INSTITUT FÜR ARBEITSMARKT- UND BERUFSFORSCHUNG
Die Forschungseinrichtung der Bundesagentur für Arbeit

Christian-Albrechts-Universität zu Kiel

WORKING FROM HOME, URBAN WAGE GROWTH, AND INEQUALITY

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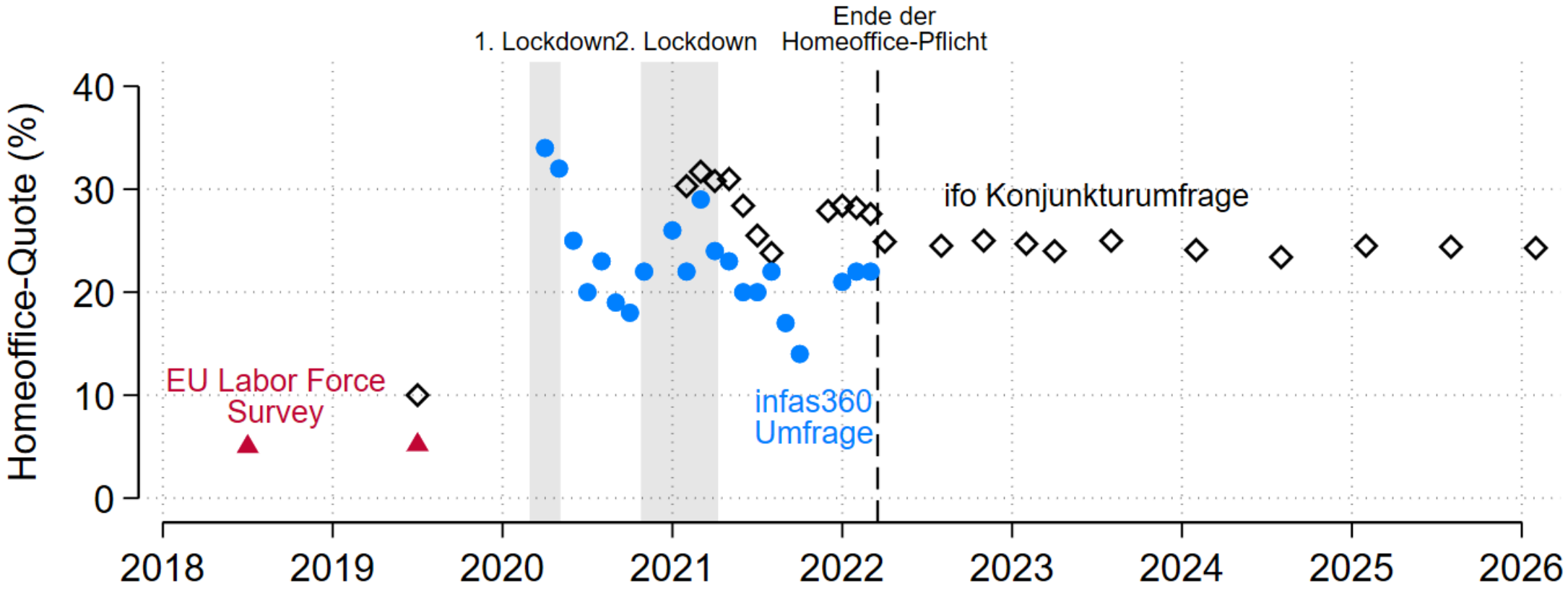
Cambridge Journal of Regions, Economy and Society 2026 conference,
St. Catharine's College, Cambridge, UK
16 - 17 of July, 2026

Motivation

Increase in working from home



Anmerkungen: Anteil Beschäftigte, die mind. teilweise Homeoffice nutzen.
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Motivation

- Persistent increase in working from home (WFH) caused by COVID-19 pandemic ⇒ spatial implications: changes in urban life and economic activity in cities (Glaeser 2022, Nathan & Overman 2020, Florida et al. 2023)
- Evidence on commuting/migration (Coskun et al. 2026, Knuepling et al. 2025, Li & Su, 2026), housing/commercial real estate (Behrens et al. 2024, Liu & Su 2021), spatial distribution of spending (Alipour et al. 2022, Althoff et al. 2022)
- Little evidence on how WFH affects size of agglomeration economies – might weaken agglomerations economies related to face-to-face interaction (Liu & Su 2025, Gaetani et al. 2026)

Literature

- Urban wage premium: workers in large cities earn significantly more than workers in rural areas (Glaeser & Maré 2001, Wheeler 2006, Yankow 2006) – due to
  - Sorting of more productive workers into large cities (Combes et al. 2008)
  - Agglomeration effects, workers at top of wage distribution seem to benefit above average (Carlsen et al. 2016, De La Roca & Puga 2017) $\Rightarrow$ wage inequality
- Urban wage growth premium: learning advantages in large cities as important source of productivity/wage growth (Marshall 1890, Glaeser 1999, Duranton & Puga 2004)
  - knowledge exchange via opportunities for face-to-face meetings and high rate of (new) contacts between workers, both increase with city size (Glaeser 1999, Storper & Venables 2004, Berliant et al. 2006)
  - higher wage premium for urban than for rural work experience, even after moving to less dense locations (De La Roca & Puga 2017, Peters 2020)

Literature

- Increase in WFH after pandemic might reduce knowledge exchange due to less face-to-face contact of workers (Yang et al. 2022, Emanuel et al. 2026)
- Effects of WFH on size of agglomeration economies
  - Liu and Su (2025): 18.4% decrease in urban wage premium in U.S. for occupations with high levels of WFH during pandemic, reduced wage returns to interpersonal skills
  - Gaetani et al. (2026): innovation premium of U.S. cities declined during pandemic by 18.5% up to 22.9% relative to pre-pandemic level, smartphone data suggest that important part of drop is due to a decline in frequency of local interactions
- Role of agglomerations economies for increase of inequality between and within regions
  - Increase in returns to size due to structural change from manufacturing to digital technologies (Bathelt et al. 2024, Kemeny & Storper 2024)
  - Increasing differences in urban wage premium between low-/medium- and high-skilled workers (Autor 2019, Baum-Snow et al. 2018), role of learning (Baum-Snow et al. 2018)

Main research questions

Increase in WFH likely results in fewer (accidental) meetings and less interaction between workers at the workplace

$\Rightarrow$ Weaken learning benefits that large cities offer

$\Rightarrow$ Decline in wage growth in cities relative to less densely populated areas

(1) Does the urban wage growth premium decline after the pandemic-related increase in remote work in 2020?

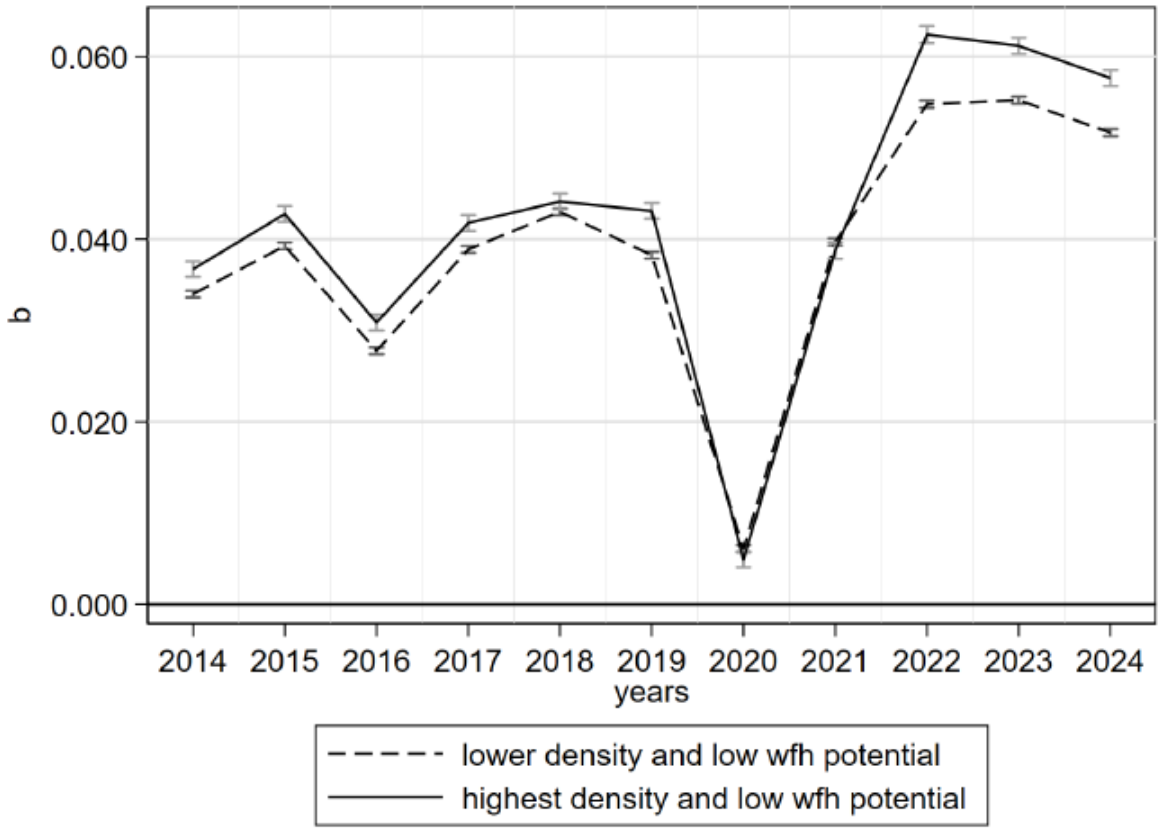
(2) Do mainly workers in occupations with a high capacity to work from home suffer from a decline in the urban wage growth premium?

(3) What are the implication for inequality between and within regions?

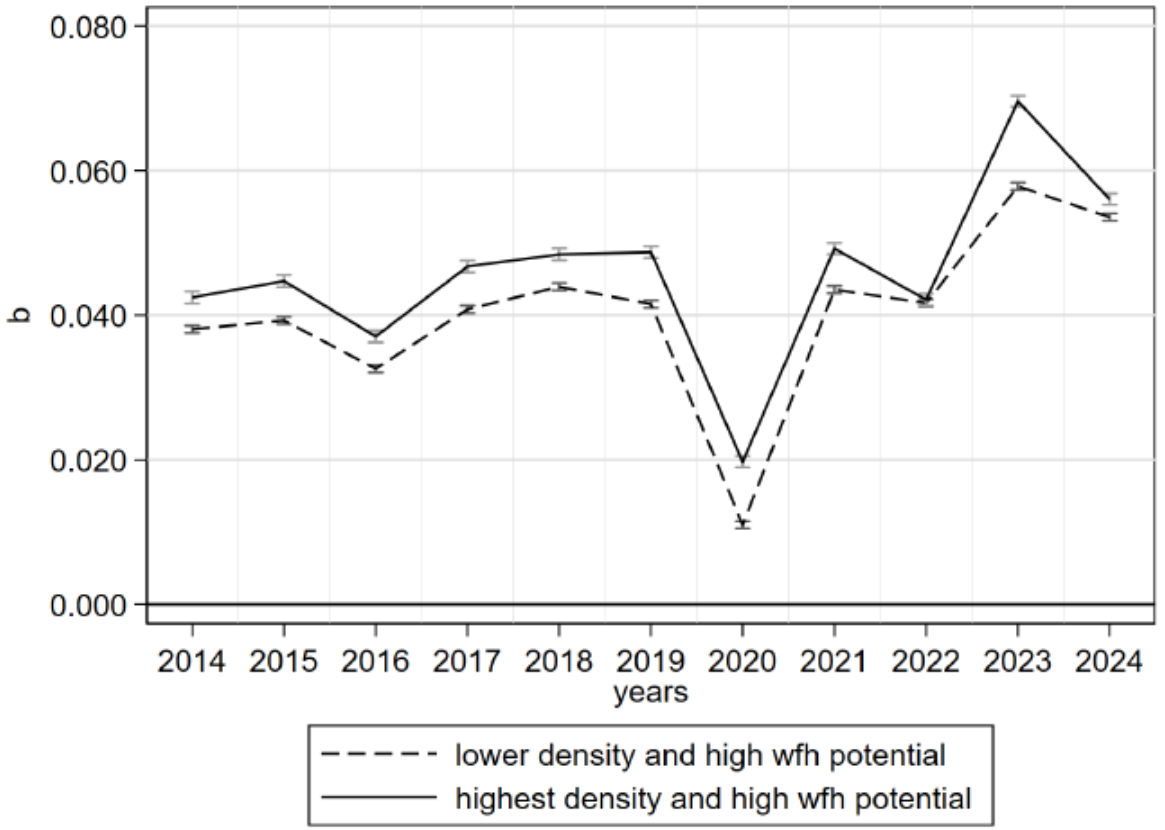
Data

- Integrated Employment Biographies (IAB) - 10 % random sample of all workers employed in Germany 2013–2024
  - worker-year panel referring to June 30, full-time employment outside public sector, temporary agency employment
  - 17.5 mill. worker-year observations for 2.5 mill. individuals
- Information: gross daily wage, occupation, establishment (municipality, size, sector), work experience since labour market entry, establishment tenure
- Pivotal variables
  - wage growth between year t and t - 1
  - location of work in t - 1: highest density vs. lower density locations [map]
  - work experience gained between June 30, t and t - 1, by location type
- Capacity to work from home in 2018 by occupation (Alipour et al. 2023) [figure]
- Monthly information on short-time work 2009–2024 on establishment level (Kagerl 2026)

Average annual wage growth (unconditional)



(a) Low working-from-home capacity



(b) High working-from-home capacity

Estimation strategy

$$\Delta ln(wage)_{i,r,t} = \beta I(r \in \text{HD}) + \sum_{\substack{\tau \in [2014,2024], \\ \tau \neq 2019}} \delta_\tau I(t = \tau) I(r \in \text{HD}) + u_i + \gamma_t + \phi_{o(i,t),t} + \mu_{s(i,t),t} + \theta_{f(i,t),t} + X_{i,t}\rho_t + \varepsilon_{i,t}$$

β, δ_τ: urban wage growth premium and its variation over time (relative to 2018→2019)

$r(i,t)$: municipality of work of worker i in year t (establishment location)

u_i, γ_t: FE for worker i and year t, respectively

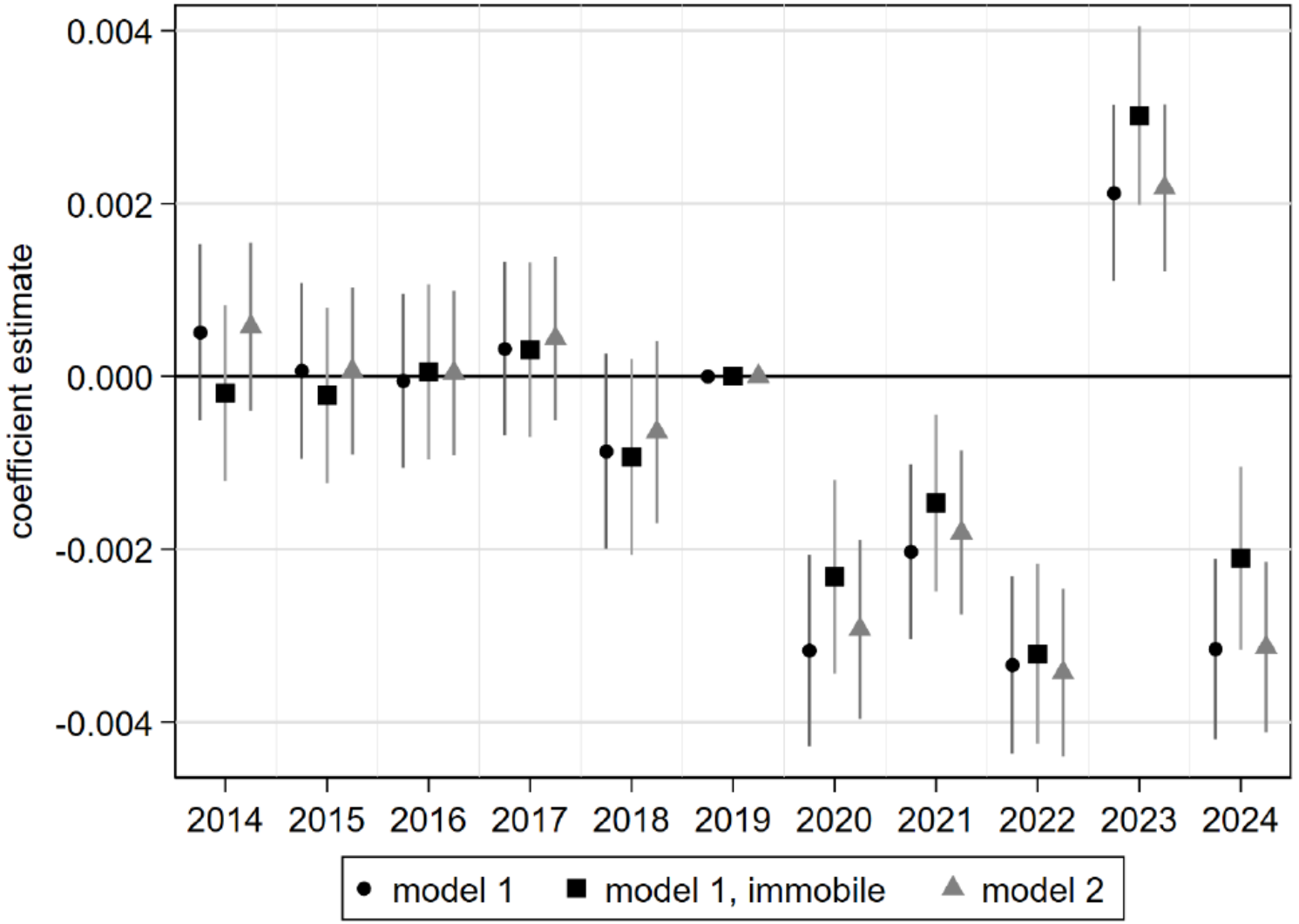
$\phi_{o(i,t),t}$: FE for occupation x year

$\mu_{s(i,t),t}$: FE for sector x year

$\theta_{f(i,t),t}$: FE for establishment size category x year

$X_{i,t}$: total work experience and establishment tenure of worker i in year t, indicators for moving to / away from highest density / establishment change between t and $t+1$

Changes in relative wage growth (conditional) – highest versus lower density locations



Differences between workers with high and low WFH capacity

Differences between age groups [table]

	all workers		working from home capacity: low		high	
	(1)	(2)	(3)	(4)	(5)	(6)
Highest density	0.002***	0.002***	0.003***	0.003***	0.003***	0.003***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Highest density x year						
2014	0.001	0.001	0.001	0.001	0.000	0.000
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
2015	0.000	0.000	-0.000	0.000	0.001	0.001
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
2016	-0.000	0.000	0.000	0.000	-0.000	-0.000
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
2017	0.000	0.000	-0.000	-0.000	0.001*	0.001*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
2018	-0.001	-0.001	-0.001	-0.001	-0.001	-0.000
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
2019			– reference –			
2020	-0.003***	-0.002***	-0.006***	-0.002***	-0.001	-0.002*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
2021	-0.002***	-0.001*	-0.003***	-0.001	-0.001	-0.001
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
2022	-0.003***	-0.003***	0.001	-0.001	-0.007***	-0.005***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
2023	0.002***	0.001***	0.001	-0.000	0.004***	0.003***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
2024	-0.003***	-0.004***	-0.000	-0.000	-0.005***	-0.005***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
N	17,526,623	17,526,623	9,507,883	9,507,883	7,922,653	7,922,653
R^2	0.119	0.120	0.133	0.134	0.116	0.116
Workers	2,461,367	2,461,367	1,425,699	1,425,699	1,150,321	1,150,321
Conditional on short-time work	no	yes	no	yes	no	yes

Implications for inequality: differences in WFH capacity across skill groups

	wfh capacity			density category		
	low	high	total	lower	highest	total
low-skilled	73 %	27 %	100 %	72 %	28 %	100 %
medium-skilled	62 %	38 %	100 %	78 %	22 %	100 %
high-skilled	20 %	80 %	100 %	58 %	42 %	100 %
unknown	79 %	21 %	100 %	71 %	29 %	100 %
all	52 %	48 %	100 %	72 %	28 %	100 %

- In addition: relatively strong decline of urban wage growth premium for high-skilled with high WFH capacity (compared to medium-skilled workers with high WFH capacity, less clear for low-skilled) [table]
- Workers with high WFH capacity $\Rightarrow$ high worker FE, occupation FE, municipality FE, location type FE [figure]
- High-skilled, high-income workers more exposed to increase in WFH / decline of face-to-face interaction, stronger decline in urban wage growth premium

Conclusions

- Significant decrease in urban wage growth premium after increase in WFH: on average by about 0.2 percentage points lower for 2020 to 2024 compared to period before 2020
- Mainly for workers with high WFH capacity, clear pattern for age group 25-44, that works most frequently remote
- Might point to decline in agglomeration economies due less face-to-face interaction between workers $\Rightarrow$ decline in learning benefits of large cities
- High-skilled workers tend to show high WFH capacity and concentrate in large cities
- Wage growth reduced primarily for high-income workers employed in high-income regions $\Rightarrow$ increase in WFH might result in declining disparities between regions and within large cities

THANK YOU FOR YOUR ATTENTION

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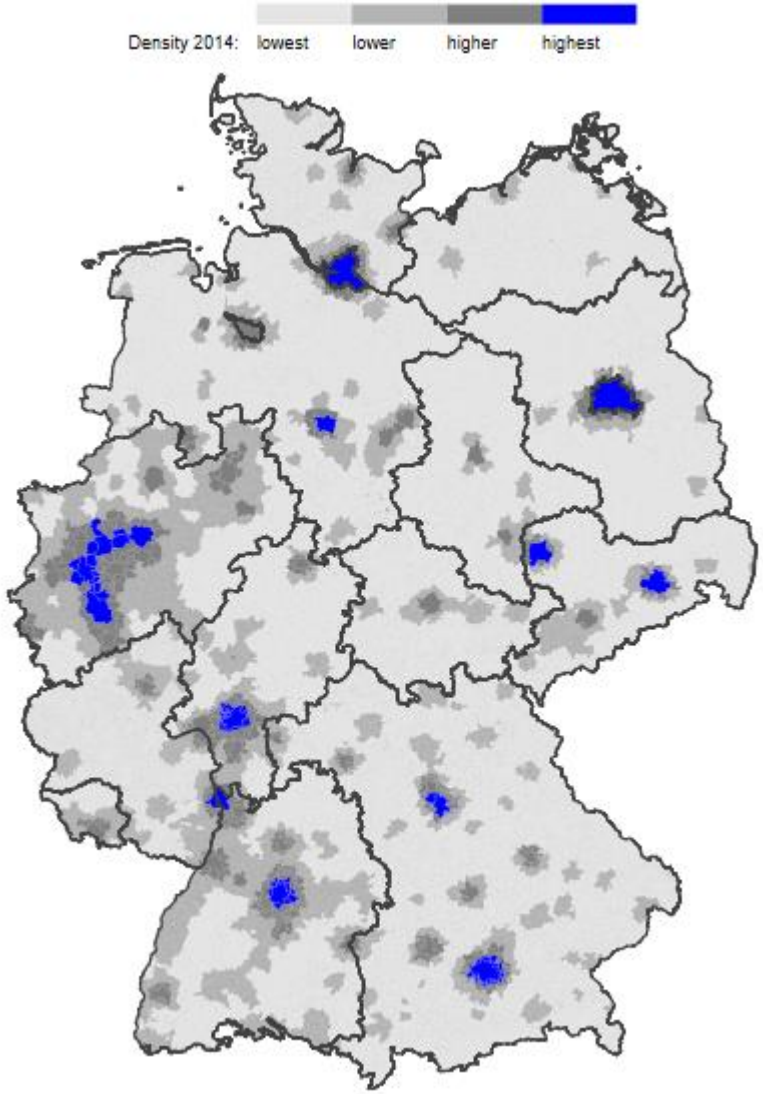
Categories of local employment density



Each category accounts for about 25% of total employment in Germany, local employment density refers to employment within a 10 km radius of the municipal centre

[BACK]

Capacity to work remotely by occupation, 2018 (Alipour et al. 2023)

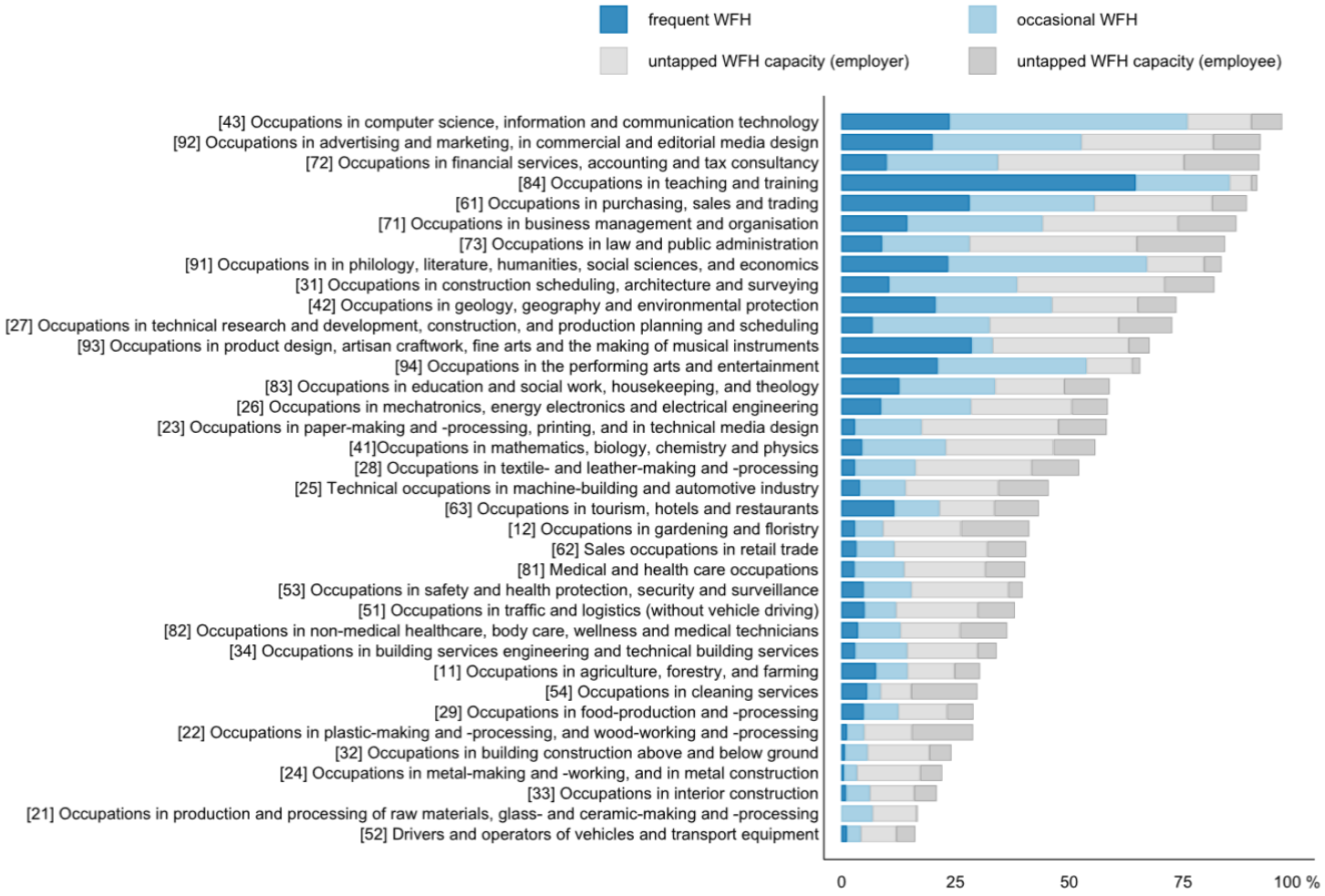


Fig. 1. Capacity to Work from Home by Occupation
Notes: The figure displays WFH capacities and pre-pandemic WFH usage by occupation (2-digit KldB). The underlying values are reported in Table A.1.
Source: 2018 BIBB/BAuA Employment Survey, own calculations.

[BACK]

Differences across age groups, workers with high WFH capacity

	<25 years	<25 years const. edu.	25–44 years	>44 years
	(1)	(2)	(3)	(4)
Highest density	0.006	0.003	0.004***	-0.000
	(0.01)	(0.00)	(0.00)	(0.00)
Highest density x year				
2014	0.022***	0.017***	0.001	-0.002**
	(0.01)	(0.01)	(0.00)	(0.00)
2015	0.020***	0.016***	-0.000	0.001
	(0.01)	(0.01)	(0.00)	(0.00)
2016	0.014***	0.013***	-0.001	-0.000
	(0.00)	(0.00)	(0.00)	(0.00)
2017	0.009**	0.008**	0.001	0.001
	(0.00)	(0.00)	(0.00)	(0.00)
2018	0.003	0.005	-0.001	-0.000
	(0.00)	(0.00)	(0.00)	(0.00)
2019		– reference –		
2020	-0.003	-0.000	-0.002	-0.000
	(0.00)	(0.00)	(0.00)	(0.00)
2021	-0.003	0.000	-0.001	0.001
	(0.00)	(0.00)	(0.00)	(0.00)
2022	0.003	0.008*	-0.003**	-0.006***
	(0.00)	(0.00)	(0.00)	(0.00)
2023	-0.006	-0.000	-0.002	0.010***
	(0.01)	(0.00)	(0.00)	(0.00)
2024	-0.026***	-0.022***	-0.007***	0.000
	(0.01)	(0.01)	(0.00)	(0.00)
N	343,208	333,906	3,921,496	3,544,587
R^2	0.344	0.341	0.142	0.084
Workers	112,031	109,751	690,490	530,202

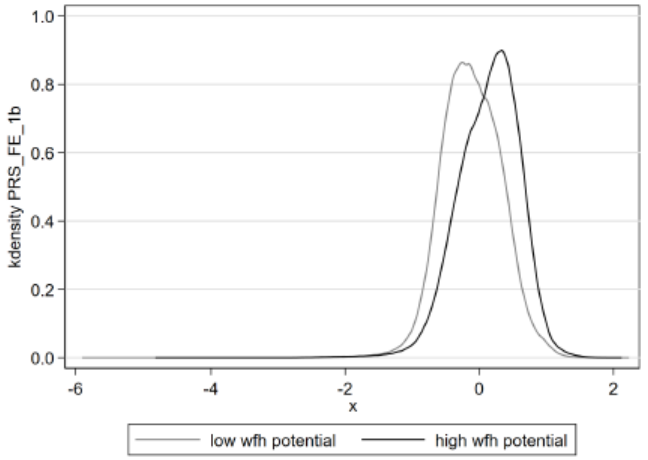
[BACK]

Differences across skill groups

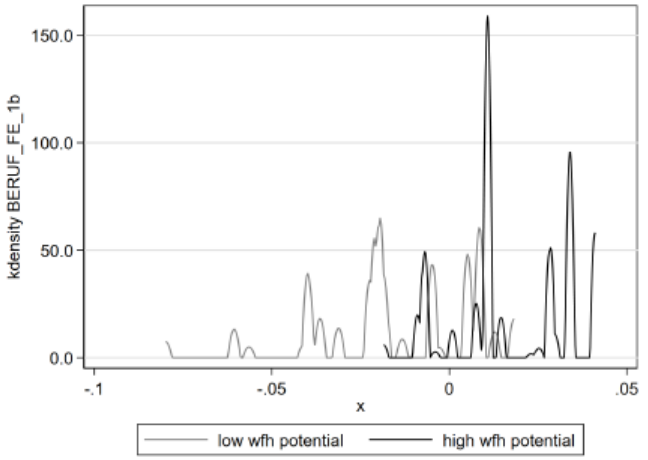
[BACK]

	low-skilled		medium-skilled		high-skilled	
	wfh capacity		wfh capacity		wfh capacity	
	low	high	low	high	low	high
	(1)	(2)	(3)	(4)	(5)	(6)
Highest density	0.003	0.009	0.006***	0.001	0.002	0.005***
	(0.004)	(0.007)	(0.001)	(0.001)	(0.003)	(0.002)
Highest density x year						
2014	-0.001	-0.006	0.002	0.002	-0.004	0.000
	(0.004)	(0.007)	(0.001)	(0.001)	(0.004)	(0.002)
2015	0.003	-0.010	-0.001	-0.000	-0.002	0.000
	(0.004)	(0.007)	(0.001)	(0.001)	(0.004)	(0.002)
2016	-0.000	-0.002	0.001	0.000	-0.005	-0.001
	(0.004)	(0.007)	(0.001)	(0.002)	(0.004)	(0.002)
2017	-0.002	0.003	-0.000	0.001	0.001	0.001
	(0.004)	(0.007)	(0.001)	(0.001)	(0.004)	(0.002)
2018	0.001	-0.013**	-0.002	0.001	-0.002	-0.001
	(0.004)	(0.007)	(0.001)	(0.002)	(0.004)	(0.002)
2019			– reference –			
2020	-0.007	-0.008	-0.003**	0.000	-0.006	-0.002
	(0.005)	(0.007)	(0.001)	(0.002)	(0.005)	(0.002)
2021	0.003	-0.002	-0.001	0.002	-0.001	-0.004**
	(0.005)	(0.006)	(0.001)	(0.002)	(0.004)	(0.002)
2022	0.003	-0.008	-0.001	0.002	-0.003	-0.006***
	(0.004)	(0.006)	(0.001)	(0.002)	(0.004)	(0.002)
2023	-0.000	-0.002	-0.000	0.001	-0.000	-0.003
	(0.004)	(0.006)	(0.001)	(0.002)	(0.004)	(0.002)
2024	-0.005	-0.008	-0.002	-0.003**	0.000	-0.009***
	(0.004)	(0.006)	(0.001)	(0.002)	(0.004)	(0.002)
N	328,613	113,561	3,449,653	1,945,184	472,713	1,667,811
R^2	0.186	0.175	0.149	0.157	0.147	0.131
Workers	65,051	22,155	590,051	339,383	96,284	293,090

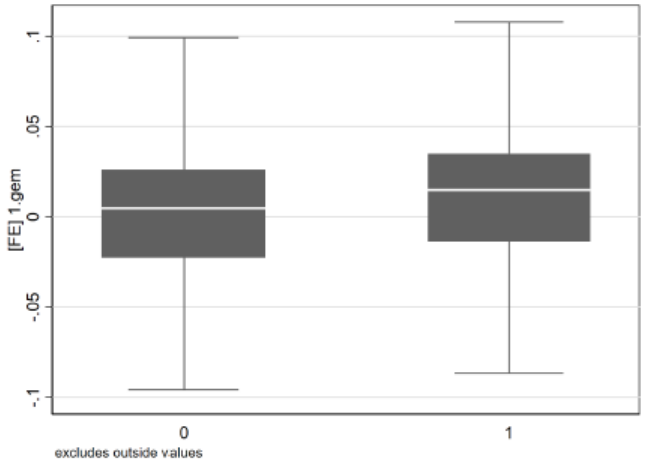
Differences in WFH capacity across fixed effects: worker, occupations, municipality/location type



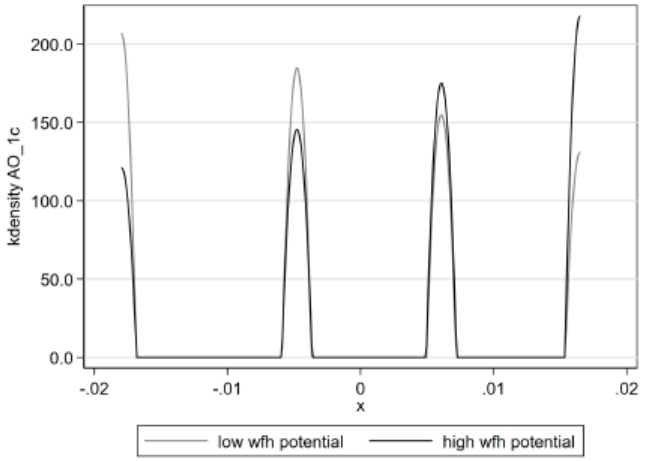
(a) x-axis: worker FE



(b) x-axis: occupation FE



(c) x-axis: WfH capacity, y-axis: municipality FE



(d) x-axis: location type FE

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