Work 4.0: How is digitalization changing workplace organization?

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Motivation

Work 4.0: How will the tomorrow's working environment look like?

Using ICT can lead to

- ... a different allocation of decision making authority
- ... a different intensity of monitoring activities

Different structures of workplace organization can appear:

- Centralization
- Decentralization
- A mix of both

What can we expect to appear?

What are we going to learn?

- We analyze how the **use of ICT** affects **worker monitoring** and **worker autonomy**
- What are the consequences on **workplace organization**?
- We focus on the **employee's perspective**
- Data: Linked Personnel Panel (LPP) and IAB Establishment Panel

What are we going to learn?

Main findings

From OLS estimations: Using digital ICT

- ... is associated with an **increase in monitoring activities** independent of the employee's hierarchical level
- ... promotes the **perception** that ICT provide more autonomy for all workers while **actual** autonomy only increases for supervisors

From IV estimations: Using digital ICT

- ... leads to both **more monitoring and autonomy for supervisors** but not for non-managerial workers

What is our contribution?

This study is related to the ongoing debate on **organizational design**

Some studies found evidence for a **more decentralized working environment** (e.g., Acemoglu et al., 2007, Bresnahan et al., 2002, Caroli and Van Reenen, 2001)

Others highlight **ambiguous findings** (Bloom et al., 2014, Colombo and Delmastro, 2004)

What is our contribution?

To the best of our knowledge, no paper contrasted centralization and decentralization

- ... by using data on policies of **worker monitoring** and **worker autonomy**
- ... and revealed an association between ICT usage and workplace organization **on both the employer and employee level**

Research Question

Does digitalization promote **centralization** or **decentralization**? Or is digitalization associated with **a mix of both**?

A Short Overview

Organizational redesign and the implementation of modern ICT

- ... as a way to handle future technological revolutions
- ... to generate new business models
- ... to enhance a computerisation of labour
- ... to increase productivity
- ... to enhance developments in products and capabilities
- ... to decrease coordination, information and communication costs
- ... to substitute routine intensive occupations

The diversity of firms' organizational structure

Decentralization versus centralization

Find the right balance between the optimal allocation of decision rights

How best to organize knowledge efficiently within a firm

- ... to make use of information
- ... to specialize on specific knowledge
- ... to coordinate different knowledge sets

Theory of a hierarchy by Garicano (2000): knowledge management

The diversity of firms' organizational structure

Benefits of centralization:

- ICT enables a better use of central knowledge
- ICT solves coordination problems
- ICT promotes worker monitoring

The diversity of firms' organizational structure

Benefits of decentralization:

- Using ICT enables workers to use their specific knowledge
- Using ICT enables workers to execute their task more autonomously
- This enhances their management skills and increases intrinsic motivation and creativity

The Linked Personnel Panel (LPP)

New **linked-employer-employee data set** on human resources, corporate culture and managements instruments in German establishments

Survey conducted every two years since 2012/2013

- **First wave:** 1219 establishments and 7508 employees
- **Second wave:** 771 establishments and 7282 employees (4011 first-time respondents)

Both waves may be linked with the **IAB Establishment Panel**

Data set enables a division between the establishment and employee perspective

Monitoring variables as proxies for centralization

Three different measures:

- Appraisal interviews
- Targets in written form
- Performance evaluation

Double standardization (STD) approach as e.g. in Bresnahan et al. 2002:

$$M_1 = STD\left\{STD(interview) + STD(target) + STD(perfeval)\right\}$$

and

$$M_2 = interview + target + perfeval$$

Autonomy variables as proxies for decentralization

Three different measures:

- Perception whether or not the use of ICT increases worker autonomy ($autodigi$)
- Extent of job autonomy
- Working from home

Double standardization (STD) approach as e.g. in Bresnahan et al. 2002:

$$Empowerment = STD\left\{STD(jobautonomy) + STD(wfh)\right\}$$

ICT variables as proxies for digitalization

'Do you use digital information or communication technologies such as computer, the internet, laptop, tablet computer or smart phone for your professional activity?'

We generate the following interaction terms:

- Supervisors use digital ICT (ICT^{11})
- Employees without management responsibility use digital ICT (ICT^{10})
- Supervisors do not use digital ICT (ICT^{01})
- Employees without management responsibility do not use digital ICT (ICT^{00})

Econometric Modeling: ICT and centralization

$$Monitoring^E = \varsigma_0 + \varsigma_1 ICT^{01} + \varsigma_2 ICT^{10} + \varsigma_3 ICT^{11} + Y\beta + u$$

$Monitoring^E$:	equivalent to M_1 and M_2
ICT^{01}, ICT^{10}, ICT^{11}:	ICT interaction terms (ICT^{00} as reference group)
Y:	matrix of individual- and establishment-level control variables
ς_1, ς_2, ς_3, β:	parameters to be estimated
ς_0 :	a constant
u:	stochastic error term with zero mean and finite variance

Econometric Modeling: ICT and decentralization

$$Autonomy^E = \rho_0 + \rho_1 ICT^{01} + \rho_2 ICT^{10} + \rho_3 ICT^{11} + Y\beta + u$$

$Autonomy^E$:	equivalent to $autodigi$ and $empowerment$
ICT^{01}, ICT^{10}, ICT^{11}:	ICT interaction terms (ICT^{00} as reference group)
Y:	matrix of individual- and establishment-level control variables
ρ_1, ρ_2, ρ_3, β:	parameters to be estimated
ρ_0 :	a constant
u:	stochastic error term with zero mean and finite variance

Results: ICT effects on monitoring activities (M_1)

Method	**OLS 1**	**OLS 2**	**OLS 3**
ICT^{01}	0.161***	0.097	0.109
	(0.060)	(0.065)	(0.074)
ICT^{10}	0.629***	0.314***	0.179***
	(0.027)	(0.034)	(0.042)
ICT^{11}	0.766***	0.376***	0.325***
	(0.032)	(0.040)	(0.050)
LPP EE	no	yes	yes
LPP	no	no	yes
IAB EP	no	no	yes
R^2	0.0726	0.1655	0.2815
N	6793	6130	3477

Results: ICT effects on monitoring intensity (M_2)

Method	**OLS 1**	**OLS 2**	**OLS 3**
ICT^{01}	0.198***	0.120	0.134
	(0.073)	(0.080)	(0.090)
ICT^{10}	0.768***	0.386***	0.217***
	(0.034)	(0.042)	(0.051)
ICT^{11}	0.934***	0.462***	0.393***
	(0.039)	(0.049)	(0.060)
LPP EE	no	yes	yes
LPP	no	no	yes
IAB EP	no	no	yes
R^2	0.0723	0.1653	0.2813
N	6793	6130	3477

Results: ICT effects on perceived autonomy ($autodigi$)

Method	**OLS 1**	**OLS 2**	**OLS 3**
ICT^{01}	0.026	0.014	0.024
	(0.024)	(0.026)	(0.032)
ICT^{10}	0.185***	0.132***	0.128***
	(0.011)	(0.014)	(0.018)
ICT^{11}	0.235***	0.154***	0.162***
	(0.014)	(0.018)	(0.023)
LPP EE	no	yes	yes
LPP	no	no	yes
IAB EP	no	no	yes
R^2	0.0361	0.0775	0.0912
N	6793	6130	3477

Results: ICT effects on actual autonomy (*empowerment*)

Method	**OLS 1**	**OLS 2**	**OLS 3**
ICT^{01}	0.368***	0.205***	0.192
	(0.048)	(0.053)	(0.066)
ICT^{10}	0.512***	0.089***	0.021
	(0.029)	(0.033)	(0.042)
ICT^{11}	1.041***	0.377***	0.342***
	(0.034)	(0.038)	(0.048)
LPP EE	no	yes	yes
LPP	no	no	yes
IAB EP	no	no	yes
R^2	0.1189	0.2871	0.3104
N	6793	6130	3477

Robustness Checks

We included **several dependent variables** to measure centralization or decentralization

We used **instrumental variables** to interpret our results as causal effects

We instrument the ICT interaction terms by using **group specific mean values**

Categories for generating the group specific mean values:

- Age group
- Gender
- Blue vs. white color workers
- Occupational group

According to the IV estimates, ICT increases **both monitoring and autonomy but only for supervisors** and not for non-managerial workers

Results: ICT effects on monitoring activities (M_1)

Method	**OLS 1**	**OLS 2**	**OLS 3**	**IV 1**	**IV 2**
ICT^{01}	0.161***	0.097	0.109	-0.167	-0.176
	(0.060)	(0.065)	(0.074)	(0.521)	(0.455)
ICT^{10}	0.629***	0.314***	0.179***	0.658***	0.273
	(0.027)	(0.034)	(0.042)	(0.203)	(0.262)
ICT^{11}	0.766***	0.376***	0.325***	1.477***	0.637**
	(0.032)	(0.040)	(0.050)	(0.328)	(0.319)
LPP EE	no	yes	yes	yes	yes
LPP	no	no	yes	no	yes
IAB EP	no	no	yes	no	yes
R^2	0.0726	0.1655	0.2815	0.0332	0.2595
N	6793	6130	3477	6130	4076

Results: ICT effects on monitoring intensity (M_2)

Method	**OLS 1**	**OLS 2**	**OLS 3**	**IV 1**	**IV 2**
ICT^{01}	0.198***	0.120	0.134	-0.201	-0.633
	(0.073)	(0.080)	(0.090)	(0.643)	(0.447)
ICT^{10}	0.768***	0.386***	0.217***	0.805***	0.140
	(0.034)	(0.042)	(0.051)	(0.249)	(0.315)
ICT^{11}	0.934***	0.462***	0.393***	1.811***	0.669*
	(0.039)	(0.049)	(0.060)	(0.403)	(0.385)
LPP EE	no	yes	yes	yes	yes
LPP	no	no	yes	no	yes
IAB EP	no	no	yes	no	yes
R^2	0.0723	0.1653	0.2813	0.1783	0.2575
N	6793	6130	3477	6130	4.208

Results: ICT effects on actual autonomy (*empowerment*)

Method	**OLS 1**	**OLS 2**	**OLS 3**	**IV 1**	**IV 2**
ICT^{01}	0.368***	0.205***	0.192	0.102	0.240
	(0.048)	(0.053)	(0.066)	(0.576)	(0.497)
ICT^{10}	0.512***	0.089***	0.021	0.476**	0.479
	(0.029)	(0.033)	(0.042)	(0.210)	(0.294)
ICT^{11}	1.041***	0.377***	0.342***	2.016***	1.462***
	(0.034)	(0.038)	(0.048)	(0.344)	(0.349)
LPP EE	no	yes	yes	yes	yes
LPP	no	no	yes	no	yes
IAB EP	no	no	yes	no	yes
R^2	0.1189	0.2871	0.3104	0.1804	0.1711
N	6793	6130	3477	6130	4208

Conclusion

We have learned **from the OLS estimations** that

- ... the use of ICT is associated with more worker monitoring, irrespective of hierarchical level
- ... the use of ICT is associated with the perception of more worker autonomy, irrespective of hierarchical level
- ... the use of ICT is associated with more actual worker autonomy, but only for supervisors and not for non-managerial workers

We have learned **from the IV estimations** that

- ... the use of ICT leads to more worker monitoring for supervisors
- ... the use of ICT leads to more worker autonomy for supervisors

Thank you for your attention!

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References I

Acemoglu, D.; Aghion, P.; Lelarge, C.; Van Reenen, J.; Zilibotti, F. (2007): Technology, information, and the decentralization of the firm. The Quarterly Journal of Economics 122 (4), 1759-1799.

Bloom, N.; Garicano, L.; Sadun, R.; Van Reenen, J. (2014): The distinct effects of information technology and communication technology on firm organization. Management Science 60 (12), 2859-2885.

Bresnahan, T. F.; Brynjolfsson, E.; Hitt, L. M. (2002): Information technology, workplace organization, and the demand for skilled labor: Firm-level evidence. The Quarterly Journal of Economics 117 (1), 339-376.

Caroli, E.; Van Reenen, J. (2001): Skill-biased organizational change? Evidence from a panel of British and French establishments. The Quarterly Journal of Economics 116 (4), 1449-1492.

References II

Colombo, M. G.; Delmastro, M. (2004): Delegation of authority in business organizations: An empirical test. The Journal of Industrial Economics 52 (1), 53-80.

Garicano, L. (2000): Hierarchies and the organization of knowledge in production. Journal of Political Economy 108 (5), 874-904.