

LOCAL IMPACTS OF GLOBAL MARKETS

Tasks, Skills, and Wages in an Open Economy

Marc Muendler

WTO 2017

Research Agenda

- Explore interrelation between job requirements and wages
- Account for technical change, offshoring and export participation
- *Tasks*: Characteristics of workplace
In Germany time-varying worker-level information over 35 years
- Build employer-level evidence and theory of division of labor
- Combine task information with linked employer-employee data

Related Literature

- **Tasks.** Polarization (Autor, Katz, Kearney 06), offshoring (Levy, Murnane 04)
- **Tasks and trade.** Heckscher-Ohlin (Grossman, Rossi-Hansberg 08), Ricardian (Rodriguez-Clare 10; Acemoglu, Autor 11).
- **Tasks, worker performance and automation.** Ability-job match quality reduces training costs (Barron, Black, Loewenstein 89) and raises efficiency (Meyer 94; Burgess et al. 10); automation displaces routine tasks (Cortes, Jaimovich, Siu 16)
- **Human resource practices.** Management quality (Bloom, van Reenen 11) or hierarchies (Caliendo, Monte, Rossi-Hansberg 15) and effort incentives (Cunat, Guadalupe 09)
- **Between-firm matching.** Trade-induced changes in match quality (Davidson, Heyman, Matusz, Sjöholm, Zhu 14; Helpman, Itskhoki, Muendler, Redding 17)
- **Within-firm matching.** Lazear, Shaw 09: Wage structure more dependent on employer-internal sorting to occupations than on sorting to employers. Bombardini, Orefice, Tito (15): Permanent wage component in firm-worker sorting model based on Eeckhout, Kircher (11)

Trade, Technical Change, and the Labor Market

- Trade in tasks, beyond skills and occupations

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Shares of Routine and Codifiable Tasks

	1979	1986	1992	1999	2006	2012
	(1)	(2)	(3)	(4)	(5)	(6)
Routineness	0.398	0.460	0.447	0.464	0.457	0.506
Codifiability	0.600	0.654	0.622	0.661	0.686	0.693
Observations	29,737	26,361	34,277	34,343	20,000	20,036
<i>U.S. Routineness</i>	0.405	0.406		0.376	0.317	0.312

Source: BIBB-BAuA 1979-2012 and Cortes, Jaimovich & Siu (2016).

Note: For Germany shares of worker observations that indicate frequent requirements of routineness

(*Repeated work steps*) and codifiability (*Work procedures prescribed in detail*)

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Shares of Cumulative Performance Requirements at the Workplace

	1979	1986	1992	1999	2006
	(1)	(2)	(3)	(4)	(5)
0	.056	.022	.009	.004	.004
1	.040	.034	.028	.035	.014
2	.065	.061	.073	.054	.035
3	.103	.099	.159	.101	.074
4	.143	.138	.312	.150	.162
5	.168	.186	.234	.184	.240
6	.156	.196	.185	.182	.228
7	.129	.138		.143	.167
8	.085	.085		.088	.076
9	.055	.041		.059	
<i>Total</i>	1.000	1.000	1.000	1.000	1.000
<i>Average</i>	4.91	5.13	4.18	4.76	5.83
<i>Observations</i>	29,737	26,361	24,090	27,634	16,964

Source: BIBB 1979-2006.

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Source: BIBB 1979-2006.

Shares of Simultaneous Activities at the Workplace

	1979	1986	1992	1999	2006	2012
	(1)	(2)	(3)	(4)	(5)	(6)
0	.184	.071	.105	.034	.008	.008
1	.403	.331	.350	.063	.016	.014
2	.204	.263	.236	.087	.028	.028
3	.096	.156	.138	.114	.049	.046
4	.053	.093	.078	.121	.072	.071
5	.029	.052	.046	.127	.101	.099
6	.015	.023	.025	.119	.123	.121
7	.008	.006	.013	.110	.135	.134
8	.004	.002	.006	.085	.125	.130
9	.002	.001	.003	.062	.114	.116
10	.001	.001	.001	.038	.092	.092
11	.001	.0001	.0004	.025	.068	.068
12 or more	.000		.0004	.015	.070	.073
<i>Average</i>	1.676	2.177	2.105	5.250	7.261	7.316
<i>Observations</i>	29,737	26,361	24,090	27,634	16,964	16,718

Source: BIBB-BAuA 1979-2012.

Shares of Simultaneous Activities at the Workplace

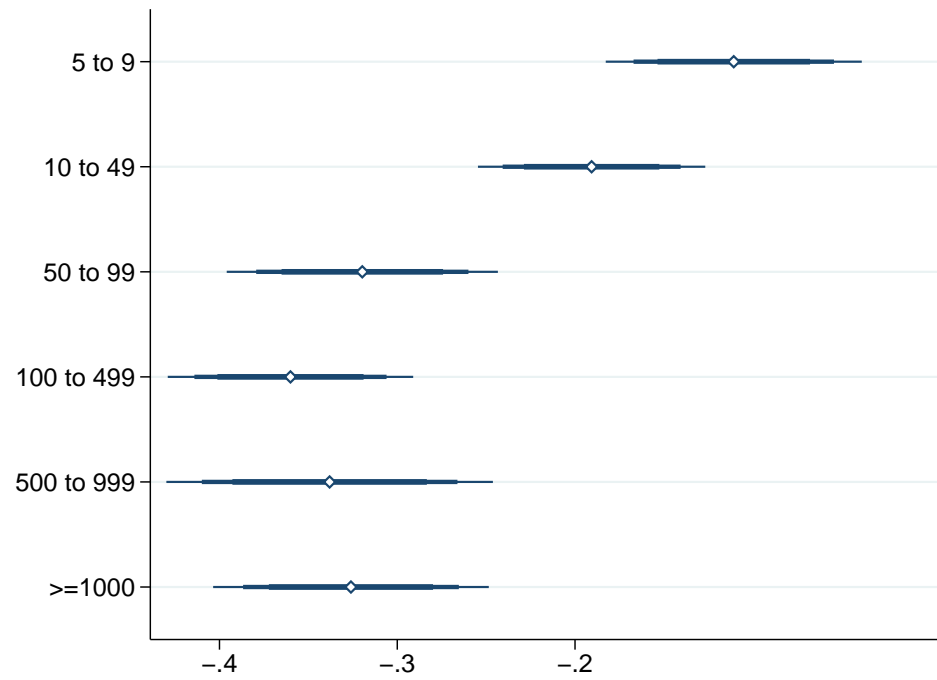
	1979	1986	1992	1999	2006	2012
	(1)	(2)	(3)	(4)	(5)	(6)
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2	.204	.263	.236	.087	.028	.028
3	.096	.156	.138	.114		

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How do activity assignments vary between employers?

Range of Activities and Plant Size



How do activity assignments vary between employers?

- Larger employers assign a strictly narrower activity range.
- Except for the very largest employers (with more than 500 workers).
Top plants assign slightly wider activity range than mid-size plants

How do activities relate to requirements and automation?

Shares of Simultaneous Activities at the Workplace in 1979

	Codifiability (1)	Routineness (2)	Computerization (3)	Automation (4)
1	0.647	0.444	0.035	0.019
2	0.594	0.396	0.068	0.032
3	0.550	0.340	0.098	0.038
4	0.541	0.315	0.112	0.050
5	0.496	0.275	0.125	0.064
6	0.536	0.332	0.119	0.060
7	0.495	0.309	0.144	0.054
8	0.541	0.287	0.172	0.033
9	0.441	0.309	0.029	0.074
10	0.514	0.314	0.200	0.114
11	0.733	0.200	0.067	0.200
12 or more	0.571	0.571	0.143	0.286
<i>Average</i>	0.549	0.299	0.088	0.068

Source: BIBB-BAuA 1979. *Note:* Share of workers per activity count who also report performance requirement or main tool use. Computerization indicates that the main tool is a computer, workstation, or CAD equipment. Automation indicates that the main tool is a robot or fully automated equipment.

Shares of Simultaneous Activities at the Workplace in 1986-2006

	Codifiability (1)	Routineness (2)	Computerization (3)	Automation (4)
1	0.687	0.529	0.177	0.018
2	0.664	0.480	0.275	0.026
3	0.642	0.435	0.335	0.029
4	0.637	0.414	0.398	0.043
...
8	0.615	0.402	0.435	0.095
9	0.609	0.401	0.468	0.125
10	0.620	0.416	0.474	0.149
11	0.631	0.420	0.460	0.186
12	0.627	0.412	0.460	0.174
13	0.721	0.478	0.495	0.229
14	0.674	0.463	0.909	0.273
15	0.574	0.476	.	.
<i>Average</i>	0.644	0.444	0.415	0.102

Source: BIBB-BAuA 1986-2006. *Note:* Share of workers per activity count who also report performance requirement or main tool use. Computerization indicates that the main tool is a computer, workstation, or

How do activities relate to requirements and automation?

- Codifiability shows little covariation, routineness is negatively associated with multi-tasking
- Computer use and automation of the own workplace positively associated with multi-tasking, strongly in 1986-2006

How does offshoring by German industries evolve over time?

Additional Data

- Merchandize trade by country from World nM7B82722(f)-0.177264(3431)5a6(F1

German Imports 1979-2006 by Product and Use

Total Imports by Product

Imported Inputs and Final Goods

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Share of Intermediate Product Imports in Production

Shares of	1978 (1)	1986 (2)	1992 (3)	1999 (4)	2006 (5)
Intermediate Imports in Total Intermediate Input	.143	.149			

How does offshoring by German industries evolve over time?

- Intermediate inputs are smaller share of imports now than in 1979.
- Offshore outsourcing raises share of total outsourcing by one-half.

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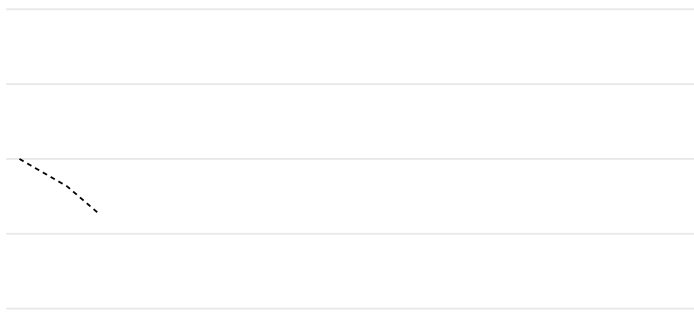
Prediction Design

- Summarize evolution of 15 activities and 9 performance requirements over 5 time intervals
- Aggregate BIBB data to cells by task i , year t , industry j , occupation k , gender s , age a and count heads performing the task within cell (L_{itjksa})
- Estimate $\ln L_{itsajk} = \alpha_{it} + \beta_t + \gamma_s + \delta_a + \epsilon_j + \zeta_k + \eta_{itsajk}$
- Report $\exp\{\alpha_{it}\}$.
Estimates reflect *relative* frequencies compared to omitted reference

Activity Content of German Work

Not Conditional on Industries, Occupations

Conditional on Industries, Occupations



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How do task shifts relate to industry-occupation variation?

- Task shifts more pronounced within industries and occupations.

Interpretation. Industries and occupations expand that are less intensive in rising tasks.

Predictions

- Activity Content
 - All activities gain in importance relative to *Manufacture/Produce*, strongest shift by 1986
 - Shift affects “high-end activities” (*Organize/Plan, Oversee/Control*) and “low-end activities” (*Repair/Maintain*)
- Performance Requirements
 - Expected U-shape profile: tasks gain relative to *Prescribed work*
 - Small change over time (except *Improve/adopt new techniques*)

How do imported tasks shift?

Task Content of Imports

- Impute implied task trade flows through a weighting procedure.

Weights $w_{ijt} = L_{ijt} / (\sum_j L_{ijt})$ for task i , year t , industry j

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Tasks Embedded in German Imports

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What trade flows predict domestic task shifts?

Prediction Design

- Three types of trade flows \mathbf{T} : imported intermediate inputs, imported final products, exports
- Extend previous specification

$$\ln L_{itsajk} = \sum_{\mathbf{T}} \beta_{i\mathbf{T}} X_{j\mathbf{T}t} + \alpha_{it} + \gamma_t + \delta_s + \eta_a + \epsilon_{itsajk}$$

- Aggregation over all source and destination countries
- Full set of $\beta_{i\mathbf{T}}$ (all tasks) admissible, no need of reference category

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What trade flows predict domestic task shifts?

- *Across* industries and occupations, exports and imported inputs exhibit mostly same signs, raising task frequencies.
- Relatively weak effect of intermediate-input trade.
- *Within* industries and occupations, positively affected by exports and imported inputs are coordination related tasks: *8 Program Computer, 10 Consult/Inform, 14 Organize/Plan, A Deadlines, C New situations.*

How do market conditions relate to task shifts?

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How do market conditions relate to task shifts?

- Change in tasks more pronounced in less tight labour markets.

Additional Data

- German MNEs and offshore affiliates (MiDi-Ustan Dt. Bundesbank)
- Offshore-affiliate employment rises from 3.1 to 3.7 million (1998-2001)
- Link plants to MNEs for manufacturing and services, 1998-2001 through Social-security records (German Federal Labor Agency BA)
- Include workplace tool use (from BIBB)
 1. workplace tool implies interactive tasks (interaction with others)
 2. workplace tool implies non-routine tasks (non-repetitive methods)

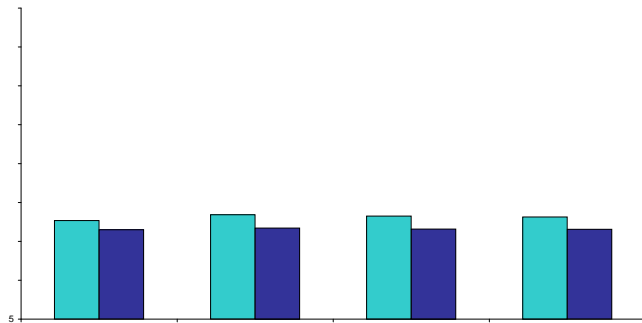
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Wage-bill shares of interactive tasks

Manufacturing

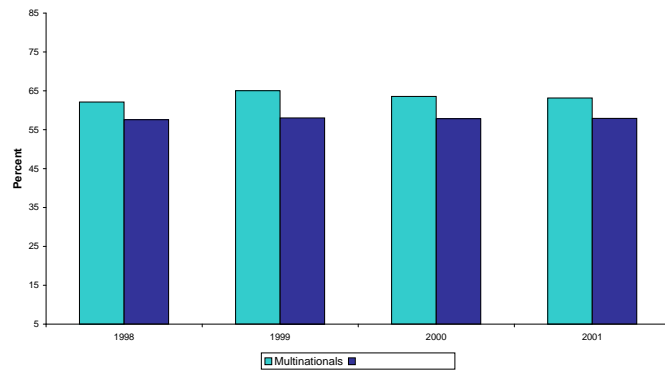
Services



Wage-bill shares of non-routine tasks

Manufacturing

Services



Offshoring, Education and Occupations

Sectors	Upper-secondary education				White-coll. occ.	
	Manuf.	Serv.	All	All	Manuf.	Serv.
	(1)	(2)	(3)	(4)	(5)	(6)
Offshore employmt	7.486 (3.573)	12.328 (4.724)	8.443 (2.251)	5.819 (1.796)	9.726 (5.056)	2.233 (3.748)
LogCap./Val. add.	.123 (.607)	1.100 (1.143)	.890 (.538)	.370 (.497)	-.877 (.717)	-.705 (.697)
Log Value added	.383 (.539)	1.120 (.829)	.969 (.369)	.789 (.325)	-3.371 (1.096)	.786 (1.325)
Non-routine perc.				79.370 (7.068)		
Interactive perc.				8.827 (14.831)		
Obs.	1,871	1,007	4,921	4,921	1,876	1,020
R ² (within)	.038	.036	.013	.107	.096	.022

Source: Linked BA-MIDI data 1998-2001 and BIBB-IAB survey 1998/99, balanced MNE-plant panel.

Notes: Wage-bill shares in percent, varying between zero and 100. Estimators are plant random effects, conditional on year effects. Standard errors in parentheses:

How do market conditions relate to task shifts?

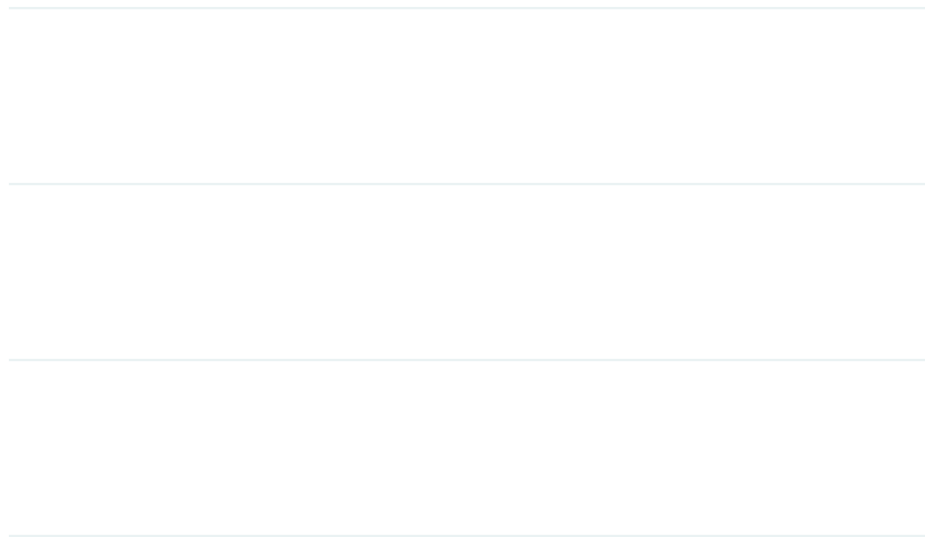
- Skilled wages strongly relate to in-house offshoring beyond task shifts.

How does wage inequality evolve?

Plant-Worker and Additional Data

- Federal Employment Office, Institute for Employment Research (IAB): **Linked plant-worker data** extract for plant random sample
- LIAB: Administrative worker-level data (social security records) combined with **plant survey information** since 1996
- UN Comtrade: **Bilateral merchandise trade**,
World Bank TSD: **Bilateral services trade**.
- Consolidated data with 39 longitudinally consistent industries, based on an aggregation of NACE 1.1

Variance of log Daily Wages Within and Between Plants



How does wage inequality evolve?

- Log wage inequality increases over time.
- Between- and within-plant components contribute roughly equally.
-

To what extent may task assignments relate to inequality?

Three Facts and a Hypothesis

1. Larger plants and exporters offer more occupations.
 2. Workers at larger plants perform fewer tasks within occupations.
 3. Overall and residual wages are more dispersed at larger plants.
- **Hypothesis:** Workers at larger plants are more specialized in fewer tasks. Their abilities are better matched to these tasks, and wages therefore more dispersed.

Revenues and the Range of Activities

	Dependent variable: log Normalized number of activities					
	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	OLS	OLS	IV	IV	IV
log Revenues	-0.091*** (0.003)	-0.057*** (0.007)	-0.051*** (0.009)	-0.021* (0.013)	-0.259*** (0.077)	-0.257*** (0.076)
log Nr. of jobs		-0.257*** (0.037)	-0.328*** (0.075)		4.363** (1.975)	4.428** (2.010)
log Revenues × log Nr. of jobs		0.009*** (0.003)	0.013** (0.005)		-0.226** (0.110)	-0.230** (0.112)
Plant FE			yes			
Adj. R^2	0.234	0.243	0.793			
Hansen J (p-val.)	.	.	.	0.288	.	0.872
Obs.	126,488	126,488	126,488	64,616	64,777	64,563

Source: LIAB 1996-2014 and BIBB-BAuA 1992-2012. Plants with more than 2 full-time workers.

Note: Regressions include time, region, and sector fixed effects. IV estimation based on GMM. Standard errors in parentheses. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Revenues and the Within-plant Residual Wage Dispersion

Dependent variable: log StDev Residual daily wage

(1)	(2)	(3)	(4)	(5)	(6)
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Theory and the Implications for Inequality

- Plants optimally partition task range into occupations
- Productive plants assign narrower task ranges, improve match quality
- Globalization leads productive plants into exporting, raising prosperity
- Variance of wages increases at exporters, declines at non-exporters
- Economy-wide wage inequality higher in open economies

Conclusions

- Increasing importance of “high end” tasks in Germany.
Organizing and consulting activities under deadlines, changing business conditions and tougher performance standards
- Significant offshoring since 1979, predicts observed task frequencies
- Task ranges within occupations narrower at large plants and exporters
- Globalization can raise within-plant wage dispersion in all economies

BACKUP

Shares of Simultaneous Activities at the Workplace in 2012

	Codifiability (1)	Routineness (2)	Computerization (3)	Automation (4)
1	0.853	0.533	0.253	
2	0.840	0.544	0.379	
3	0.826	0.575	0.471	
4	0.763	0.553	0.530	
...	
8	0.649	0.489	0.475	
9	0.666	0.483	0.448	
10	0.657	0.502	0.405	
11	0.672	0.518	0.360	
12	0.694	0.520	0.357	
13	0.723	0.551	0.333	
14	0.738	0.503	0.262	
15	0.882	0.471	0.294	
<i>Average</i>	0.742	0.512	0.394	

Source: BIBB-BAuA 2012. *Note:* Share of workers per activity count who also report performance requirement or main tool use. Computerization indicates that the main tool is a computer, workstation, or CAD equipment. Automation indicates that the main tool is a r

MNE Estimation Strategy

- Predict relative demand for work type **i** at onshore plant **j** of MNE **k**

$$ij_t = \sum OE_{k,t} + \kappa \ln \frac{K_{kt}}{Y_{kt}} +$$

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Revenues and the Within-plant Overall Wage Dispersion

	Dependent variable: log CV Daily wage					
	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	OLS	OLS	IV	IV	IV
log Revenues	0.086*** (0.005)	0.056*** (0.013)	0.067*** (0.021)	0.127*** (0.027)	0.038 (0.067)	0.026 (0.067)
log Nr. of jobs		-0.827*** (0.083)	1.425*** (0.208)		0.118 (2.111)	0.221 (2.148)
log Revenues × log Nr. of jobs		-0.040*** (0.006)	-0.075** (0.014)		0.003 (0.121)	-0.001 (0.123)
Plant FE			yes			
Hansen J (p-val.)	.	.	.	0.172	.	0.196
Adj. R^2	0.156	0.195	0.688			
Obs.	126,483	126,483	126,483	64,614	64,775	64,561

Source: LIAB 1996-2014 and BIBB-BAuA 1992-2012. Plants with more than 2 full-time workers.

Note: Regressions include time, region, and sector fixed effects. IV estimation based on GMM. Standard errors in parentheses. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.