Complex-Skill Biased Technical Change and Labor Market Polarization

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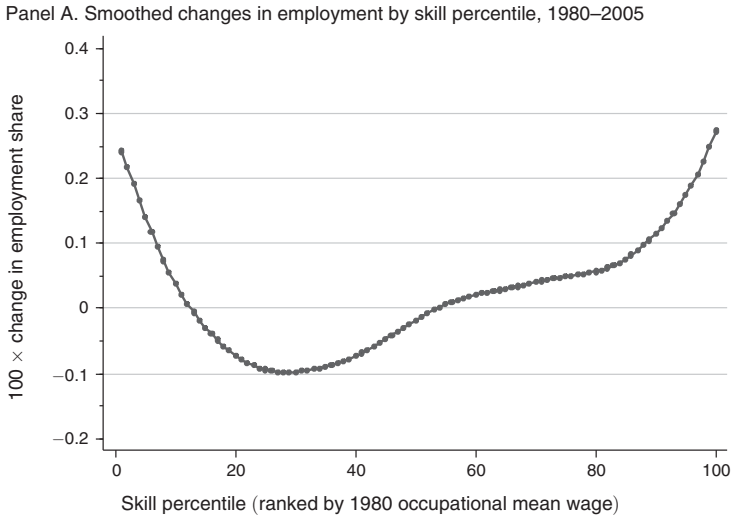
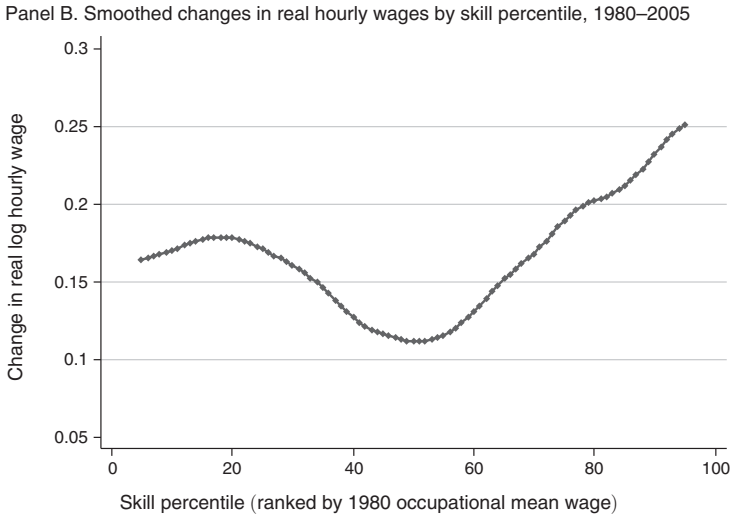
Motivation: Autor-Dorn (2013) Facts





- Mean wage growth low in middle of wage distribution
- Common explanation: routinization results in substitution away from labor in middle-wage occupations

Motivation

Are 1980 wage levels a good measure of skills or predictor of wage growth?

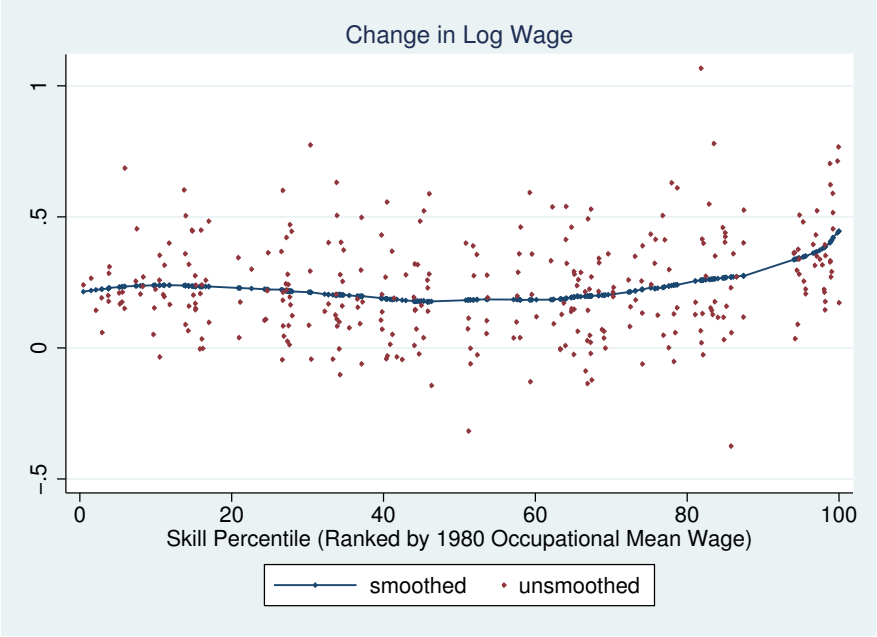
- Fix 1980 wage level at approx. 50th percentile
  - Drilling machine operator (0%) vs. Occupational therapists (59%)
  - Truck driver (4%) vs. Auto mechanics (19%)
- Fix 1980 wage level at approx. 25th percentile
  - Janitor (10%) vs. Licensed nurse(48%)
  - Taxi Driver (11%) vs. Dental assistant (46%)

Motivation

Are low-skill service jobs and routine occupations drawing from different labor supply in segmented markets?

- Routine vs. low-skill service occupations, high wage growth
  - Precision makers (30%) vs. Library assistant (27%)
  - Legal assistants/Paralegals (49%) vs. Child care workers (24%)
- Routine vs. low-skill service occupations, low wage growth
  - Mixing/blending machine operator (7%) vs. Food preparation (6%)
  - Shipping and receiving clerks (-4%) vs. Ushers (-3%)

Motivation



- Large dispersion in wage growth throughout 1980 wage distribution

Our Approach

- Autor-Dorn kernels smooth highly aggregated occupation-level data $\Longrightarrow$ interpretation?
- We view the "residuals" as highly informative
  - Is there something systematic about occupations that are above/below kernels?
- We deviate from the focus on computerization
  - Develop new occupational classification
  - Classification more directly linked to skill, not necessarily to computerization

Main Findings

- Without smoothing, routinization/computerization index has no strong and robust explanatory power for wage and employment growth
- Task complexity is strongly related to wage and employment growth
  - Complex tasks: abstract, analyze, make connections, form decisions, communicate effectively
  - Highly relevant no matter routinization index or 1980 wage level
- Has clear implications for policies targeting skills and human capital

The German BIBB dataset

BIBB

- To classify occupations use BiBB data on task usage
- Advantages:
  - Worker-level data collected in repeated cross-sections
  - Detailed information on task usage on job
    - : well-defined tasks
    - : rather than job attributes that are correlated with skills and are often vague (DoT)
  - Useful validity check: relationship between occupation-level task inputs and share of apprentices

BIBB

- Survey data on “qualification and working conditions in Germany”
- Repeated cross-sections (1979, 1986, 1992)
- Reports task usage on the job
  - those interviewed choose main task performed on job from list of approx. 20 tasks

Tasks

Aggregate tasks into 5 task groups (Gathmann and Schoenberg, 2010):

1. Manual simple (e.g. equip machines, pack, ship, transport, archive)
2. Manual complex (e.g. manufacture, process, serve, nurse)
3. Cognitive simple (clerical)
4. Cognitive complex (e.g. research, test, calculate, IT, manage, organize)
5. Interactive (e.g. sell, teach, present)

more...

Islands

- Assign the 3 digit occupations to one of four islands:
  1. simple
  2. complex
  3. advanced
  4. college
- Step 1: “Exogenous” Assignments
  - college occupations: defined by occupational requirement (college degree)
  - advanced: upgrade from other 3 digit occupations
    : (advanced) technicians
    : foremen
    : management, various levels

Islands

- Step 2: Assignments based on task data

  (a) island 1 if reporting fraction of simple tasks is $>= 66.6\%$

  (b) island 2 if reporting fraction of complex tasks is $>= 66.6\%$

  (c) island 2 if multiple tasks have high reporting fraction

  (d) island 1 if simple tasks increase significantly over time ("automatization")

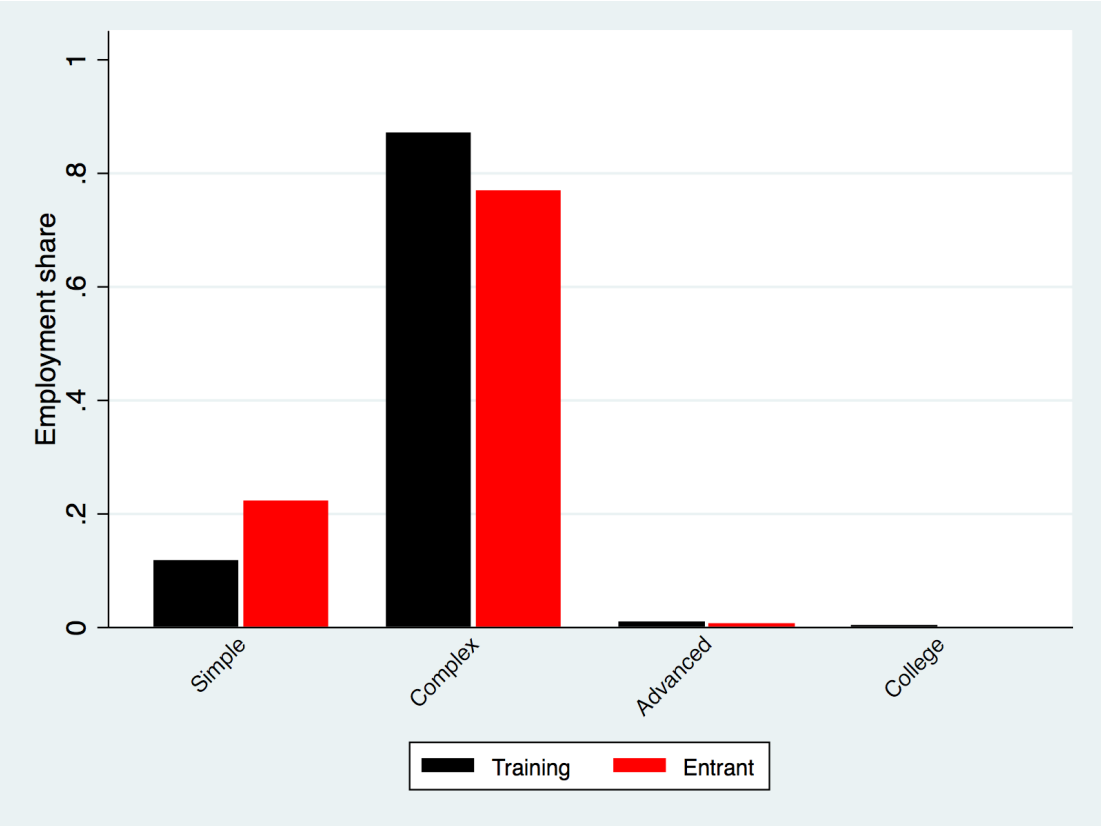
Validity Check: German Apprenticeship System

- Germany operates largest apprenticeship training program in the world
- Can be started after completion of a secondary degree
- Explicitly occupation-specific
  - Well-defined “curricular” for over 500 occupations
  - Combination of general education (public schools, 40%) and on-the-job-training (employer, 60%)
  - Highly regulated and monitored by various institutions (e.g. chambers of industry and commerce; ministry of labor)

Validity Check: Tasks and Apprenticeship

- Well-documented: Significant opportunity cost
  - Training wage one third to one half of market wage
    - : Training wage commonly bargained between chambers and unions
  - Two to three years long; ends with series of examinations
- Our hypothesis: apprentices should be concentrated in occupations that involve some level of task complexity

Island Employment Shares: Vocational Training



data source: SIAB 1975-2010

- vocational training mostly in complex occupations
- trainees enter the labor market in the training occupation

Task Usage

Aggregate task usage of labor market entrants:

	manual simple	manual complex	cognitive simple	cognitive complex	interactive
no formal degree	.44	.36	.02	.14	.04
apprenticeship degree	.26	.47	.03	.16	.08
university/tech college	.08	.11	.08	.52	.21

data source: SIAB 1975-2010

Educational Attainment Amongst Island, 1980

	$<$ Grade 12	Grade 12	College
Island 1	0.327	0.457	0.216
Island 2	0.206	0.427	0.367
Island 3	0.115	0.316	0.569
Island 4	0.022	0.083	0.895
AD RTI - Nonintensive	0.225	0.357	0.418
AD RTI - Intensive	0.192	0.464	0.344

- Share of college-educated workers higher in complex occupations, lower amongst routine-intensive occupations
- Share of high school dropouts higher in simple occupations

more...

Comparison of Island Designation and Routinization I

Routinizable Occupations with High Skill Content

Occupation Title	Wage Percentile (1980)	Island	High-Routine Intensive (AD)
Insurance sales occupations	84.381	2	1
Real estate sales occupations	76.315	2	1
Accountants and auditors	74.703	2	1
Editors and reporters	69.003	4	1
Insurance underwriters	66.285	2	1

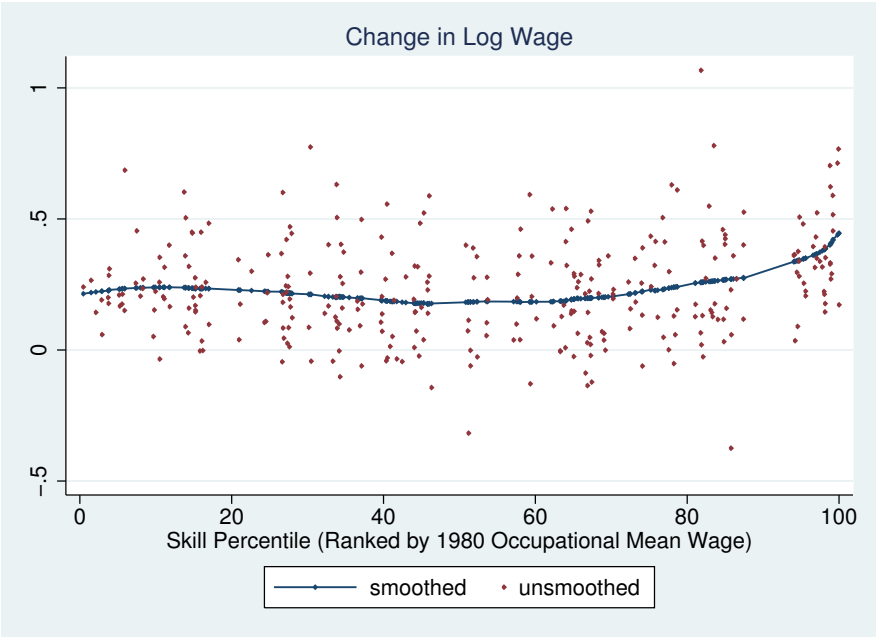
Comparison of Island Designation and Routinization II

Low Skill Occupations that are not Highly Routinizable

Occupation Title	Wage Percentile (1980)	Island	High-Routine Intensive (AD)
Parking lot attendants	12.246	1	0
Gardeners and groundskeepers	12.617	1	0
Mail carriers for postal service	75.644	1	0
Janitors	22.849	1	0
Taxi cab drivers and chauffeurs	23.037	1	0

Empirical Findings

Hypothesis



- Occupations above kernel are different from those below, no matter the 1980 wage

Wage Growth and Island Designation

Fraction of Occupations Above Wage Growth Kernel

Island	Overall	By 1980 Wage Tercile		
		Bottom 1/3	Middle 1/3	Top 1/3
1	0.25	0.33	0.14	0.23
2	0.49	0.59	0.50	0.45
3	0.67	0.00	0.80	0.67
4	0.55	1.00	0.80	0.48

- Simple occupations concentrated below kernel throughout 1980 wage distribution

Effect of Tasks on Δ Log Hourly Wages 1980-2005

Independent Variable	(i)	(ii)	(iii)	(iv)
Island 2	0.112***	0.0991***	0.107***	0.104***
	(5.52)	(4.91)	(5.30)	(5.17)
Island 3	0.153***	0.0857**	0.0782**	0.0854**
	(4.28)	(2.17)	(2.00)	(2.17)
Island 4	0.188***	0.138***	0.134***	0.138***
	(5.06)	(3.54)	(3.48)	(3.57)
Routine-Intensive				0.0293
				(1.53)
Order of Wage Poly.	1	2	3	3
$N = 312$				

$^{*}\,p < 0.1\,;\ ^{**}\,p < 0.05\,;\ ^{***}\,p < 0.01$

Effect of Tasks on Δ Employment Share 1980-2005

Independent Variable	(i)	(ii)	(iii)	(iv)
Island 2	0.000694*	0.000697*	0.000634*	0.000668*
	(1.87)	(1.88)	(1.69)	(1.78)
Island 3	0.00126*	0.00125*	0.00116*	0.00119*
	(1.91)	(1.89)	(1.74)	(1.77)
Island 4	0.00101*	0.000956	0.00100	0.000911
	(1.73)	(1.57)	(1.65)	(1.48)
Routine-Intensive				-0.000166
				(-0.48)
Order of Wage Poly.	1	2	3	2
$N = 321$				

$^{*}\, p < 0.1\,;\ ^{**}\, p < 0.05\,;\ ^{***}\, p < 0.01$

Robustness Checks

Effect of Tasks on Δ Log Hourly Wages 1980-2005

Independent Variable	Bottom Skill Tercile	Middle Skill Tercile	Top Skill Tercile	Routine Intensive	Not Routine Intensive
Island 2	0.0870***	0.129***	0.0727	0.101***	0.122***
	(3.30)	(3.70)	(1.21)	(3.21)	(4.68)
Island 3	-0.0659	0.164	0.0561	-0.168	0.197***
	(-0.09)	(0.90)	(0.87)	(-0.56)	(4.89)
Island 4	0.145	0.0456	0.133**	0.325***	0.195***
	(0.39)	(0.35)	(2.08)	(3.49)	(4.68)
Order of Skill Poly.	1	1	1	1	1
N	101	95	116	106	206

Wage Regression Across Occupation Groups

Indep. Variable	Occ. Group A	Occ. Group B	Occ. Group C	Occ. Group D	Occ. Group E
Island 2	-0.0628	0.0973**	0.134***	-0.0121	0.0465**
	(-0.63)	(2.63)	(4.65)	(-0.28)	(2.61)
Island 3	-0.174*	-0.0507	0	0.0381	-0.0147
	(-1.74)	(-0.48)	(.)	(0.68)	(-0.04)
Island 4	-0.163	0.0275	0.157*	0	0
	(-1.64)	(0.10)	(1.76)	(.)	(.)
N	88	67	33	65	59

A	Managerial & Professional Speciality Occupations
B	Technical, Sales and Administrative Support Occupations
C	Service Occupations
D	Precision Production, Craft and Repair Occupations
E	Operators, Fabricators and Laborers

Control For Education

Island Designation Correlated with Education Level

- Sort occupations based on largest education group share of labor force
  - Group 1: Less than grade 12
  - Group 2: Grade 12
  - Group 3: College

Wage Regression with Education Controls

	(i)	(ii)	(iii)	(iv)
Island 2	0.0617***	0.0466**	0.0547***	0.0547***
	(3.31)	(2.51)	(2.94)	(2.94)
Island 3	0.0427	-0.0175	-0.0226	-0.0241
	(1.28)	(-0.49)	(-0.64)	(-0.67)
Island 4	0.0397	-0.00267	-0.00469	-0.00582
	(1.11)	(-0.07)	(-0.13)	(-0.16)
Routine-Intensive				-0.00404
				(-0.23)
Education group 2	0.0742***	0.102***	0.0956***	0.0970***
	(3.01)	(4.08)	(3.83)	(3.78)
Education group 3	0.287***	0.303***	0.296***	0.298***
	(8.58)	(9.19)	(9.06)	(8.81)

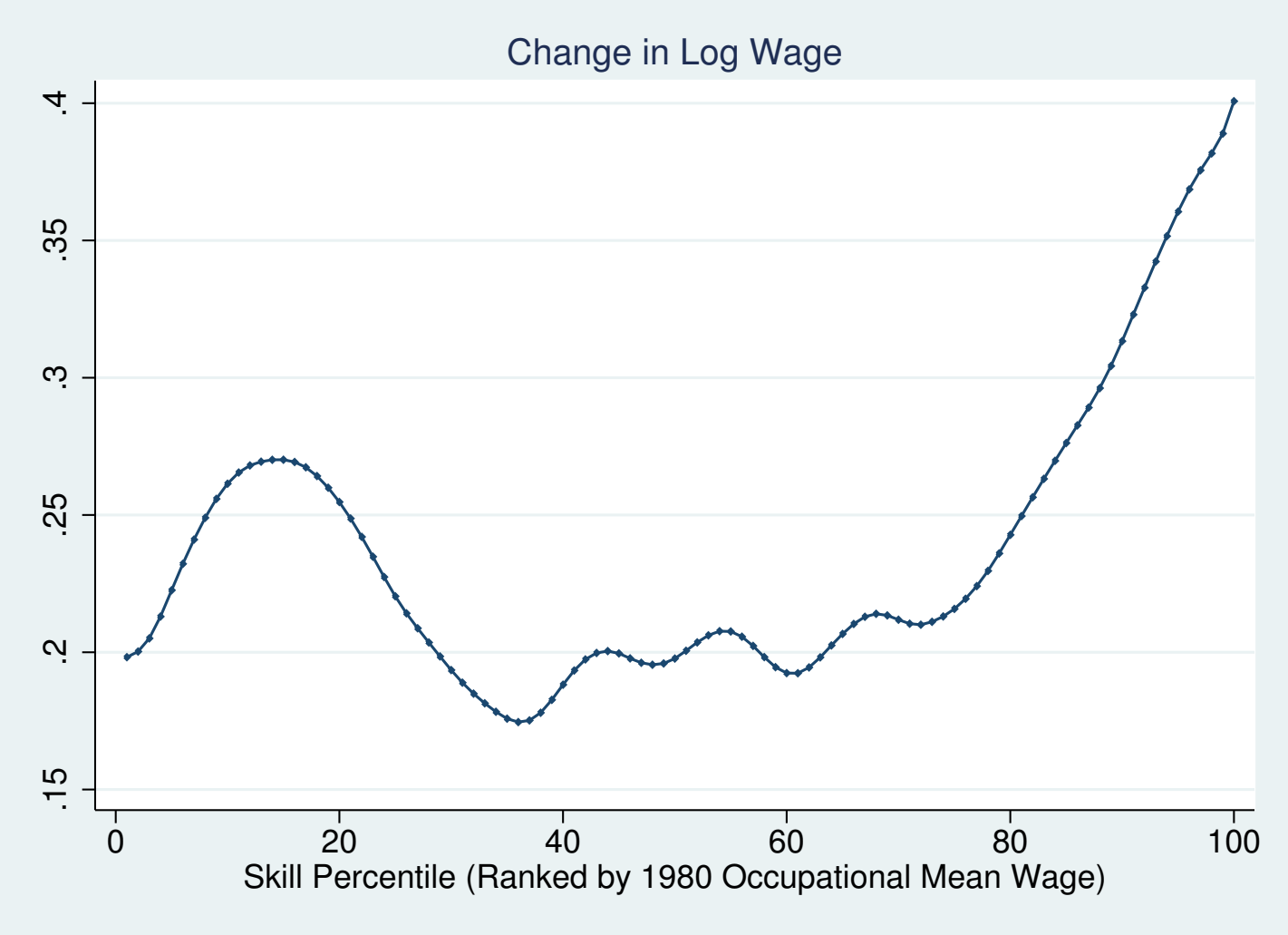
Summary

- Our paper brings back skills into polarization debate
- Low-skill ocupations: involve simple tasks
  - Predominantly draws from lower educations
  - No matter if service or non-service occupations
  - Biggest losers in terms of wage and employment growth
- Higher-skill occupations: involve increasing degree of complex tasks
  - Abstract, analyze, make connections, form decisions
  - Winners in terms of wage and employment growth
  - Includes many “middle-class” manual occupations
- These result are hidden when focusing on Autor & Dorn-like kernels

Further Throughts and Questions

- Findings are consistent with Complex-Skill Biased Technical Change
- Can potentially reconcile conflicting findings on effects of computerization and outsourcing on labor market outcomes (e.g. Firpo, Fortin, and Lemieux (2013) and Autor & Dorn (2013))
- Implications for life-cycle occupations choices (e.g. Cortes (2015) and Cortes, Jaimovich, Nekarda, Siu (2015))
- Integration into structural models of human capital accumulation (e.g. Caines, Hoffmann, Kambourov (2015))

Wage Growth By 1980 Wage Percentile



Island Employment Shares

Island	Overall	By 1980 Wage Tercile		
		Bottom 1/3	Middle 1/3	Top 1/3
1	0.259	0.345	0.373	0.061
2	0.546	0.649	0.601	0.377
3	0.110	0.000	0.009	0.321
4	0.085	0.005	0.018	0.231

- Occupations concentrated in islands 1 & 2 (esp. in bottom and middle 1/3)
- Task complexity increasing in wage levels

Wage Growth and Island Designation

Δ Log Wages 1980-2005 by Island

Island	Overall	By 1980 Wage Tercile		
		Bottom 1/3	Middle 1/3	Top 1/3
1	0.139	0.157	0.116	0.186
2	0.254	0.251	0.245	0.272
3	0.319	0.084	0.284	0.320
4	0.350	0.316	0.172	0.364

- Wage growth increasing in task complexity
- Holds throughout 1980 wage distribution

Routinization Index From DoT (Autor-Dorn)

$$Routinization_k = \ln(T_k^R) - \ln(T_k^M) - \ln(T_k^A)$$

- T_k^R is routine task input, arithmetic mean of:
  - 'FINGDEX': finger dexterity (routine manual)
  - 'STS': adaptability to work requiring Set limits, Tolerances, or Standards (routine cognitive)
- T_k^M is manual task input:
  - 'EYEHAND': Eye-Hand-Foot coordination (nonroutine manual)
- T_k^A is abstract task input, arithmetic mean of:
  - 'GED-MATH': quantitative reasoning requirements (nonroutine-cognitive/analytic)
  - 'DCP': extent to which occupations involve Direction, Control, and Planning of Activities (nonroutine-cognitive/interactive)

back

Correlation between AD and BIBB Task Measures

	Manual		Cognitive		Interactive
	Simple	Complex	Simple	Complex	
Abstract (AD)	-0.543	-0.291	-0.001	0.559	0.367
Routine (AD)	0.006	0.208	0.286	0.036	-0.474
Manual (AD)	0.400	0.304	-0.362	-0.348	-0.218

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