



Measuring tasks at the firm-level - results from an employer survey

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- The task-approach, task-biased technological change and routinization hypothesis (Autor, Levy, Murnane 2003)
 - Routinization and polarization in Germany (Spitz-Oener 2006, 2008, Gathmann and Schoenberg 2007, Antonczk et al. 2009, Dustmann et al. 2009, Goos et al. 2009, Black and Spitz-Oener 2010)
 - The role of firms in substituting tasks by computers or off-shoring (ALM 2003, Nordhaus 2007, Gossmann and Rossi-Hansberg 2008)
- Depending on their tasks structure, firms should differ in how they cope with technological change



Motivation of the paper

- The task-approach is challenged by measurement problems (Autor and Handel 2009, p. 3)
 - Level of analysis
 - Measuring and classifying tasks
- At present, few efforts to measure the task structure of firms by self-report of firms (subjective method)
- Questions:
 - Is there between-firm variance in routine and non-routine manual, cognitive and interactive tasks?
 - Do firms substitute computer capital for routine tasks?
 - Is the tasks structure of firms systematically related to the firms' skill, qualification and job structure?
 - **(How) can we validly measure it?**

1. (How) can we validly measure it? - Conceptual implementation and operationalization of the task approach in a firm-level survey
2. Data collection
3. Is there between-firm variance in routine and non-routine manual, cognitive and interactive tasks? – Evaluating the measures
4. Study the determinants and outcomes of the firms' task structure:
 - Do firms substitute computer capital for routine tasks?
 - Is the tasks structure of firms systematically related to the firms' skill, qualification and job structure?
5. Is the measurement of tasks at the firm-level a valuable complement to existing task data?

(How) can we measure tasks at the firm-level?

- BIBB Reference-Establishment System (RBS)
 - an access panel of currently 1,283 German firms providing apprenticeship training,
 - since 1993 up to four short (~2 pages) paper and pencil surveys per year
 - covers a large population of German firms, i.e. firms of all branches and sizes in different regions
- Task requirements (BIBB/BAUA Employment Survey 2006), competency research, idiosyncratic items
- Frequency scale (never, sometimes, often)

→ *”If you think about all tasks that are performed in your firm for the production of your goods and services, how frequent do your employees perform tasks that are [item]?”.*

(How) can we measure tasks at the firm-level?

Table A1: Task categories and their questionnaire items

Routine

Tasks that are predetermined in each detail

Tasks that are repetitive in each detail

Tasks controlling different work flows at the same time (negative)

Tasks reacting to unexpected problems (negative)

Manual

Tasks that need physical strength

Tasks using tools

Tasks operating machines

Tasks steering vehicles

Tasks using specific manual skills and 'sleight of hand'

Interactive

Tasks working together with colleagues

Tasks forwarding information to customers or patients

Tasks counseling customers or patients

Tasks that involve responsibility for the well-being of others

Tasks convincing others and mediating compromises

Tasks communicating difficult issues in an understandable way

Analytic

Tasks getting acquainted with new duties/responsibilities

Tasks analyzing and identifying coherences

Tasks consecutively completing and extending knowledge

Tasks developing new knowledge or solutions to problems

Tasks improving current and testing new procedures

Tasks taking difficult decisions on own responsibility

(How) can we measure tasks at the firm-level?

- Additional measures:
 - Number of employees with different formal qualifications (firm size)
 - Number of jobs with different formal qualificational requirements
 - Over- and underqualification of employees
 - Number of apprentices with different qualifications (schooling levels)
 - Economic sector
 - Introduction of (new) computer technology (last 2 years)
 - Substitution of tasks (labor) due to computer technology
 - Organizational change (last 2 years)
 - Substitution of tasks (labor) due to organizational change

Table A2: Summary statistics of structural variables

Variable	Mean	Std. Dev.	N
Qualification structure of employees			
No degree	66.53	238.95	120
Vocational qualification	334.2	867.38	119
Master/technician	100.25	377	119
Technical college/University	110.12	498.02	119
Total number of employees	611.35	1816.59	119
Qualification structure of apprentices			
No degree	0.03	0.28	111
'Hauptschule' (basic school: ends after 9th grade)	7.44	18.8	112
'Realschule' (middle school: ends after 10th grade)	26.45	71.04	111
'Abitur' (high school: ends after 12th grade)	10.9	33.67	111
Total number of apprentices	44.13	110.23	113
Firm-size			
Between 1 and 19 employees	0.31	0.46	119
Between 20 and 49 employees	0.15	0.36	119
Between 50 and 99 employees	0.14	0.35	119
Between 100 and 499 employees	0.23	0.42	119
More than 500 employees	0.17	0.38	119
Economic sector			
Agriculture, forestry, mining	0.02	0.13	119
Manufacturing	0.51	0.5	119
Trade and repair	0.18	0.38	119
Public sector	0.01	0.09	119
Company services	0.03	0.18	119
Other services	0.25	0.44	119

Is there meaningful between firm variance?

Table A7: Eigenvalues of factor analysis

Factor analysis/correlation				Number of obs = 117
Method: principal-component factors				Retained factors = 4
Rotation: orthogonal varimax (Kaiser off)				Number of parameters = 78
Factor	Variance	Difference	Proportion	Cumulative
Factor1	4.50651	0.77744	0.2146	0.2146
Factor2	3.72907	0.00467	0.1776	0.3922
Factor3	3.7244	1.86935	0.1774	0.5695
Factor4	1.85505	.	0.0883	0.6579
LR test: independent vs. saturated: $\chi^2(210) = 1.30E+04$ Prob> $\chi^2 = 0$				

Is there meaningful between firm variance?

- Scales:
 - Analytic tasks: $\alpha = .82$
 - Interactive tasks: $\alpha = .80$
 - Manual tasks: $\alpha = .79$
 - Routine tasks: $\alpha = .71$
- Measures that failed:
 - „having to react to control different work flows at the same time (routine, negatively coded) → high uniqueness, no high loading on any of the four factors
 - „reacting to unexpected problems (routine, negatively coded) → high loadings on the interactive task factor
 - „working together with colleagues“ (interactive) → high loading on the analytic task factor

Is there meaningful between firm variance?

Table A9: Descriptive statistics of scales

Variable	Obs	Mean	Std. Dev.	Min	Max
Analytic	117	2.279	0.404	1.5	3
Manual	115	2.377	0.493	1	3
Interactive	116	2.210	0.512	1	3
Routine	117	2.248	0.596	1	3

Is there meaningful between firm variance?

Table 3: Average substitutability of tasks by introducing new technologies

Variable	Mean	Std. Dev.	N
Routine tasks	0.18	0.36	58
Manual tasks	0.20	0.26	50
Analytic tasks	0.11	0.24	60
Interactive tasks	0.03	0.10	42

Do firms substitute computer capital for routine tasks?

Table A5: Summary statistics of items: Consequences of technological change

Variable	Mean	N
New IT-or production-technologies in the last 2 years (yes=1)	0.58	119
Tasks replaced due to new technologies (last 2 years)		67
many	0.04	
some	0.48	
almost none	0.48	
Change in employment due to new technologies (last 2 years)		68
yes, less	0.16	
no, no change	0.75	
yes, more	0.09	
Percentage change employment (new technology) (last 2 years)	7.25	16
Change in number of employees: No degree		58
less	0.34	
unchanged	0.66	
more	0.00	
Change in number of employees: Vocational qualification		66
less	0.05	
unchanged	0.80	
more	0.15	
Change in number of employees: Master/technician		65
less	0.03	
unchanged	0.65	
more	0.32	
Change in number of employees: Technical college/University		58
less	0.00	
unchanged	0.64	
more	0.36	

Do firms substitute computer capital for routine tasks?

Table 1: Multinomial logit models on the on the presence of routine tasks

Tasks that are repetitive in each detail

	Coeff.	St. Error	Coeff.	St. Error
Sometimes				
New IT-or production-technologies in the last 2 years	0.64	(0.546)	1.51**	(0.698)
50 to 499 employees			0.37	(0.698)
More than 500 employees			-2.12**	(0.868)
Manufacturing (including agriculture)			0.41	(0.826)
Services			0.82	(0.897)
Constant	0.80**	(0.401)	0.14	(0.811)
Often				
New IT-or production-technologies in the last 2 years	0.05	(0.570)	0.28	(0.724)
50 to 499 employees			0.98	(0.724)
More than 500 employees			-0.42	(0.875)
Manufacturing (including agriculture)			0.23	(0.827)
Services			-0.43	(0.940)
Constant	0.75*	(0.405)	0.37	(0.811)
Observations	115		112	

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Is the tasks structure of firms systematically related to the firms' skill, qualification and job structure?

Table 2: Multinomial logit models on the presence of routine tasks

Tasks that are repetitive in each detail				
	Coeff.	St. Error	Coeff.	St. Error
Sometimes				
Share of high-skilled employees	-5.12***	(1.920)	-5.54***	(2.090)
1 to 49 employees			-0.40	(0.715)
More than 500 employees			-1.32	(0.837)
Manufacturing (including agriculture)			-0.11	(0.837)
Services			1.05	(0.952)
Constant	1.84***	(0.398)	2.10**	(0.894)
Often				
Share of high-skilled employees	-6.85***	(2.353)	-8.10***	(2.868)
1 to 49 employees			-0.97	(0.766)
more than 500 employees			-0.49	(0.835)
Manufacturing (including agriculture)			-0.12	(0.875)
Services			0.11	(1.036)
Constant	1.62***	(0.416)	2.29**	(0.946)
Observations	115		113	

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$



Is the measurement of tasks at the firm-level a valuable complement to existing task data?

Considering ..

- data limitations:
 - Preliminary results, small number of cases
 - Sample structure
- the limitation of measures:
 - some items failed, but high reliability of scales
 - validity hard to assess
- the results
 - No clear evidence on routinization
 - Some support in favor for a link between the firms' task and skill structure

we would conclude that firm-level data are a promising complement to existing task data!



Thank you!

Do firms substitute computer capital for routine tasks?

Table A6: Summary statistics of items: Consequences of organizational change

Variable	Mean	N
New organizational structures (last 2 years)	0.48	117
Tasks replaced due to reorganization (last 2 years)		53
many	0.13	
some	0.38	
almost none	0.49	
Change in employment due to reorganization (last 2 years)		56
yes, less	0.16	
no, no change	0.64	
yes, more	0.20	
Percentage change employment (reorganization) (last 2 years)	8.1	20
Change in number of employees (reorganization): No degree		52
less	0.21	
unchanged	0.75	
more	0.04	
Change in number of employees: Vocational qualification		55
less	0.07	
unchanged	0.75	
more	0.18	
Change in number of employees: Master/technician		54
less	0.07	
unchanged	0.65	
more	0.28	
Change in number of employees: Technical college/University		51
less	0.00	
unchanged	0.71	
more	0.29	