Lecture 9: Labour economics

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Literature: Chapter 10 Cahuc-Carcillo-Zylberberg: 633-638
Bennmarker-Calmfors-Seim
Foged and Peri

Topics

- **Technological progress and unemployment**
- **Skill-biased technological progress and wage inequality**
- **Skill-biased technological progress and wage rigidity**
- **US versus Europe**
- **Germany versus Sweden**
- **Wages, working time and the Earned Income Tax Credit in Sweden**
- **Low-skilled wages and immigration**

Technological progress

- **Labour productivity growth**
- **Capitalisation effect increases the profit due to job creation.**
- **The individual's productivity *y* grows at the rate *g*.**
- **Assume a balanced growth path where productivity, the real wage and profits all increase at the rate of *g*.**

π_e = **profit from a filled vacancy (discounted value)**

π_V = **profit from an unfilled vacancy (discounted value)**

$$\pi_e = \frac{1}{1 + rdt}\left[(y - w)dt + qdt(1 + gdt)\pi_V + (1 - qdt)(1 + gdt)\pi_e\right] \quad (3)$$

q **= rate of job destruction**

Equation (3) can be rewritten:

$$(r - g)\pi_e = (y - w) + q(1 + gdt)(\pi_V - \pi_e)$$

$$dt \to 0 \Rightarrow$$

$$(r - g)\pi_e = (y - w) + q(\pi_V - \pi_e) \quad (4)$$

$$r\pi_e = (y - w) + q(\pi_V - \pi_e) + g\pi_e$$

- **If π_e is "invested" in the labour market it earns a return made up of the instantaneous profit $(y - w)$ and an expected "capital gain" $q(\pi_V - \pi_e)$.**
- **In addition the value of the asset has risen by $g\pi_e$.**
- **A financial investment yields $r\pi_e$.**
- **$(r - g)\pi_e$ is the return from a financial investment less the "opportunity cost" $g\pi_e$ in an environment characterized by growth g.**
- **$(r - g)\pi_e$ is the <u>effective</u> rate of return on an investment.**
- **Growth is accompanied by a capitalisation effect equivalent to a reduction in the interest rate.**
- **The cost of a vacancy is assumed to be indexed to productivity, i.e. it is *hy*.**

<u>The return from an unfilled vacancy</u>

$$(r - g)\pi_V = -hy + m(\theta)(\pi_e - \pi_V) \qquad (4a)$$

The free-entry condition π_V = 0 together with (4) and (4a) give:

$$\frac{y - w}{r - g + q} = \frac{hy}{m(\theta)} \qquad (5)$$

The expected present value from a filled job, π_e, is equal to the average cost of a vacancy, $hy / m(\theta)$.

- **(5) represents labour demand.**
- $g \uparrow \Rightarrow LHS \uparrow \Rightarrow \pi_e \uparrow$
- **Hence, the *RHS*, the cost of an unfilled vacancy, must also go up. This occurs if the average duration of a vacancy** $1/m(\theta)$ **increases, which happens when labour market tightness increases.**
- **Hence,** $g \uparrow \Rightarrow \theta \uparrow$**, i.e. an upward shift of the labour demand schedule.**

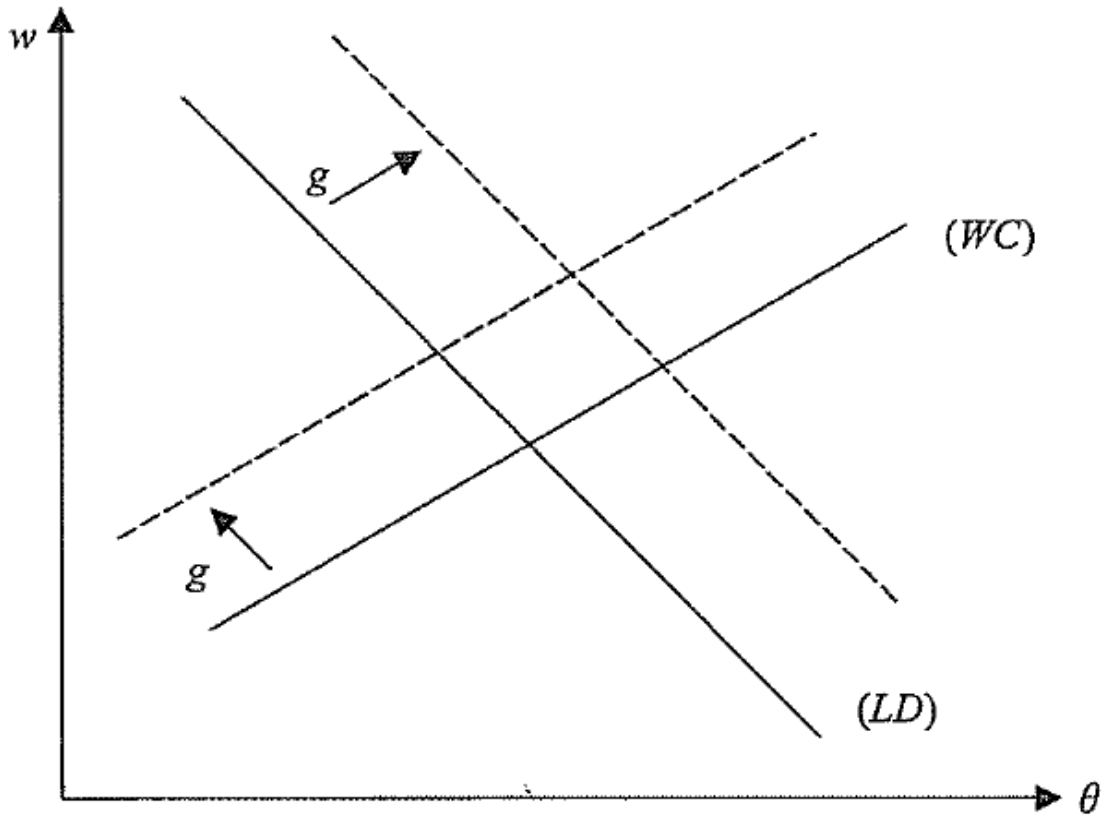


FIGURE 10.1
The effect of an increase in productivity.

Wage setting

V_e **= the present value of an employed worker**

V_u **= the present value of an unemployed worker**

$$(r-g)V_e = w + q(V_u - V_e) \qquad (6)$$

We assume that the income of an unemployed worker is indexed to productivity, such that it is *zy*.

Then:

$$(r-g)V_u = zy + \theta m(\theta)(V_e - V_u) \qquad (7)$$

Apply the same wage bargaining model as in chapter 9, but change *z* to *zy* and *r* to (*r*-*g*).

Equation (20) in chapter 9 can then be rewritten:

$$w = y\left[z + (1-z)\Gamma(\theta)\right]$$

$$\Gamma(\theta) = \frac{\gamma\left[r-g+q+\theta m(\theta)\right]}{r-g+q+\gamma\theta m(\theta)} \qquad (8)$$

- **The "strength of the employee in bargaining", $\Gamma(\theta)$, increases with g.**
- **$g \uparrow$ reduces the effective interest rate.**
- **The "capital loss" from job destruction is increased.**
- **Hence, relatively better to be unemployed.**
- **WC curve is shifted upwards.**

<u>From Figure 10.1</u>

A rise in productivity growth:

(i) raises the wage

(ii) has an ambiguous effect on θ.

But (5) and (8) together give:

$$\frac{(1-\gamma)(1-z)}{r-g\ +\ q\ +\ \gamma\theta m(\theta)} = \frac{h}{m(\theta)} \qquad (9)$$

Differentiation of (9) shows that rise in *g* raises *θ*.

$$\frac{d\theta}{dg} = \frac{h}{h\gamma\underbrace{\left[m(\theta)\ +\ \theta m'(\theta)\right]}_{(+)} - \underbrace{(1-\gamma)(1-z)m'(\theta)}_{(+)}} > 0$$

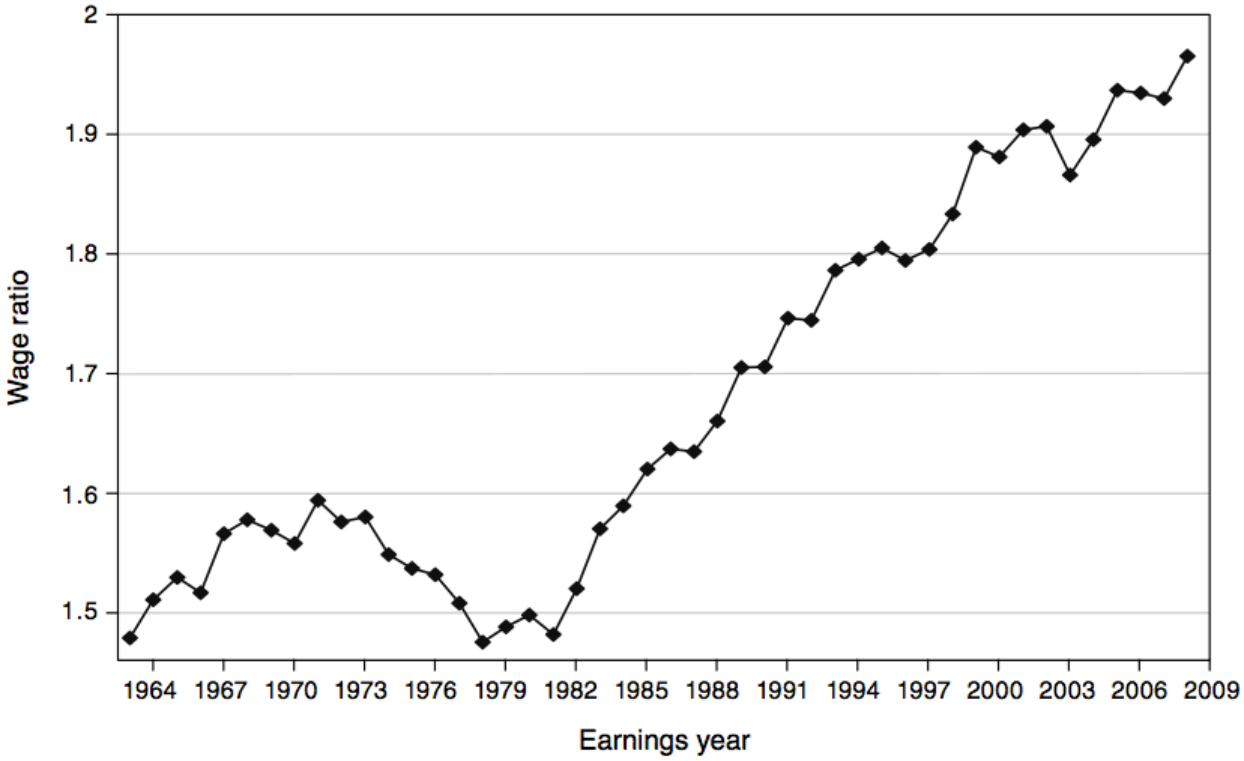


FIGURE 10.9
College/high school weekly wage ratio in the United States, 1963–2008.

Source: Acemoglu and Autor (2011) data set.

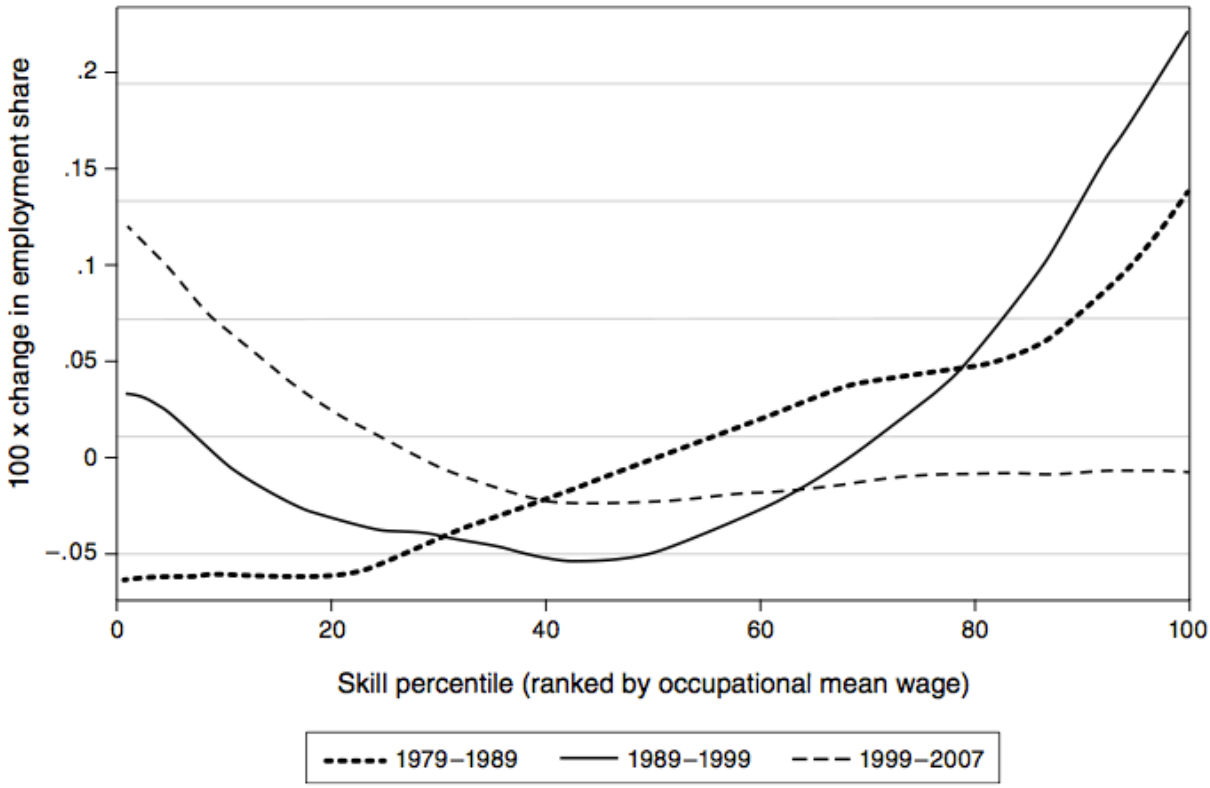
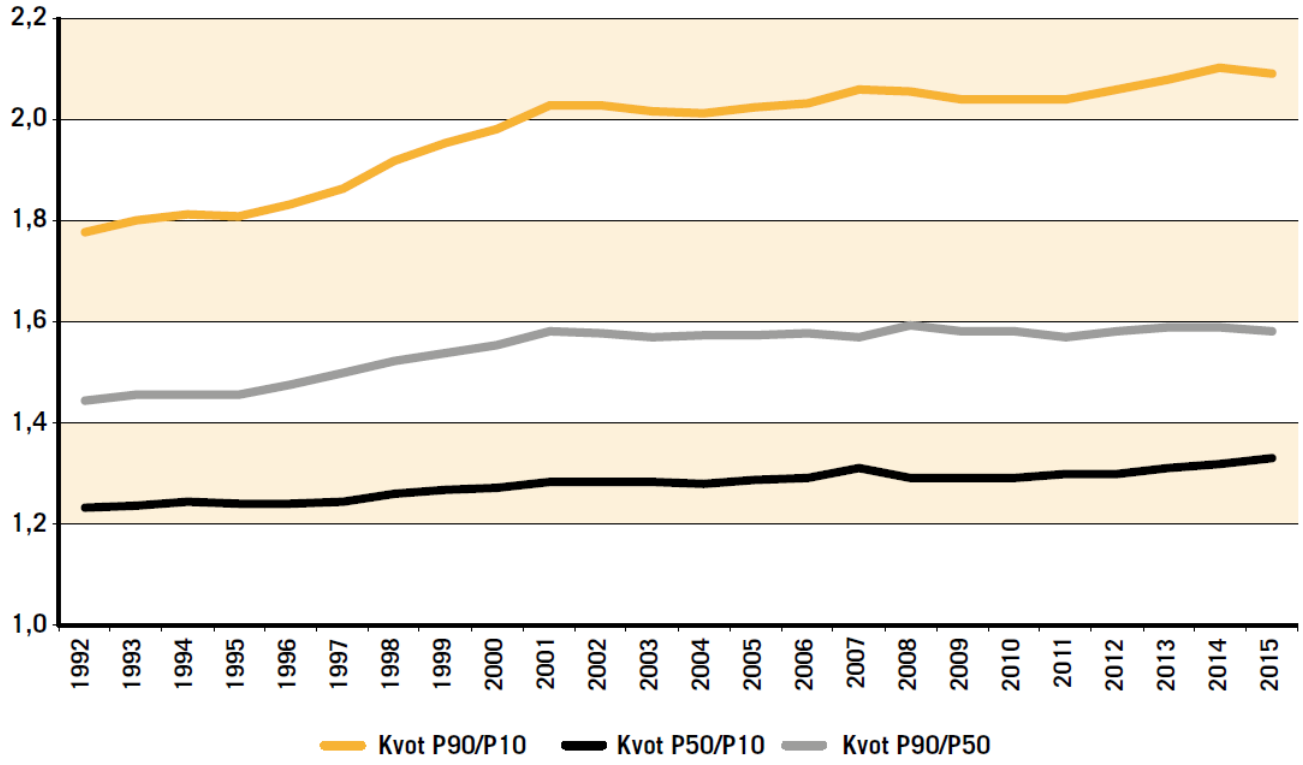


FIGURE 10.8

Changes in employment by occupational skill percentile. All occupation and earnings measures in these samples refer to prior year's employment. The figure plots log changes in employment shares by 1980 occupational skill percentile rank using a locally weighted smoothing regression, where skill percentiles are measured as the employment-weighted percentile rank of an occupation's mean log wage.

Source: Acemoglu and Autor (2011, figure 10).

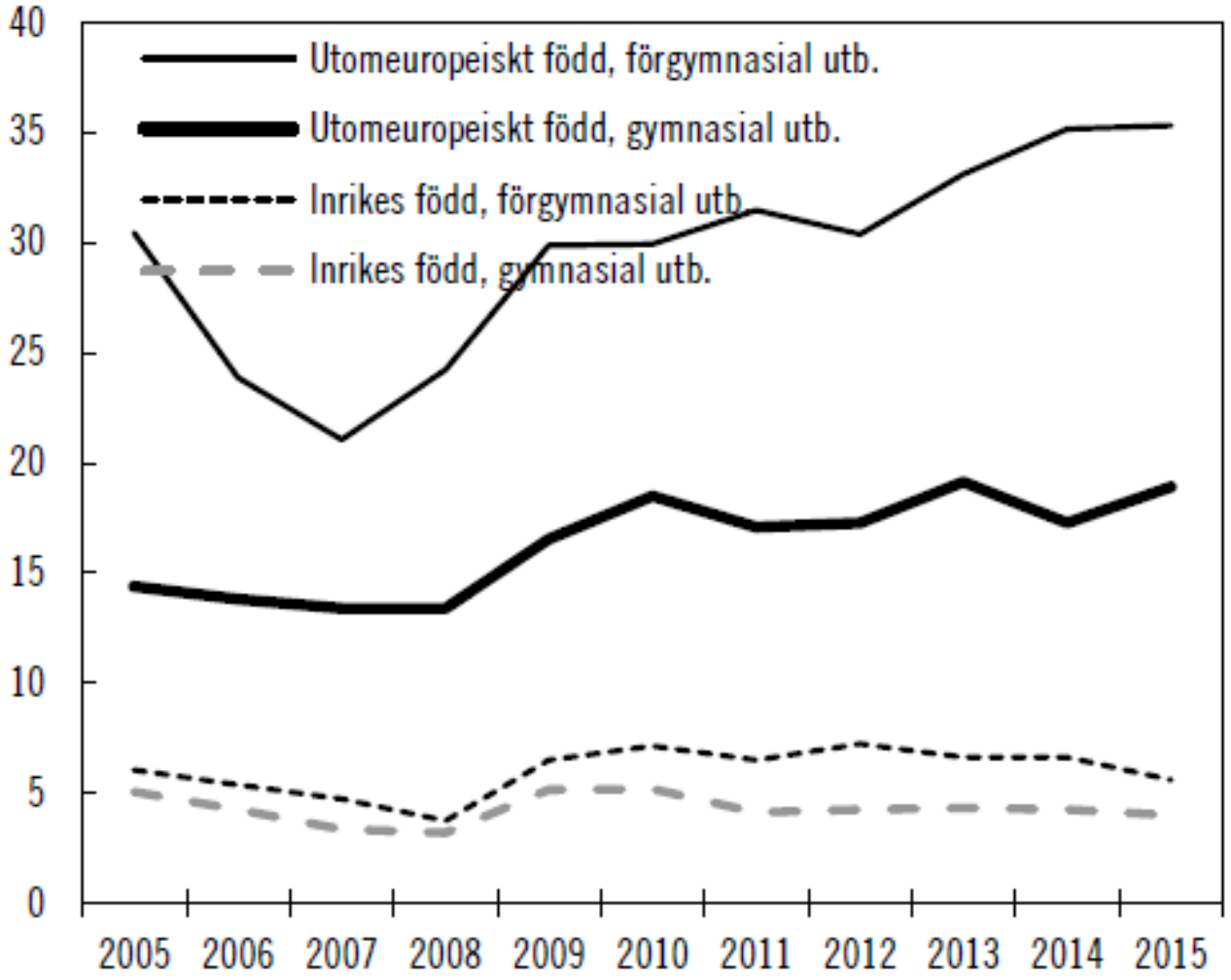
Wage dispersion in Sweden



Källor: Medlingsinstitutet och SCB

Diagram 9.15 Arbetslöshet (25–74 år) fördelat på utbildningsnivå för inrikes och utomeuropeiskt födda

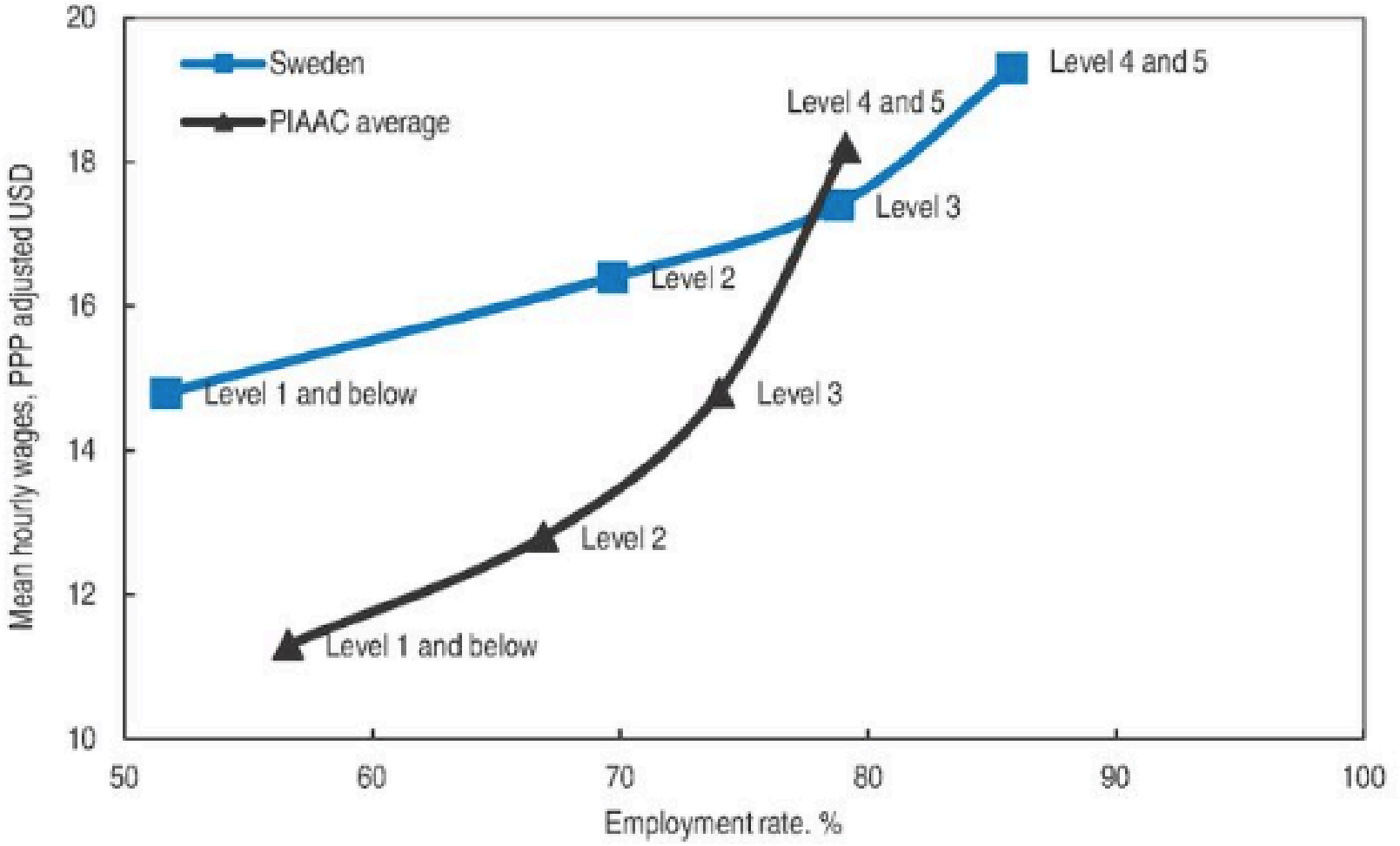
Procent



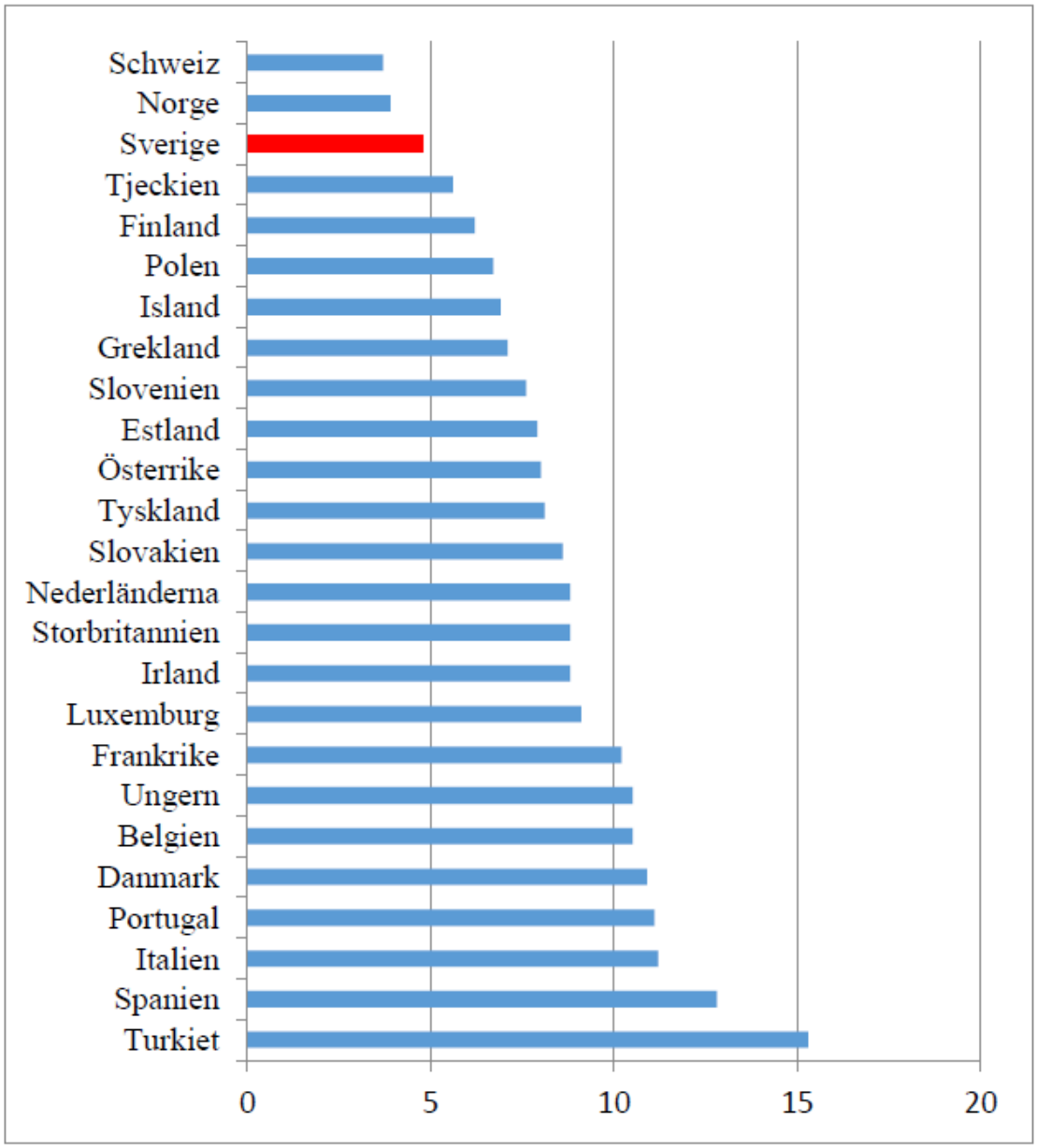
Anm.: Tidsseriebrott 2007/2008 medför att tolkningar från 2008 och framåt jämfört med åren innan 2008 bör göras med försiktighet.
Källa: Statistiska centralbyrån.

Figure 14. **Skills and labour market outcomes**

Mean hourly wages and employment rates by PIAAC skill levels



Figur 5 Andel anställda i yrken med inga eller låga utbildningskrav, 2015

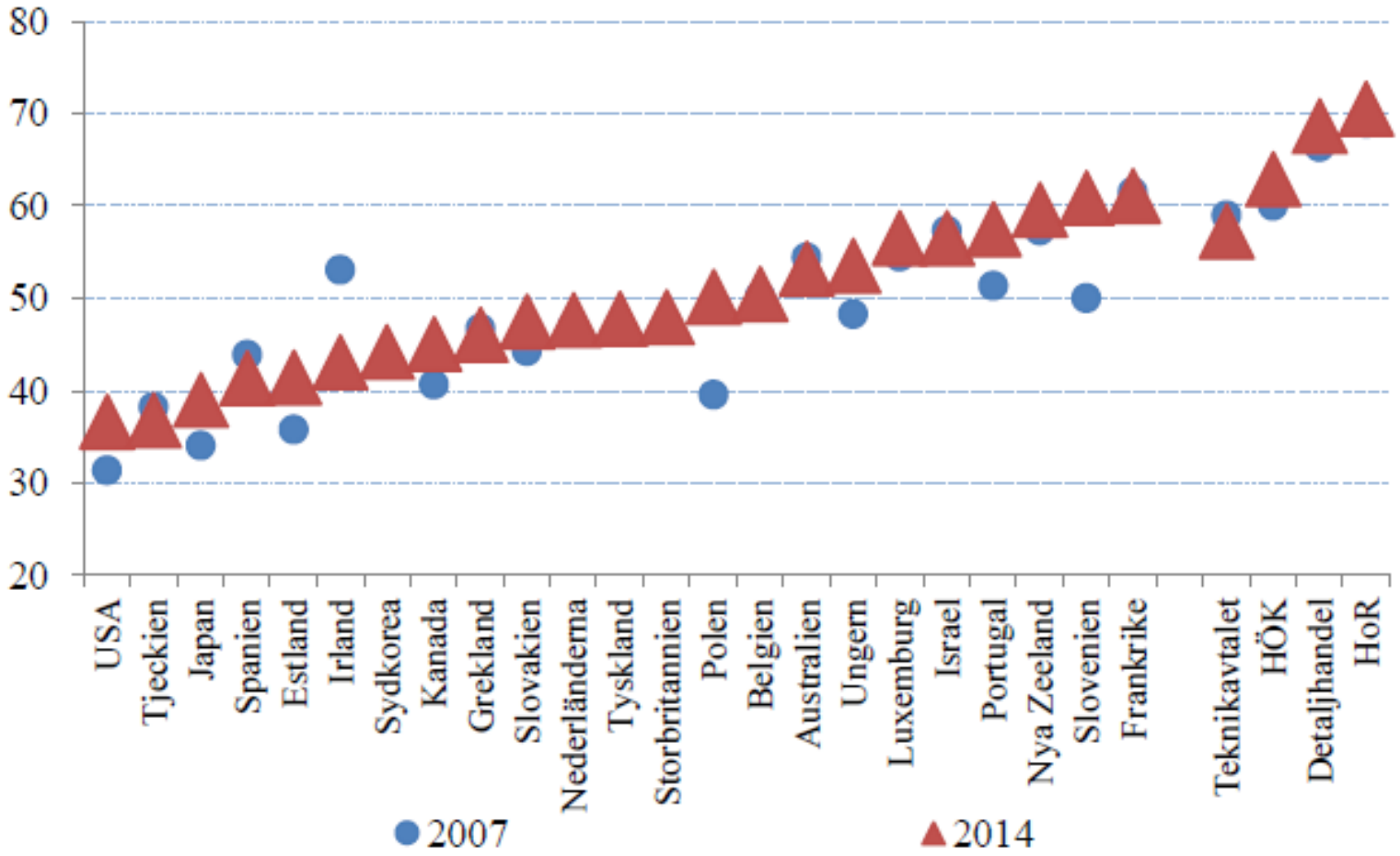


Tabell 1 Lönespridningen i olika OECD-länder, 2014

	Decil 5/Decil 1	Decil 9/Decil 1
Sverige	**1,36**	**2,28**
Belgien	1,39	2,46
Danmark	1,45	2,56
Finland	1,46	2,57
Frankrike	1,49	2,98
Italien	1,50	2,17
Norge	1,62	2,42
Nederländerna	1,66	2,94
OECD	**1,70**	**3,46**
Österrike	1,72	3,33
Storbritannien	1,80	3,56
Tyskland	1,87	3,41
Polen	1,92	4,03
Estland	2,08	4,40
USA	2,09	5,01

Källa: OECD Employment Outlook 2016.

Minimum wages in percent of median wages



Relativlön för prestationsnivå 1 i läs- och skrivkunnighet i IALS och PIAAC (nivå 1/nivå 3)

	IALS 1994	PIAAC 2012
Sverige	0,89	0,85
Tyskland	0,86	0,73

Relativ sysselsättningsgrad för prestationsnivå 1 i läs- och skrivkunnighet i IALS och PIAAC (nivå 1/nivå 3)

IALS 1994	IALS 1994	PIAAC 2012
Sverige	0,66	0,65
Tyskland	0,59	0,78

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Relativ sysselsättningsgrad för prestationsnivå 1 i läs- och skrivkunnighet i IALS och PIAAC (invandrare nivå 1/invandrare nivå 3)

	IALS 1994	PIAAC 2012
Sverige	0,60	0,58
Tyskland	0,48	0,84

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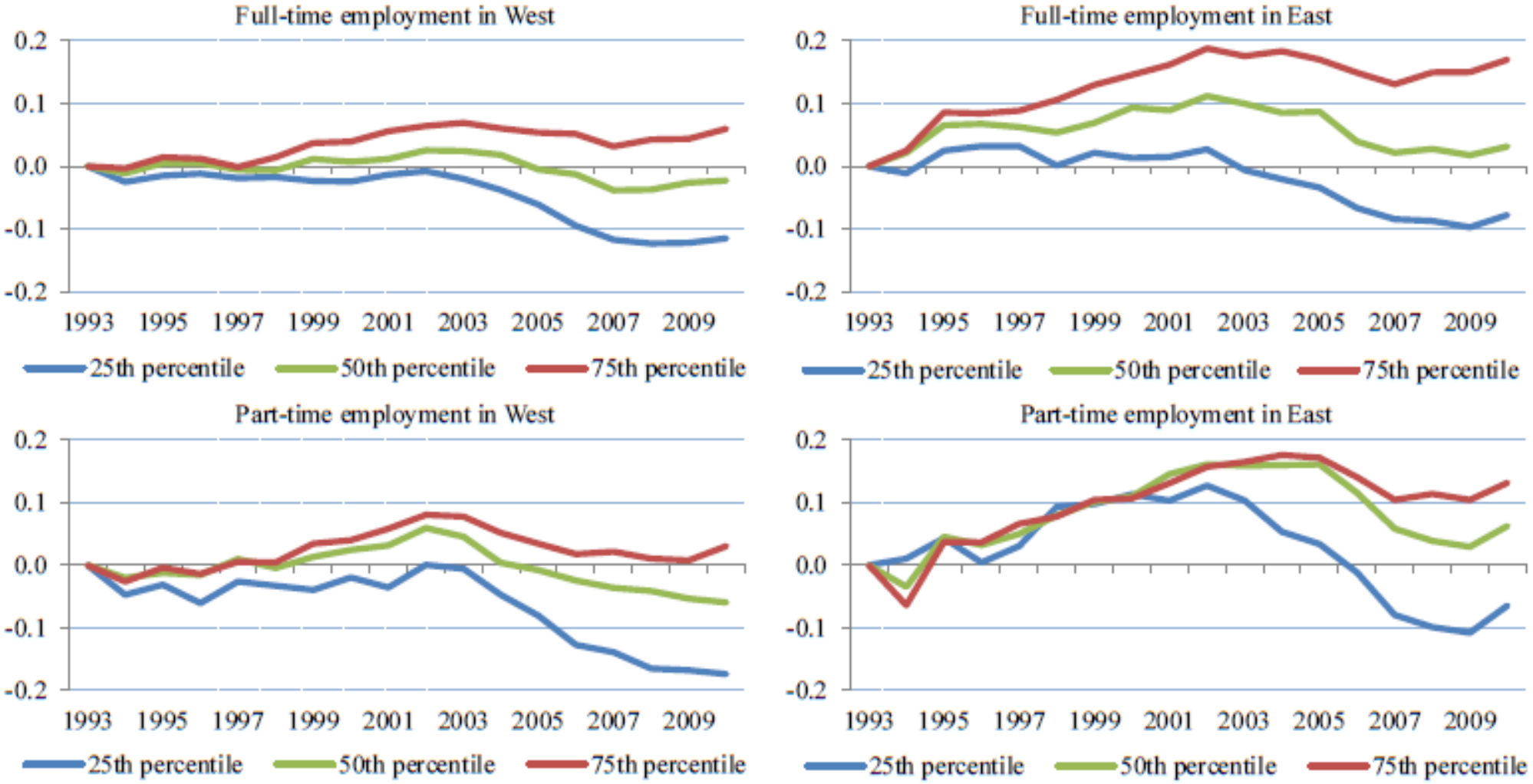
Figure 12 Cumulative real wage growth at 25th, 50th and 75th percentiles, workers by full- and part-time status, 1993-2010



Note: In each panel, the green middle curve depicts the cumulative evolution of the median real wage since 1993. The lower blue and upper red curves depict the cumulative evolution of real wages at the 15th and 85th percentiles, respectively.
Source: SIAB, Burda and Seele (2016).

Table 2 Full-time and part-time employment growth at different segments of the earnings distribution, percent, 1993-2010

	1993–1998	1998–2003	2003–2010
Full-time			
Western Germany			
Lowest segment	-0.5	-7.2	24.6
Middle segment	-11.5	-11.4	-11.8
Upper segment	0.9	14.6	-3.0
Eastern Germany			
Lowest segment	-13.8	-11.2	22.7
Middle segment	-27.6	-25.2	-12.3
Upper segment	20.9	-4.3	-7.5
Part-time			
Western Germany			
Lowest segment	10.5	9.8	59.7
Middle segment	4.8	1.5	10.4
Upper segment	38.1	38.7	27.3
Eastern Germany			
Lowest segment	6.3	-3.7	81.7
Middle segment	43.8	-19.1	11.7
Upper segment	63.6	36.7	16.2

Source: Tabulations in Burda and Seele (2016) based on micro data (SIAB).

The Anglo-Saxon vs the European model

- **Biased technological progress**
- **Two labour markets: skilled and unskilled labour**
- **Three goods**
  - **final good**
  - **two intermediate goods (one produced with skilled labour; one produced with unskilled labour)**
- **Each employee produces one intermediate good per unit of time.**

Production of the final good

$F(A_h L_h,\ A_l L_l)$ A_h **and** A_l **measure the levels of technical progress**

- **The market for the final good is perfectly competitive.**

$$\underset{L_h, L_l}{\text{Max}} \quad F(A_h L_h,\ A_l L_l) - p_h L_h - p_L L_L$$

$$p_i = A_i F_i(A_h L_h,\ A_l L_l) \qquad i = h,\ l$$

$$\frac{p_h}{p_l} = \frac{A_h F_h(A_h L_h, A_l L_l)}{A_l F_l(A_h L_h, A_l L_l)}$$

Stationary state

$$r\pi_i = p_i - w_i + q_i(\pi_{Vi} - \pi_i) \qquad (39)$$

h_i = **cost of a vacancy**

$\theta_i = V_i / U_i =$ **labour market tightness**

$m(\theta_i) = M_i(V_i / U_i)/V_i =$ **the rate at which vacant jobs of type *i* are filled**

$$r\pi_{Vi} = -h_i + m_i(\theta_i)(\pi_i - \pi_{Vi}) \qquad (40)$$

From free-entry condition π_{Vi} = 0, (39) and (40) we have:

$$\frac{h_i}{m(\theta_i)} = \frac{p_i - w_i}{r + q_i} \qquad (41)$$

Wage negotiations

z_i = **income of an unemployed person**

V_{ei} = **discounted utility of an employed *i* worker**

V_{ui} = **discounted utility of an unemployed *i* worker**

$$rV_{ei} = w_i + q_i(V_{ui} - V_{ei})$$

$$rV_{ui} = z_i + \theta_i m(\theta_i)(V_{ei} - V_{ui})$$

From eq. (20) in chapter 9

$$w_i = z_i + (p_i - z_i)\Gamma_i(\theta_i) \qquad (42)$$

$$\Gamma_i(\theta_i) = \frac{\gamma_i\left[r + q_i + \theta_i m(\theta_i)\right]}{r + q_i + \gamma_i\theta_i m(\theta_i)} \qquad i = h,\ l$$

$$z_i = b_i w_i$$

$$h_i = hp_i$$

$$w_i = b_i w_i + (p_i - b_i w_i)\Gamma_i(\theta_i)$$

$$w_i = p_i\Phi(\theta_i) \qquad \Phi(\theta_i) = \frac{\Gamma_i(\theta_i)}{1 - b_i + b_i\Gamma_i(\theta_i)} \quad i = 1,\ 2 \qquad (42a)$$

(41) and (42a) give:

$$\frac{h}{m_i(\theta_i)} = \frac{1 - \Phi_i(\theta_i)}{r + q_i}$$

- **Labour market tightness is independent of the prices of the intermediate goods and thus of technological progress.**
- **Hence, unemployment from the Beveridge curve does not depend on technological progress (bias).**
- **But the relative wage w_l / w_h does depend on technological bias (prices).**
- **This is an Anglo-Saxon labour market.**

A European labour market

- **Unskilled workers are paid a minimum wage.**
- **Assumption: The minimum wage is indexed to the wage of skilled workers.**

$$w_l = \mu w_h = \mu p_h \Phi_h(\theta_h) \qquad 0 \leq \mu \leq 1$$

$$\frac{h_l}{m(\theta_l)} = \frac{p_l - w_l}{r + q_l} = \frac{p_l - \mu p_h \Phi_h(\theta_h)}{r + q_l}$$

$$\frac{hp_l}{m(\theta_l)} = \frac{p_l - \mu p_h \Phi_h(\theta_h)}{r + q_l}$$

$$\frac{h}{m(\theta_l)} = \frac{1 - \mu \frac{p_h}{p_l} \Phi_h(\theta_h)}{r + q_l}$$

- **Obviously θ_l is affected by a change in p_h / p_l due to technological bias.**
- **θ_h is determined as in the Anglo-Saxon model and is not affected by technological bias.**
- **It follows that relative unemployment is affected by technological bias.**

CES production function

$$F(A_h L_h,\ A_l F_l) \ = \ \left[(A_h L_h)^{(\sigma-1)/\sigma} \ + \ (A_l L_l)^{(\sigma-1)/\sigma}\right]^{\sigma/(\sigma-1)}$$

$$\frac{p_h}{p_l} \ = \ \left(\frac{A_h}{A_l}\right)^{(\sigma-1)/\sigma} \left(\frac{L_h}{L}\right)^{-1/\sigma} \qquad (46)$$

Anglo-Saxon model

$$\frac{w_h}{w_l} \ = \ \left(\frac{A_h}{A_l}\right)^{(\sigma-1)/\sigma} \left[\frac{N_h(1-u_h)}{N_l(1-u_l)}\right]^{-1/\sigma} \qquad \frac{\Phi_h(\theta_h)}{\Phi_l(\theta_l)}$$

European labour market

(46) together with $L_i \ = \ N_i(1-u_i)$ **and**

$$\frac{h_l}{m_l(\theta_l)} \ = \ \frac{p_l - w_l}{r \ + \ q_l}$$

gives:

$$\frac{h(r \ + \ q_l)}{m_l(\theta_l)} \ = \ 1 - \mu\left(\frac{A_h}{A_l}\right)^{(\sigma-1)/\sigma} \left[\frac{N_h(1-u_h)}{N_l(1-u_l)}\right]^{-1/\sigma} \Phi_h(\theta_h)$$

- θ_h **and** u_h **are independent of technological bias.**
- **It can be derived that** $\nu_l = \nu_l(u_l)$
- **Rise of** $x = A_h / A_l$ **with** $\sigma > 1$ **shifts *LD* curve downwards in Figure 10.11.**
- $u_l \uparrow$ **and** $\frac{u_l}{u_h} \uparrow$**.**

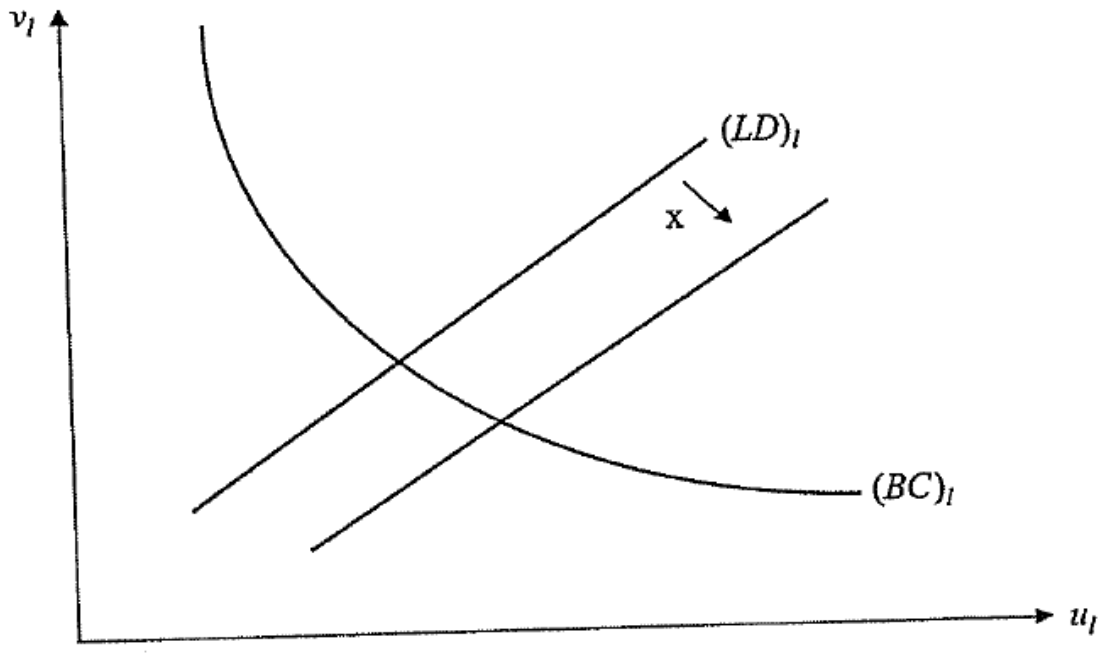


FIGURE 10.11
The unskilled labor market equilibrium.

5.1 Sysselsättningsgrad för personer med inhemsk respektive utländsk bakgrund efter prestationsnivå i läs- och skrivkunnighet, 2012, procent av befolkningsgruppen

	Prestationsnivå 1		Prestationsnivå 2		Prestationsnivå 3		Prestationsnivå 4	
	Inhemsk bakgrund	Utländsk bakgrund	Inhemsk bakgrund	Utländsk bakgrund	Inhemsk bakgrund	Utländsk bakgrund	Inhemsk bakgrund	Utländsk bakgrund
Danmark	57	54	72	65	80	71	85	75
Finland	47	47	64	73	75	76	79	71
Frankrike	56	52	65	57	68	63	72	65
Irland	44	56	58	59	68	63	77	75
Italien	49	69	53	59	62	57	71	76
Nederländerna	62	50	72	60	82	72	86	73
Norge	60	66	74	74	83	81	90	91
Spanien	46	50	58	58	67	66	75	73
Storbritannien	54	57	68	68	77	75	84	81
Sverige	**57**	**47**	**70**	**70**	**78**	**81**	**85**	**90**
Tyskland	62	64	76	69	81	77	83	77
USA	59	74	68	70	80	74	83	81
Österrike	63	59	71	67	80	74	82	76
OECD	57	69	66	67	77	73	82	79

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5.2 Sysselsättningsgrad för personer med inhemsk respektive utländsk bakgrund efter utbildningsnivå, 2012, procent av befolkningsgruppen

	Lägre än gymnasium		Gymnasium		Eftergymnasial utbildning, ej högskola		Högskola	
	Inhemsk bakgrund	Utländsk bakgrund	Inhemsk bakgrund	Utländsk bakgrund	Inhemsk bakgrund	Utländsk bakgrund	Inhemsk bakgrund	Utländsk bakgrund
Danmark	59	46	75	63	84	74	89	79
Finland	40	42	69	61	83	90	89	76
Frankrike	43	49	67	56	84	72	82	72
Irland	42	33	59	56	69	69	84	73
Italien	45	65	64	64	77	17	79	70
Nederländerna	66	45	81	64	90	70	88	80
Norge	62	58	81	77	84	78	93	84
Spanien	45	48	59	62	71	69	81	67
Storbritannien	56	52	72	63	79	65	85	83
Sverige	**52**	**40**	**78**	**76**	**81**	**79**	**92**	**82**
Tyskland	46	55	77	75	88	76	90	79
USA	46	64	71	70	77	80	87	83
Österrike	54	57	78	68	83	76	91	80
OECD	45	61	71	70	80	73	87	80

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Wage effects of immigration

- Current Swedish debate on lower minimum wages to help labour market integration of low-skilled immigrants
- Fear that this will cause lower wages for low-skilled natives as well
- No available research on this issue
- But research in other countries on the effects of low-skilled immigration on wages of low-skilled natives
- Some studies have found **positive** or **no** effects
- Methodological problems with these studies
  - causality: immigration can be driven by demand (not supply)
  - not panel data on individuals: instead cross-sectional data on regions (encompassing both incumbents and those who move in but not those who move out)

Foged-Peri study of Denmark

- Supply-driven allocation of refugee immigrants to Denmark 1986-1998
  - allocation according to housing situation (not labour-demand situation)
  - natural experiment (quasi-experiment)
- Results
  - Less educated native workers are pushed to change occupation (moves to non-manual occupations especially when changes of establishment)
  - Positive or null wage and employment effects on native workers
  - Cohort-based and area-based analyses give similar results

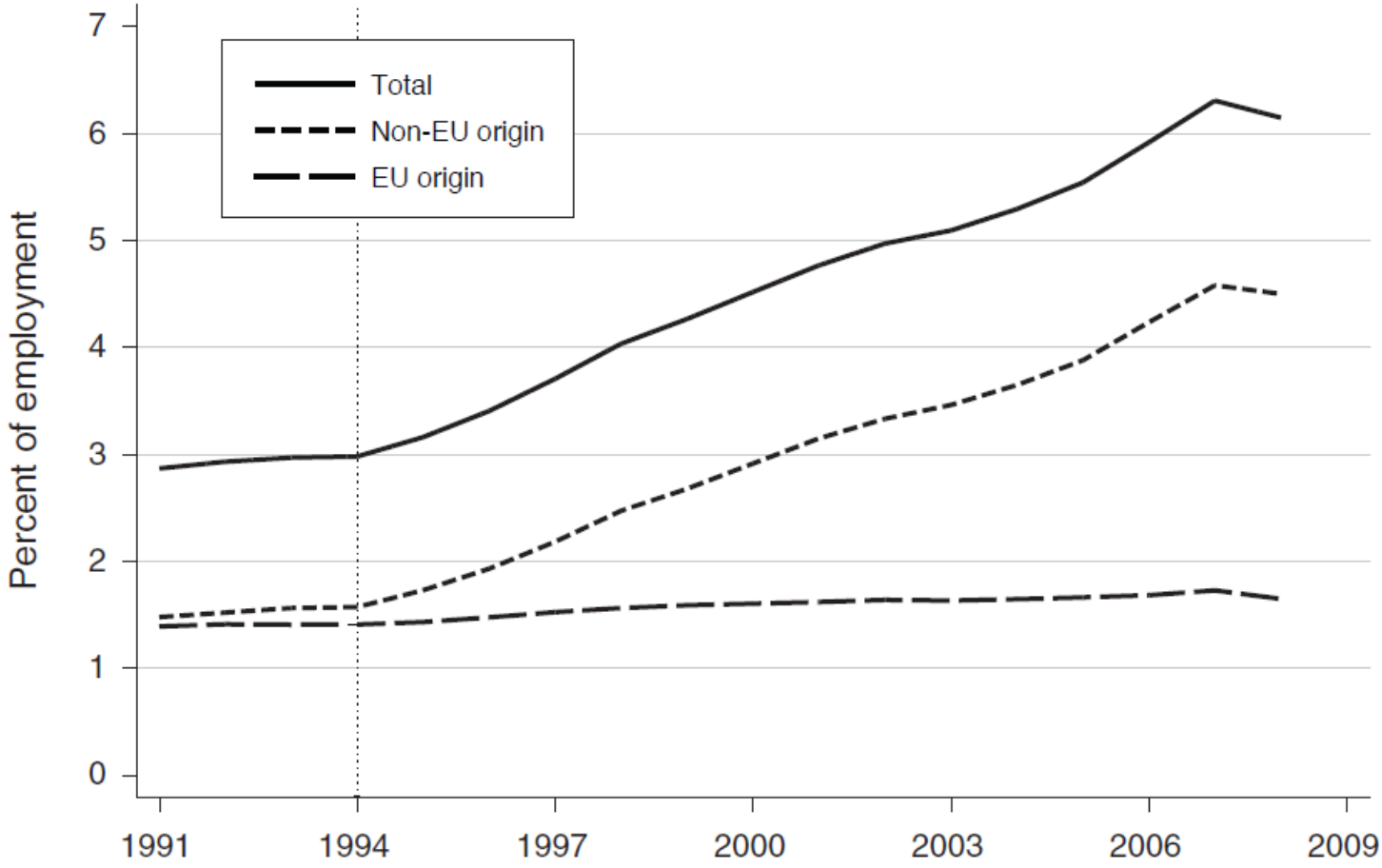

FIGURE 1. FOREIGN BORN SHARE IN DENMARK, 1991–2008

TABLE 2—SKILL LEVELS

	Refugee	Natives
Panel A. Education		
Primary	0.292	0.265
Secondary	0.104	0.059
Vocational	0.293	0.403
Higher	0.214	0.265
Unknown	0.097	0.008
Panel B. Occupation		
Most complex	0.000	0.002
Least complex	0.134	0.041
Best paid	0.003	0.030
Least paid	0.026	0.030

Notes: Observations with unknown education in the register likely have foreign education. Occupation groups are the 2-digit ISCO classifications.

TABLE 3—SKILL CONTENT OF OCCUPATIONS AND CHANGE IN REFUGEE IMMIGRANTS SHARE, 1994–2008

	Difference in refugee share	Skill content of occupation			
		Cognitive	Communication	Manual	Complexity
Panel A. Lowest inflow					
Managers of small enterprises	−0.003	0.666	0.677	0.432	1.136
Legislators and senior officials	0.001	0.897	0.989	0.303	1.828
Skilled agricultural and fishery workers	0.001	0.362	0.248	0.736	−0.328
Corporate managers	0.002	0.796	0.796	0.367	1.488
Armed forces	0.002	0.441	0.390	0.633	0.225
Panel B. Highest inflow					
Laborers in mining, construction, manufacturing, and transport	0.022	0.215	0.156	0.769	−0.783
Drivers and mobile plant operators	0.023	0.352	0.265	0.810	−0.322
Other elementary occupations	0.027	0.260	0.205	0.742	−0.633
Machine operators and assemblers	0.036	0.276	0.146	0.790	−0.655
Sales and services elementary occupations	0.051	0.126	0.103	0.695	−1.234

Notes: Complexity index = ln((Communication + Cognitive)/Manual). The skill content of each occupational grouping (2-digit ISCO) is the population weighted average of the underlying occupations (4-digit ISCO).

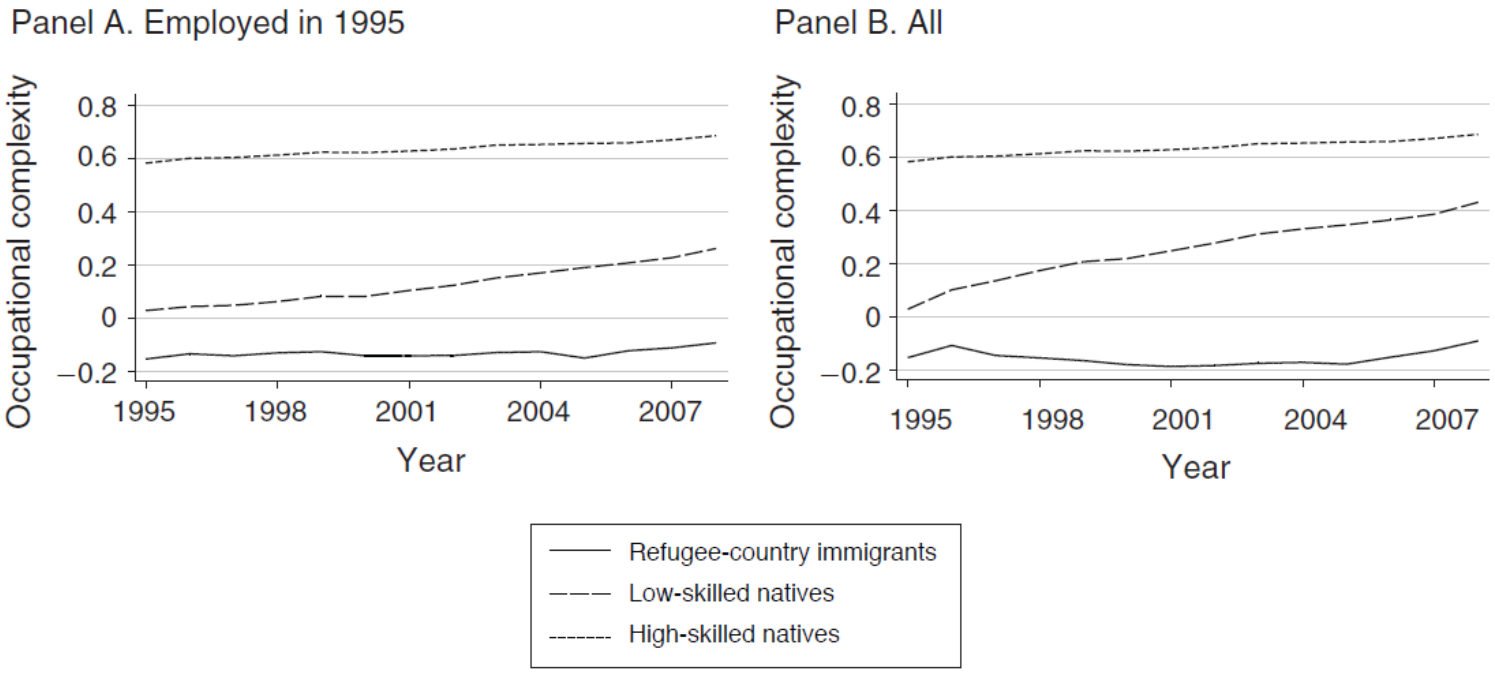

FIGURE 3. MEAN COMPLEXITY OF TASKS OVER TIME FOR GROUPS OF WORKERS

Notes: Each year the figure shows (for three groups) the mean complexity of tasks performed by either those employed in 1995 (panel A) or all, i.e., including new entrants to Danish employment (panel B).

$$y_{ijmt}^{NAT} = x_{it}'\alpha + \beta S_{mt} + \phi_{t,IND} + \phi_{t,REG} + \gamma_{i,u} + \varepsilon_{ijmt},$$

where

y_{ijmt}^{NAT} = complexity, wages or employment

x_{it} = vector of time-varying individual characteristics

S_{mt} = refugee immigrant share of employment

$\phi_{t,IND}$ = industry-by-year effects

$\phi_{t,REG}$ = region-by-year effects

$\gamma_{i,u}$ = various fixed effects

ε_{ijmt} = error term

$$y_{imt}^{NAT} = x_{it}'\alpha + \sum_{s=-3}^{-1} \gamma_S M_m D(year = s) + \sum_{s=1}^{14} \gamma_S M_m D(year = s) + \phi_{t,IND} + \phi_{t,REG} + \phi_{t,EDUC} + \phi_{t,OCC} + \phi_m + \varepsilon_{it},$$

where

y_{imt}^{NAT} = complexity, wages or employment

x_{it} = vector of time-varying individual characteristics

M_m = treatment dummy (upper or lower quartile of refugee inflows)

$\phi_{t,IND}$ = industry-by-year effects

$\phi_{t,REG}$ = region-by-year effects

$\phi_{t,EDUC}$ = education-by-year effects

$\phi_{t,OCC}$ = occupation-by-year effects

ϕ_m = fixed municipality effects

Instrumentation of Refugee Immigration

F_{ct} = total refugee immigration from country c in year t

S_{cm} = share of immigrants from country c who settled in municipality m 1986-1998

$\hat{F}_{cmt}$ for $t > 1994 =$ S_{cm} x F_{ct} = imputed working-age population from refugee-sending country c in year t

$\hat{S}_{mt} = \frac{\sum_c \hat{F}_{cmt}}{P_{m1998}}$

P_{m1998} = total working-age population in municipality m in 1998

TABLE 6—FIXED EFFECT REGRESSIONS, LOW SKILLED

	Worker-establishment		Worker-municipality		Worker	
	FE (1)	FE-IV (2)	FE (3)	FE-IV (4)	FE (5)	FE-IV (6)
Occupational complexity	0.255	0.259	1.310*	3.170*	0.602*	1.340**
	(0.326)	(0.580)	(0.612)	(1.534)	(0.275)	(0.478)
Manual intensity	−0.122	−0.289	−0.717**	−1.947**	−0.388**	−0.851***
	(0.143)	(0.337)	(0.224)	(0.680)	(0.131)	(0.230)
Communication intensity	−0.144	−0.514	0.200	0.559	0.156	0.668*
	(0.315)	(0.526)	(0.512)	(1.001)	(0.210)	(0.333)
Cognitive intensity	0.327	0.144	0.821*	1.417	0.213	0.238
	(0.198)	(0.488)	(0.407)	(0.855)	(0.148)	(0.233)
Occupational mobility	0.320	1.004	0.502	1.933*	0.931***	1.781***
	(0.295)	(0.785)	(0.412)	(0.983)	(0.214)	(0.457)
Hourly wage	0.620*	1.601**	0.169	0.983	0.787**	1.802**
	(0.265)	(0.507)	(0.351)	(0.601)	(0.300)	(0.642)
Fraction of year worked	0.151	0.554*	0.259*	0.794**	0.408***	0.735***
	(0.129)	(0.262)	(0.106)	(0.287)	(0.066)	(0.101)
Observations	1,564,737	1,564,737	1,816,727	1,816,727	1,864,027	1,864,027
First-stage *F*-statistic		53.53		58.01		468.87
First-stage coefficient		0.551***		0.603***		0.476***
		(0.075)		(0.079)		(0.022)

TABLE 7—FIXED EFFECT REGRESSIONS, HIGH SKILLED

	Worker-establishment		Worker-municipality		Worker	
	FE (1)	FE-IV (2)	FE (3)	FE-IV (4)	FE (5)	FE-IV (6)
Occupational complexity	−0.038	0.245	0.406	1.149**	0.288*	0.477*
	(0.256)	(0.457)	(0.256)	(0.410)	(0.139)	(0.220)
Manual intensity	−0.132	−0.448	−0.308*	−0.777**	−0.237***	−0.387***
	(0.112)	(0.243)	(0.120)	(0.246)	(0.070)	(0.096)
Communication intensity	−0.346	−0.239	0.005	0.484	0.050	0.218
	(0.224)	(0.361)	(0.246)	(0.352)	(0.122)	(0.176)
Cognitive intensity	−0.084	−0.447	0.101	−0.009	0.021	−0.096
	(0.184)	(0.522)	(0.199)	(0.396)	(0.111)	(0.197)
Occupational mobility	0.106	1.301*	0.395	1.944***	0.209	0.378
	(0.235)	(0.546)	(0.272)	(0.569)	(0.160)	(0.260)
Hourly wage	0.512***	2.068***	0.522*	2.316***	−0.301	−0.034
	(0.148)	(0.452)	(0.203)	(0.584)	(0.381)	(0.483)
Fraction of year worked	−0.083	0.178	−0.048	0.120	0.096*	0.223***
	(0.080)	(0.176)	(0.073)	(0.166)	(0.040)	(0.060)
Observations	2,860,183	2,860,183	3,125,934	3,125,934	3,160,757	3,160,757
First-stage *F*-statistic		63.28		68.02		294.85
First-stage coefficient		0.563***		0.607***		0.495***
		(0.071)		(0.074)		(0.029)

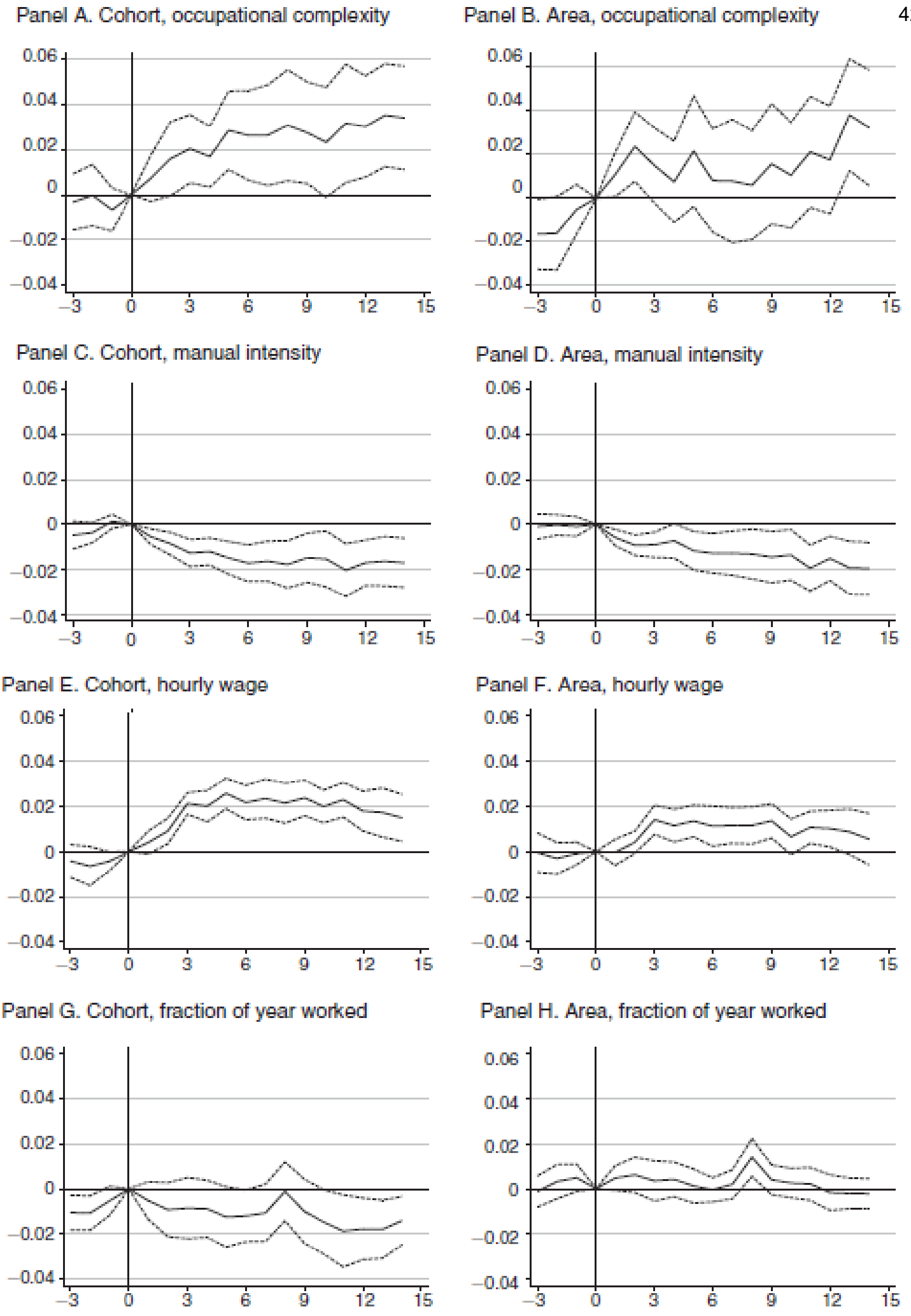

FIGURE 4. TREATMENT-CONTROL DIFFERENCES IN OUTCOMES, LOW SKILLED

variables without a superscript to employment in some other firm. The flow value functions for a worker in firm *i* are then:

$$rV_E^i = \omega_E^i + q\left(V_U - V_E^i\right) \tag{1}$$

$$rV_U = b + s(\theta)(V_E - V_U), \tag{2}$$

where r is the exogenous discount rate, q is the exogenous job destruction rate, b is the after-tax real unemployment benefit, and s is the hazard rate, i.e. the rate at which unemployed workers exit unemployment, which depends positively on labour market tightness θ (the ratio between vacancies and unemployment), so that $s'(\theta) > 0$. $\omega_E^i = w^i - T_E\left(w^i\right)$ is the after-tax real wage of a worker in firm i with w^i being the pre-tax real wage and T_E the income tax paid by the worker.

Let Π_E^i and Π_V^i denote the values of a firm *i*'s profit streams associated with employment of a worker and an unfilled vacancy, respectively. Then the following asset return equations apply:

$$r\Pi_E^i = y - \omega_F^i + q\left(\Pi_V^i - \Pi_E^i\right) \tag{3}$$

$$r\Pi_V^i = -h + m(\theta)\left(\Pi_E^i - \Pi_V^i\right), \tag{4}$$

where y is output per worker, h is the cost of a vacancy and m is the probability of filling a vacancy, which depends negatively on labour market tightness θ, so that $m'(\theta) < 0$. $\omega_F^i = (1+\tau)w^i$ is the real wage cost of a worker to firm *i* with τ being the proportional payroll tax rate.

Letting $\lambda \in (0,1)$ denote the relative bargaining power of workers, the Nash bargaining solution for the real wage in firm *i* is obtained as:

$$\max_{lnw^i} \Lambda = \lambda ln\left(V_E^i - V_U\right) + (1-\lambda) ln\left(\Pi_E^i - \Pi_V^i\right),$$

where (1) implies

$$V_E^i - V_U = \frac{\omega_E^i - rV_U}{r+q}. \tag{5}$$

Since free entry of firms ensures that $\Pi_V^i = 0$, (3) gives:

$$\Pi_E^i - \Pi_V^i = \frac{y - \omega_F^i}{r + q}. \tag{6}$$

Taking account of (5) and (6) and solving the optimization problem gives the first-order condition:

$$\frac{\partial ln\Lambda}{\partial lnw^i} = \lambda \frac{\mu^i \omega_E^i}{(\omega_E^i - rV_U)} - (1 - \lambda)\frac{\omega_F^i}{y - \omega_F^i} = 0, \tag{7}$$

where

$$\mu^i \equiv \frac{\partial ln\omega_E^i}{\partial lnw^i} = \frac{1 - T_E'(w^i)}{1 - T_E/w^i},$$

is the elasticity of the individual's after-tax real wage with respect to the before-tax real wage. μ^i, sometimes denoted the *coefficient of residual income progression*, is a measure of income tax progressivity. If $\mu^i < 1$, a one per cent increase in the before-tax real wage w^i causes a less than one per cent increase in the after-tax real wage ω_E^i, indicating that the income tax is progressive. This occurs when the marginal tax rate T_E', is higher than the average tax rate T_E/w^i. The lower the elasticity μ^i, the more progressive is the income tax.

Using (1) and (2) to solve for rV_U we obtain:

$$rV_U = \left[\frac{r + q}{r + q + s(\theta)}\right] b + \left[\frac{s(\theta)}{r + q + s(\theta)}\right] \omega_E,$$

where ω_E is the after-tax wage that the worker would obtain in another firm. Substituting this expression into (7) yields:

$$\lambda \frac{\mu^i}{(1 - \left(\frac{r + q}{r + q + s(\theta)}\right)\rho^i - \left(\frac{s(\theta)}{r + q + s(\theta)}\right)\omega_E/\omega_E^i)} = (1 - \lambda)\frac{\omega_F^i}{y - \omega_F^i}, \tag{8}$$

where $\rho^i = b/\omega_E^i$ is the after-tax replacement rate of individual i. Because $\omega_E^i = w^i - T_E(w^i)$, $\omega_E = w - T_E(w)$ and $\omega_F^i = (1+\tau)w^i$, the condition (8) implicitly defines a real wage equation for an individual worker:

$$w^i = w^i(\rho^i, \mu^i, \tau, \theta, y, w; r, q, \lambda). \tag{9}$$

Here w is the worker's outside option in terms of the before-tax wage that he would obtain in another firm. The individual's real wage thus depends on the net replacement rate ρ^i (which reflects both the before-tax replacement rate and EITCs), income tax progressivity μ^i, the payroll tax rate τ, labour market tightness θ, labour productivity y and the outside wage w as well as on the real interest rate r, the separation rate q and the bargaining power of workers λ.

Differentiating (8), we find that:

$$\frac{\partial w^i}{\partial \rho^i} = \frac{(1-\lambda)(r+q)(w^i/\mu^i)}{\phi} > 0,$$

$$\frac{\partial w^i}{\partial \mu^i} = \frac{\lambda(r+q+s(\theta))(y/\omega_F^i - 1)(w^i/\mu^i)}{\phi} > 0,$$

$$\frac{\partial w^i}{\partial \tau} = -\frac{\lambda(r+q+s(\theta))(y/(1+\tau)^2)}{\phi} < 0,$$

$$\frac{\partial w^i}{\partial \theta} = \frac{(\omega_E/\omega_E^i - \rho^i)(1-\lambda)s'(\theta)(r+q)/(r+q+s(\theta))(w^i/\mu^i)}{\phi} \lesseqgtr 0,$$

$$\frac{\partial w^i}{\partial y} = \frac{\lambda(r+q+s(\theta))/(1+\tau)}{\phi} > 0,$$

$$\frac{\partial w^i}{\partial w} = \frac{(1-\lambda)s(\theta)(1-T_E'(w))(\mu w^i \omega_E/\mu^i w \omega_E^i)}{\phi} > 0,$$

where

$$\phi = (1-\lambda)s(\theta)(\omega_E/\omega_E^i) + \lambda\big(r+q+s(\theta)\big)(y/\omega_F^i) > 0.$$

An increase in the individual's net replacement rate ρ^i raises the real wage because it gives the worker a better outside option (higher income if there is no agreement with the employer and the worker stays unemployed). An increase in the before-tax replacement rate affects the real wage in a similar way as an EITC as both increase the net replacement rate. A decrease in income tax progressivity, i.e. an increase in the progressivity variable μ^i, also raises the wage, as it gives the worker a higher payoff from a before-tax real wage increase in terms of the after-tax real wage. An increase in the payroll tax rate τ reduces the real wage because it decreases the surplus that workers and employers can share. An increase in labour market tightness θ has an ambiguous effect but raises the real wage if $\omega_E/\omega_E^i > \rho^i$. The interpretation is that the worker's outside option is improved the faster a job can be found in another firm provided that the wage there is not too low compared to the unemployment benefit. An increase in labour productivity y raises the real wage because the surplus to be shared between workers and employers increases. Finally, an increase in the outside wage also increases the individual's wage, as it improves the outside opportunity.

In a symmetric equilibrium, defined as wages being identical across firms, the expressions are simplified. Imposing $w^i = w$ on (9) enables us to solve for the equilibrium real wage as:

$$w = \frac{1}{(1+\tau)}\frac{\lambda\mu(r+q+s(\theta))y}{[(1-\lambda)(1-\rho)(r+q)+\lambda\mu(r+q+s(\theta))]}. \tag{10}$$

Equation (10) now defines an aggregate equilibrium before-tax real wage which can be written in the general form:

$$w = w(\rho, \mu\,, \tau, \theta, y; r, q, \lambda). \tag{11}$$

It is straightforward to show that the signs of the partial derivatives of equation (11) are the same as those of equation (9). The only exception is $\partial w/\partial\theta$ which is now unambiguously positive, such that an increase in labour market tightness raises the equilibrium real wage. This follows immediately from the earlier expression for

variations across years. We do, however, include fixed time effects in some specifications.

The remaining variables in equation (9), i.e. the real interest rate, the job destruction rate and the bargaining strength parameter are treated as fixed.

Our benchmark regression equation is thus:

$$\Delta lnw_{it} = \beta_0 + \beta_1 \Delta lnp_t + \beta_2 \Delta \rho_{it} + \beta_3 \Delta \mu_{it} + \beta_4 \Delta \tau_{it} + \beta_5 \Delta \theta_{it} \ + \sum_j \beta_{5+j} x_{ijt} + \epsilon_{it}, \tag{13}$$

where w from now on denotes the nominal hourly wage and the $x_j : s$ denote the individual control variables. Subscript i denotes the individual and subscript t the time period.

We measure the change in the labour market situation for an individual as the change in the unemployment in the municipality of residence.[5] As the reforms to the payroll tax during the sample period were related to the individual's age (see Section 2), changes in payroll taxes are proxied by the following dummy variables:

$$D_{1it} = \begin{cases} 1 \; if \; a_{it} < 25 \; for \; t = 2007 \\ 0 \; othwerwise \end{cases}$$

$$D_{2it} = \begin{cases} 1 \; if \; \; a_{it} < 26 \; for \; t = 2009 \\ 0 \; othwerwise \end{cases}$$

where a_{it} denotes the individual's age.

A key challenge is how to deal with the fact that the net replacement rate ρ^i and the tax progressivity variable μ^i for the individual are functions of income (and thus the wage rate) and therefore endogenous. This is so because tax rates vary with income and because there has been a fixed nominal floor and a fixed nominal ceiling for the before-tax unemployment benefit (see Section 2). Moreover, the individual's net replacement rate is not directly observable since the wage data apply to employed persons. We therefore must predict the net replacement rate that the individual would obtain in the event of unemployment. To address these issues, we compute the net replacement rate

[5] Because there are no data on vacancies per municipality, labour market tightness cannot be used as a variable.

Table 1. Descriptive statistics, 2005-2009

	Year	2005	2006	2007	2008	2009
Monthly wage	Mean	24 205	25 115	25 795	27 115	27 991
	St Dev	11 591	12 171	12 229	12 527	12 590
	Min	10 000	12 000	12 000	12 000	12 000
	Max	1 043 707	1 232 252	960 882	736 626	668 145
Wage growth	Mean	.037	.044	.041	.058	.037
	St Dev	.117	.120	.125	.124	.119
	Min	-2.141	-2.086	-1.940	-2.004	-2.196
	Max	2.340	2.477	1.754	2.014	2.310
Net replacement rate	Mean	.710	.697	.630	.603	.582
	St Dev	.129	.133	.131	.132	.133
	Min	.032	.023	.019	.024	.031
	Max	.860	.859	.795	.795	.795
Net replacement rate growth	Mean		-.016	-.072	-.032	-.023
	St Dev		.051	.056	.056	.056
	Min		-.571	-.654	-.567	-.575
	Max		.614	.434	.505	.579
Progressivity variable	Mean	.871	.868	.858	.851	.864
	St Dev	.090	.088	.097	.100	.092
	Min	.672	.666	.647	.641	.637
	Max	1	1	1	1	1
Change in progressivity variable	Mean		-.004	-.012	-.009	.012
	St Dev		.067	.068	.073	.080
	Min		-.314	-.338	-.354	-.350
	Max		.319	.326	.339	.346
Local unemployment	Mean	.059	.053	.039	.037	.059
	St Dev	.016	.015	.012	.012	.018
	Min	.023	.021	.013	.009	.018
	Max	.141	.115	.089	.094	.138
Hours worked	Mean	.896	.898	.898	.897	.897
	St Dev	.215	.215	.214	.217	.216
	Min	.010	.006	.010	.004	.010
	Max	1.000	1.000	1.000	1.000	1.000
Age	Mean	42.073	42.000	41.926	41.936	42.211
Male	Mean	.500	.506	.501	.503	.498
Max observations		119 438	119 236	124 426	122 977	119 296

Note: The net replacement rate and the progressivity variable are based on wage predictions. Local unemployment is calculated as the unemployment-to-population ratio. Both openly unemployed and participants in labour market programmes are counted as unemployed.

Table 2. Estimated wage equations. Replacement rate and progressivity variable based on lagged wages. Dependent variable: first difference of log nominal wage. 2006-2009

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Inflation				.766***	.725***	.724***	.726***	.740***	.647***			.514***
				(.014)	(.018)	(.018)	(.018)	(.018)	(.020)			(.021)
Change in replacement rate	.343***		.332***	.367***	.369***	.368***	.369***	.365***	.490***	.395***	.395***	.547***
	(.006)		(.006)	(.006)	(.006)	(.006)	(.006)	(.006)	(.008)	(.007)	(.007)	(.004)
Change in Progressivity variable		.111***	.028***	.040***	.040***	.040***	.040***	.040***	.039***	.034***	.034***	.040***
		(.003)	(.003)	(.003)	(.003)	(.003)	(.003)	(.003)	(.003)	(.003)	(.003)	(.003)
Change in unemployment rate					-.057***	-.058***	-.054***	-.036**	-.319***	-.121***	-.121***	-.007
					(.017)	(.017)	(.017)	(.017)	(.019)	(.033)	(.033)	(.000)
Dummy for earlier unemployment					-.001***	-.001	-.001	-.001	.006***	-.001	-.001	.001
					(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.000)	(.001)
Male				-.018	-.020	-.027	-.027	.009	-.498***	-.019	-.019	
				(.045)	(.045)	(.045)	(.045)	(.045)	(.049)	(.045)	(.045)	
Age				-.089***	-.089***	-.226***	-.217***	-.231***	-.363***	-.224***	-.236***	-.005***
				(.002)	(.002)	(.015)	(.016)	(.015)	(.017)	(.015)	(.016)	(.001)
Age squared						.157***	.148***	.163***	.282***	.153***	.165***	.000***
						(.017)	(.018)	(.016)	(.018)	(.017)	(.018)	(.000)
Payroll dummy 2007							.004				-.002	
							(.003)				(.002)	
Payroll dummy 2009							.000				-.003	
							(.002)				(.002)	
Controls				Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Entrepreneurs excluded								Yes				
Full-time employed									Yes			
Year dummies										Yes	Yes	
Individual fixed effects												Yes
N	382 548	382 548	382 548	382545	382 545	382 545	382 545	374 786	291 656	382 545	382 545	382 545
R2	.031	.005	.031	.048	.048	.049	.049	.049	.078	.050	.050	.084

Notes: Where indicated, the controls comprise educational level and type, region of birth and civil status. The constant is not reported. Robust standard errors are reported within parenthesis. ***: significant at the 1 per cent level; **: significant at the 5 per cent level; *: significant at the 10 per cent level. The coefficients and standard errors for Male and Age have been multiplied by 100, and the coefficient and standard errors for Age squared by 100^2.

Table 3. Estimated wage equations. Replacement rate and progressivity variable based on estimated Mincer wages. Dependent variable: first difference of log nominal wage. 2006-2009

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Inflation				.660***	.688***	.685***	.687***	.707***	.595***			
				(.015)	(.019)	(.019)	(.019)	(.019)	(.021)			
Change in replacement rate	.083***		.086***	.220***	.210***	.203***	.203***	.201***	.161***	.324***	.328***	.641***
	(.008)		(.008)	(.009)	(.010)	(.010)	(.010)	(.010)	(.011)	(.022)	(.022)	(.024)
Change in progressivity variable		-.015***	-.017***	.010***	.009***	.008***	.008***	.008***	.008***	.004	.004	.006*
		(.003)	(.003)	(.003)	(.003)	(.003)	(.003)	(.003)	(.003)	(.003)	(.003)	(.003)
Change in unemployment rate					.051***	.055***	.052***	.077***	-.076***	-.124***	-.124***	-.040
					(.018)	(.018)	(.018)	(.018)	(.020)	(.034)	(.034)	(.039)
Dummy for earlier unemployment					.004***	.004***	.004***	.004***	.008***	.004***	.004***	.007***
					(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)
Male				-.054	-.039	-.045	-.044	-.014	-.237***	-.047	-.047	
				(.046)	(.046)	(.046)	(.046)	(.046)	(.050)	(.046)	(.046)	
Age				-.090***	-.088***	-.263***	-.259***	-.266***	-.388***	-.253***	-.259***	-.994***
				(.002)	(.002)	(.014)	(.016)	(.014)	(.017)	(.015)	(.016)	(.092)
Age squared						.204***	.199***	.208***	.325***	.189***	.195***	.897***
						(.016)	(.017)	(.016)	(.018)	(.016)	(.017)	(.091)
Payroll dummy 2007							-.000				-.003	
							(.003)				(.003)	
Payroll dummy 2009							.002				.001	
							(.002)				(.002)	
Controls				Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Entrepreneurs excluded								Yes				
Full-time employed									Yes			
Year dummies										Yes	Yes	
Individual fixed effects												Yes
N	427 959	427 959	427 959	427 956	427 956	427 956	427 956	418 773	320 026	427 956	427 956	427 956
R2	.000	.000	.000	.014	.014	.014	.014	.015	.020	.015	.015	.010

Notes: Where indicated, the controls comprise educational level and type, region of birth and civil status. The constant is not reported. Robust standard errors are reported within parenthesis. ***: significant at the 1 per cent level; **: significant at the 5 per cent level; *: significant at the 10 per cent level. The coefficients and standard errors for Male and Age have been multiplied by 100, and the coefficient and standard errors for Age squared by 100^2.

Table 4 Estimated wage equations. IV estimations (2SLS). Replacement rate and progressivity variable instrumented by reform variables based on estimated Mincer wages. Dependent variable: first difference of log nominal wage. 2006-2009

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Inflation				.843***	.745***	.736***	.743***	.761***	.675***
				(.048)	(.031)	(.031)	(.032)	(.031)	(.042)
Change in replacement rate	.107***		.201***	.215***	.246***	.241***	.241***	.239***	.181***
	(.010)		(.020)	(.024)	(.019)	(.019)	(.019)	(.019)	(.019)
Change in progressivity variable		-.330***	-.401***	.442***	.540***	.485***	.504***	.494***	.429***
		(.064)	(.074)	(.126)	(.155)	(.155)	(.161)	(.160)	(.155)
Change in unemployment rate					-.214***	-.189***	-.204***	-.165***	-.301***
					(.059)	(.059)	(.064)	(.060)	(.064)
Dummy for earlier unemployment					.003***	.003***	.003***	.003***	.007***
					(.001)	(.001)	(.001)	(.001)	(.001)
Male				.044	.073	.061	.064	.095*	-.160***
				(.051)	(.053)	(.052)	(.053)	(.052)	(.059)
Age				-.096***	-.096***	-.247***	-.235***	-.249***	-.385***
				(.002)	(.002)	(.015)	(.017)	(.015)	(.017)
Age squared						.176***	.164***	.180***	.311***
						(.018)	(.020)	(.018)	(.021)
Payroll dummy 2007							-.001		
							(.002)		
Payroll dummy 2009							.004**		
							(.002)		
Controls				Yes	Yes	Yes	Yes	Yes	Yes
Entrepreneurs excluded								Yes	
Full-time employed									Yes
N	426 819	426 819	426 819	426 816	426 816	426 816	426 816	417 633	319 510

Notes: Where indicated, the controls comprise educational level and type, region of birth and civil status. The constant is not reported. Robust standard errors are reported within parenthesis. ***: significant at the 1 per cent level; **: significant at the 5 per cent level; *: significant at the 10 per cent level. The coefficients and standard errors for Male and Age have been multiplied by 100, and the coefficient and standard errors for Age squared by 100^2.

Table 5. Estimated wage equations. Percentile income group level. Dependent variable: first difference of log mean nominal wage. 2006-2009

	(1)	(2)	(3)	(4)	(5)	(6)
Change in mean replacement rate	.200***	.200***	.199***	.199***	-.086	-.078
	(.046)	(.046)	(.046)	(.046)	(.182)	(.182)
Change in mean of progressivity variable		.001		.000		.019
		(.017)		(.017)		(.016)
Group fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Weights			Yes	Yes	Yes	Yes
Year dummies					Yes	Yes
N	400	400	400	400	400	400
R2	.060	.060	.060	.060	.255	.258

Notes: Mean wages and reform variables computed over percentile income intervals, based on the 2006 income distribution implied by predicted Mincer wages. The constant is not reported. Robust standard errors are reported within parenthesis. ***: significant at the 1 per cent level; **: significant at the 5 per cent level; *: significant at the 10 per cent level. Weights indicate average group size.

$$dlnw^i \,/\, d\rho^i = \beta_2 = [0.2\,, 0.4]$$

$$\rho^i = b/\omega_E^i$$

$$\omega_E^i = w^i - T_E\left(w^i\right) = (1-t)w^i$$

$$dlnw^i/dlnb = \beta_2\,\rho^i/\,(1+\beta_2\,\rho^i)$$

$$dlnw^i \,/\, dln(1-t) = -\beta_2\,\rho^i/\,(1+\beta_2\,\rho^i)$$

$$dln\omega_E^i \,/\, dln(1-t) = 1-\left[\beta_2\,\rho^i/\,(1+\beta_2\,\rho^i)\right]$$

$$\rho^i = 0.65 \Rightarrow \beta_2\,\rho^i/\left(1+\beta_2\,\rho^i\right) = [0.12\,, 0.21]$$