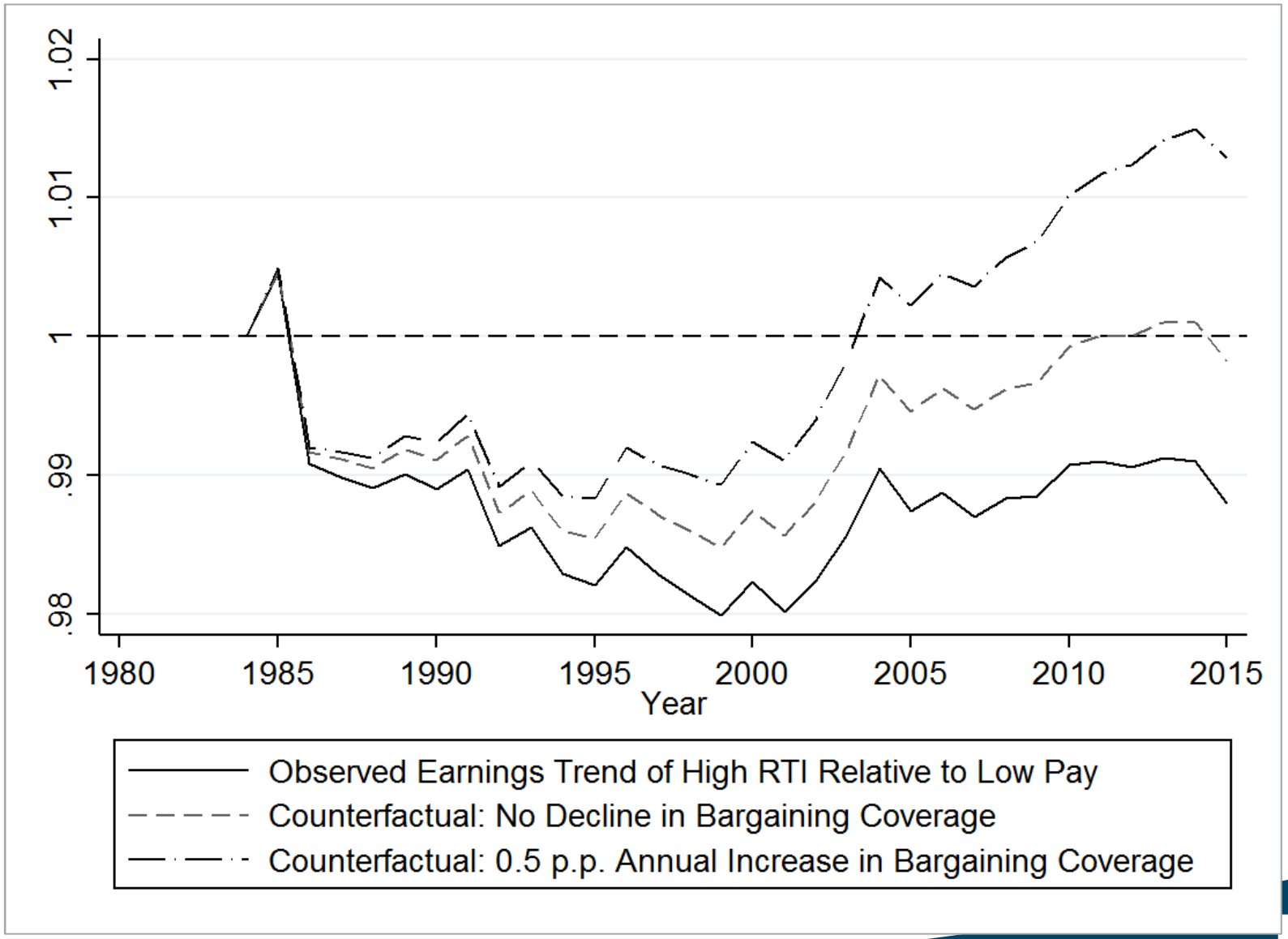
Low Pay # Year (Linear)	-.000 (-0.76)	.001* (2.45)
High Pay # Year (Linear)	-.000 (4.03)	.000 (0.57)
Bargaining Coverage # Year (Linear)		.002*** (4.57)
Low Pay # Bargaining Coverage # Year (Linear)		-.003*** (-4.61)
High Pay # Bargaining Coverage # Year (Linear)		-.001*** (-5.89)
Observations	1,905,150	1,905,150

(2) Do changes in collective bargaining coverage affect relative wage growth of automatable occupations?

Yes:

- Higher bargaining coverage is associated with greater wage growth of automatable occupations relative to low RTI occupations.

Figure 6: Counterfactual wage growth of high RTI occupations relative to low pay occupations in U.S. if bargaining coverage had increased or remained stable since 1984



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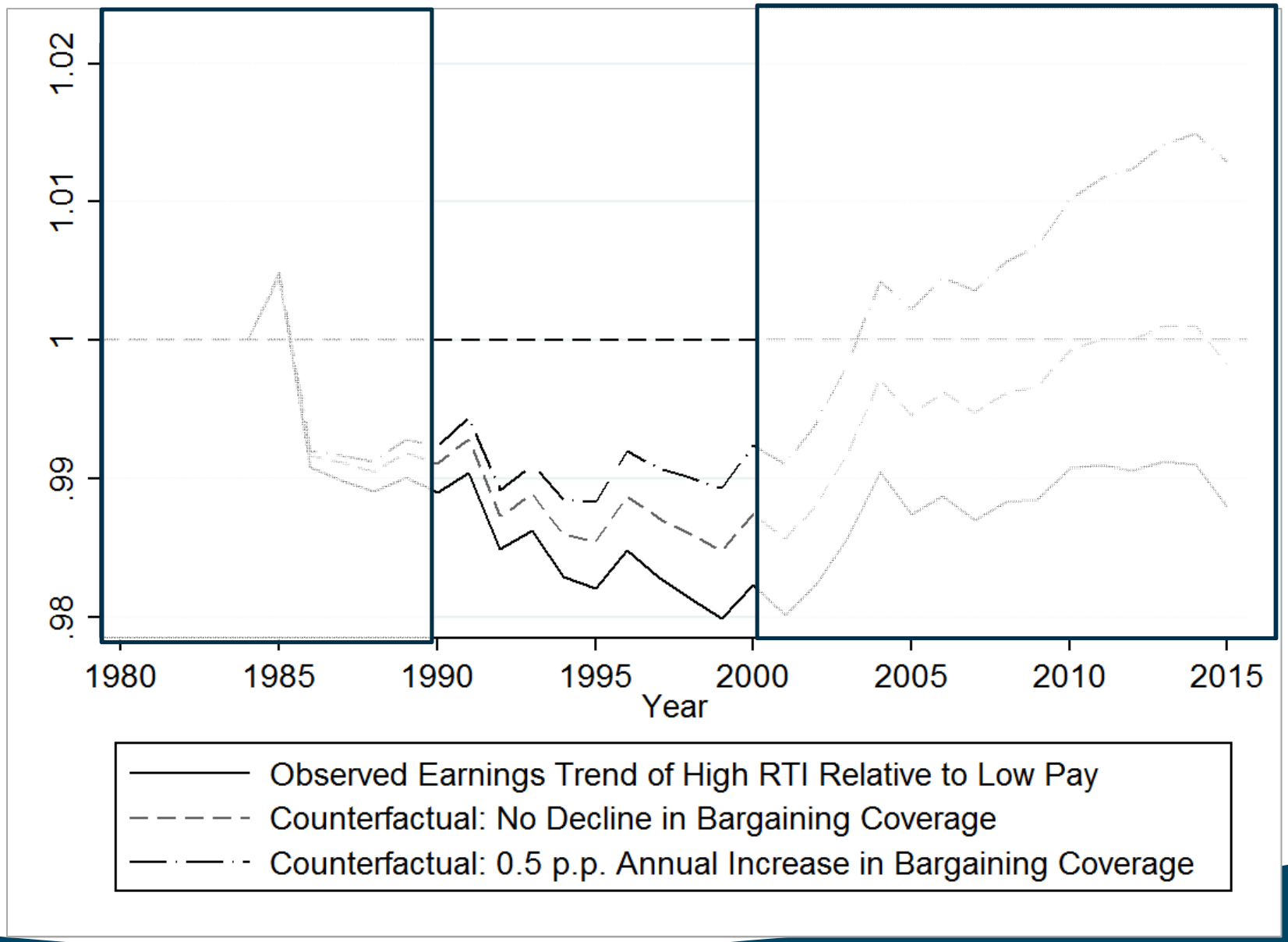

At what cost?

Employment Effect

Investment Effect

Employment Effect?

	15 OECD Member States	*50 United States*
Year (Linear)	-0.05	-0.01***
	(-0.09)	(-6.45)
Bargaining Coverage	0.15	0.13
	(0.08)	(0.05)
Bargaining Coverage # Year (Linear)	0.01	0.01
	(0.17)	(0.98)
Observations	1,398,417	1,923,985

All models include individual-level controls (education, age, sex) and state-industry-year fixed effects. Sample limited to employed adults in low pay (low RTI) and high RTI occupations. *t* statistics in parentheses. Individual controls include age, education, and sex. $^{*}\ p < 0.05$, $^{**}\ p < 0.01$, $^{***}\ p < 0.001$.

Does higher collective bargaining coverage (CBC) within a country accelerate employment polarization?

No support for this.

Investment Effect?

	ICT Investment	
	(1)	(2)
Bargaining Coverage # Year	.000 (0.04)	.000 (0.97)
High RTI Share # Year		-.03 (-0.25)
Bargaining Coverage # High RTI Share		.02 (0.01)
High RTI Share # Bargaining Coverage # Year		-.000 (-0.00)
Observations	321	321

Note: Country-Industry and Year panel data. All models include country-industry and year fixed effects. Results are robust to single-year lag specification and population-weighted country-industries. (Non-)ICT investment represents the contribution of (non-)ICT capital services to value added growth at the country and industry level (via EU KLEMS). Sample includes industries in BE, CZ, DK, FI, FR, DE, LU, NL, SK, SI, ES, US – all countries from LIS sample for which EU KLEMs data is available. *t* statistics in parentheses. Standardized coefficients presented for country-level institutions. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Does higher bargaining coverage within a country discourage investment in industries with high share of high RTI occupations?

No support for this.

Conclusions

Changes in bargaining coverage within countries affect relative wages trends of automatable occupations.

- Declines in bargaining coverage and union representation appear to affect wage growth of high RTI occupations more so than low RTI occupations.

- Stable or increasing levels of bargaining coverage may contribute to lack of wage polarization.

Conclusions

Does higher wage growth for automatable occupations (despite declining demand for routine tasks) come at a cost?

- More research needed on potential employment effects.
- No evidence of investment effect.

Conclusions

The social consequences of automation are perhaps conditional on prevailing labour market institutions.


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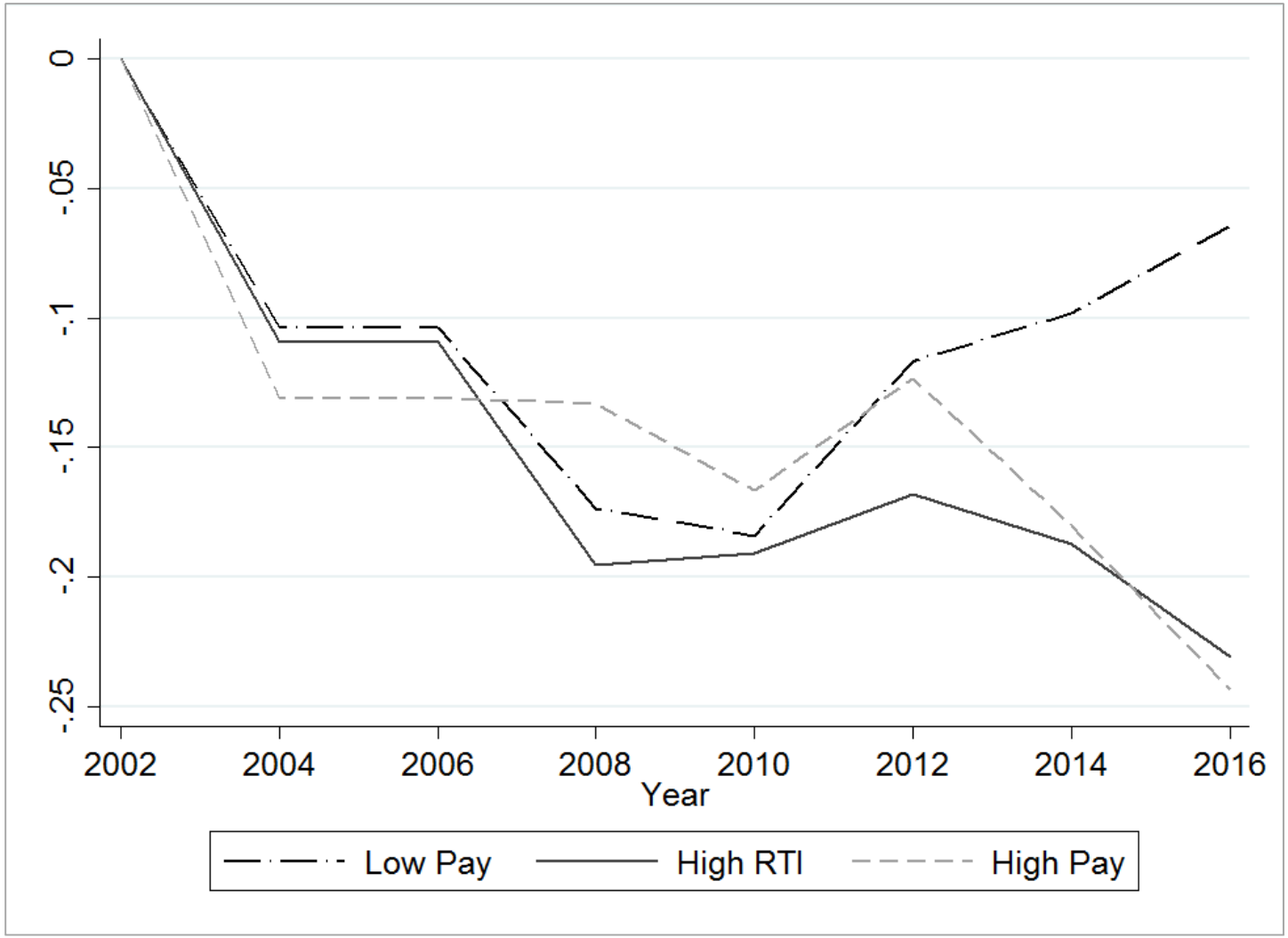
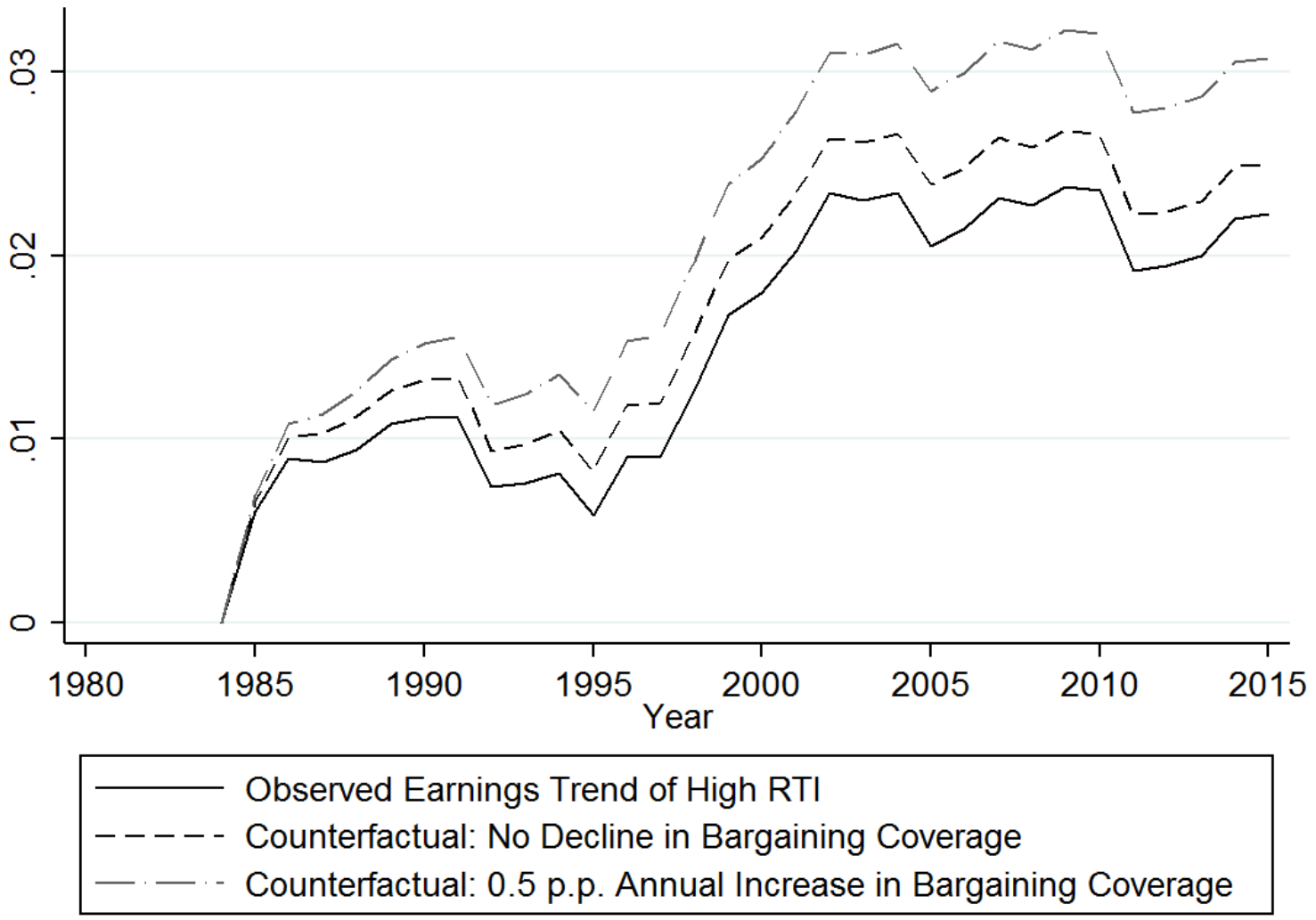
	Country	Years	N
1	Austria	2004, 2007, 2010, 2013	24,481
2	Belgium	1995, 1997, 2000	8,972
3	Canada	1994, 1997, 1998, 2000, 2004, 2007, 2010	199,438
4	Denmark	1992, 2004, 2007, 2010, 2013	359,762
5	Finland	1987, 1991, 1995, 2000, 2004, 2007, 2010, 2013	102,850
6	France	1984, 1989, 1994, 2000, 2005, 2010	65,024
7	Germany	2000, 2004, 2007, 2010, 2013	83,910
8	Greece	2004, 2007, 2010, 2013	19,561
9	Iceland	2004, 2007, 2010	14,095
10	Ireland	1994, 1995, 1996, 2000, 2004, 2007, 2010	24,430
11	Luxembourg	1997, 2000, 2004, 2007, 2010, 2013	22,299
12	Netherlands	1990, 1993, 1999, 2004, 2007, 2010, 2013	64,745
13	Spain	1980, 1990, 1995, 2000, 2004, 2007, 2010, 2013	85,884
14	Switzerland	1992, 2007, 2010, 2013	30,813
15	United States	1979, 1986, 1991, 1994, 1997, 2000, 2004, 2007, 2010, 2013	776,311

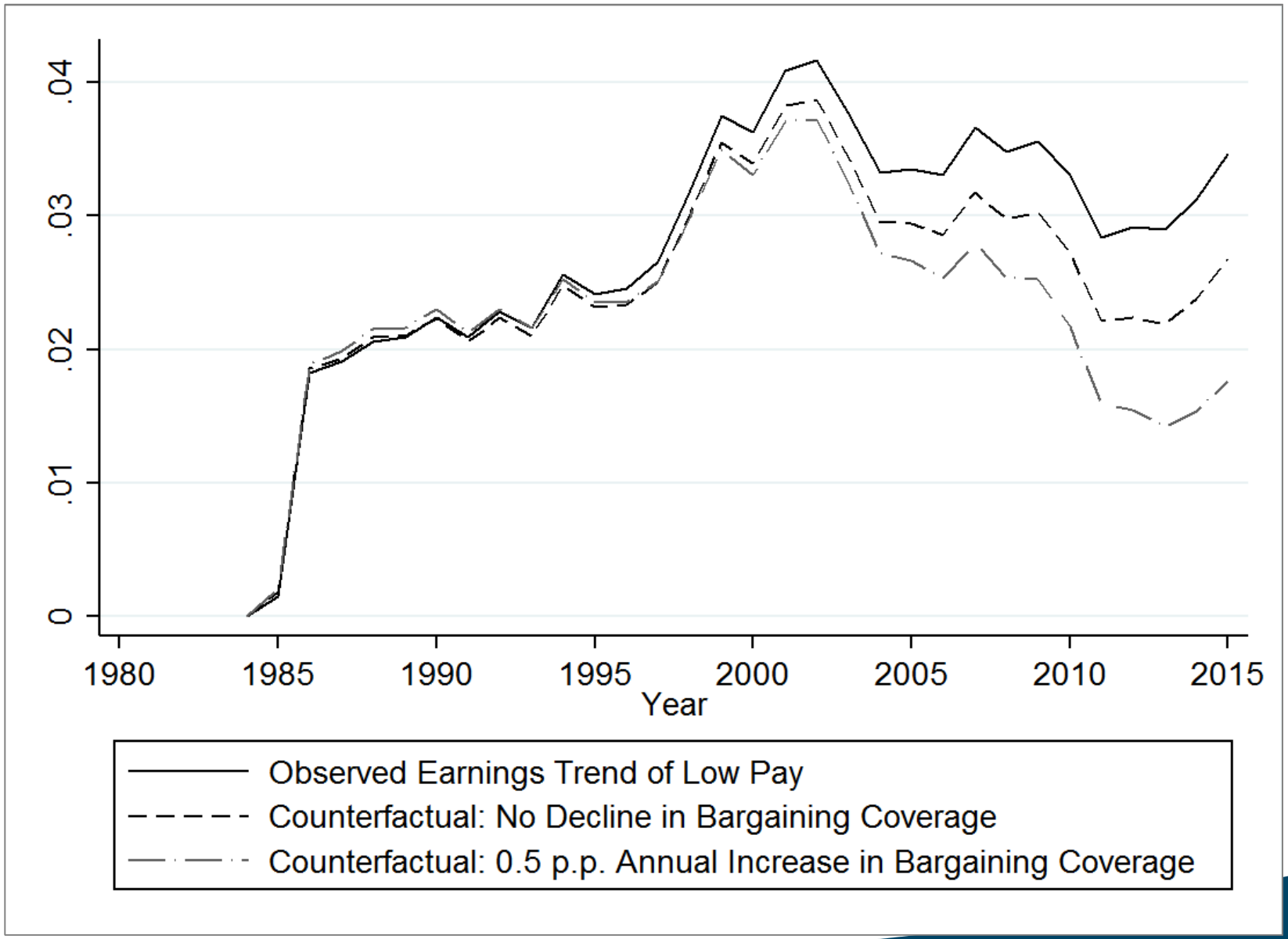
Figure A2: Percent Change in Union Coverage by Year & Occupation Type (EU Member States)



Sensitivity Checks

- Hourly wages rather than annual wages for U.S. sample
- Two-digit vs. three-digit occupation codes for U.S. sample
- Two alternative definitions of high RTI occupations:
  - Goos, Manning, Salomons: “middling occupations”
  - Country-specific RTI distributions


.03
.02
.01
0
1980
1985
1990
1995
2000
2005
2010
2015
Year
Observed Earnings Trend of High RTI
Counterfactual: No Decline in Bargaining Coverage
Counterfactual: 0.5 p.p. Annual Increase in Bargaining Coverage


0
.01
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1980
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2015
Year
Observed Earnings Trend of Low Pay
Counterfactual: No Decline in Bargaining Coverage
Counterfactual: 0.5 p.p. Annual Increase in Bargaining Coverage

Estimation Strategy

3. *Employment Effect:* Do changes in bargaining coverage (CBC) within a country accelerate declines in share of high RTI occupations?

$$HighRTI_{jnst} = \beta_1 (CBC_{st} \cdot Year_t) + \beta_2 X_j + [\alpha_s \cdot \alpha_n \cdot \alpha_t] + \varepsilon_{jnst}$$

- Unemployed not included

Estimation Strategy

4. *Investment Effect:* Do changes in bargaining coverage (CBC) within a country affect rate of industry-level investment into ICT?

$$\mathrm{ICT}_{nst} = \beta_1 (CBC_{st} \cdot Year_t) + [\alpha_s \cdot \alpha_n] + \alpha_t + \varepsilon_{nst} \qquad (7)$$

- **ICT:** investment into ICT
  - *EU KLEMS:* the contribution of ICT capital services (such as computers, software, and communication technologies) to value added growth at the country and industry level
  - *Additional estimate:* variation by share of high RTI occupations in industry?