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Work-from-home and Firms' Resilience: Evidence from the COVID-19 pandemic

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Motivations

- The COVID-19 pandemic forced a large fraction of firms to switch to work-from-home (WFH)
- Little is yet known about the impact of WFH on firms' responses to the crisis
- Current evidence
  - Focus on a specific firm or context $\Rightarrow$ Effects may be uneven across firms and places
  - Affected by unobservables (e.g. managerial capabilities)

What we do

- Use unexplored administrative data on the universe of employees working from home for Italy
- Difference-in-differences + instrumental variable (IV) approach to tease out causality
- Preliminary evidence
  - WFH had a mixed impact on firms' performance in 2020
  - Pre-pandemic investments in ICTs are a crucial mediating factor

Main Data - WFH

- WFH – Italian Ministry of Work and Social Policies
  - Universe of employees fully or partially working from home
  - Legal duty and monetary incentive to declare
  - Due to COVID-19 the procedure was simplified ⇒ fill an online form

- Italy offers an interesting institutional setting
  - First advanced economy to be severely affected by the COVID-19 pandemic
  - The Italian government immediately imposed a national lockdown in early March
  - Italy had one of the largest fractions of workers switching to WFH Eurofound (2020)

▸ WFH adoption ▸ Summary stats

Additional Data Sources

- Orbis – Bureau van Dijk ▸ Coverage
  - Balance sheet information: number of employees, labour costs, age and sales
  - Geographical information: latitude, longitude, address, postcode, city, NUTS-2, NUTS-3

- Broadband internet – Italian Ministry of Enterprises and Made in Italy
  - Share of house numbers with access to fiber technology
  - 2016-2021 at the census area level ($>$ 400k census areas) ▸ Example

- Ci Technology Database – Aberdeen group (previously known as 'Harte Hanks')
  - Measures of firm-level ICT adoption from survey interviews, online communities and estimation
  - Number of laptops and number of servers

▸ Summary stats

Empirical Strategy

$$\Delta log(Sales_i) = \alpha + \beta \Delta WFH_i + \gamma X_i + \delta_j + \delta_r + \varepsilon_i;$$

- Δ indicates the difference between the year 2020 and 2019
- WFH_i identifies whether a firm i used WFH in 2020
  - Extensive margin: when firm i has at least one employee in remote work
  - Intensive margin: firm i's share of workers in WFH in total number of employees
- X_i includes firm i's number of employees, labour productivity, age and average wage (in 2019)
- δ_j and δ_r accounts for travel-to-work-areas (> 500) and 4-digit industry fixed effects

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IV = local availability of fibre technology

- Exploit a massive public investment started by the Italian Government in 2015
- 'National Ultra-Broadband Plan' aimed at ensuring 100% coverage of fibre technology by 2020
- To minimise public spending ⇒ adjacent territories ⇒ driven by distance ▸ Distance decay
- Measure of supply rather than its actual consumption
- Fibre roll-out was not fully completed ▸ Share fibre

IV Relevance

- Fibre is more suitable than ADSL for remote working
  - Superior speed: fibre $\geq$ 30 Mbps vs ADSL $\leq$ 24 Mbps
  - Symmetrical upload and download capabilities
  - Speed not limited by the number of devices using bandwidth
  - Lower latency and more reliable

$\Rightarrow$ Crucial for remote work tasks: video conferencing, large file uploads, real-time applications

- Access to fibre technology strongly predicts WFH adoption ▸ First-stage

IV Validity

- Are firms covered by fibre technology $\neq$? Balancing tests
- Are there pre-trends in fibre adoption? Event study
- Is fibre technology affecting firms beyond remote work? E-commerce Italy

IV Results

VARIABLES	(1) Δ log(Sales)	(2) Δ log(Sales)
WFH (dummy)	-0.714**	
	(0.315)	
WFH (share)		-0.949***
		(0.358)
Observations	376,508	366,211
Controls	YES	YES
NACE 4-digit FE	YES	YES
TTWA FE	YES	YES
TTWAxArea FE	NO	NO
K-Papp F-stat	28.5	42

IV Results

VARIABLES	(1) Δ log(Sales)	(2) Δ log(Sales)	(3) Δ log(Sales)	(4) Δ log(Sales)
WFH (dummy)	-0.714**		-0.620*	
	(0.315)		(0.355)	
WFH (share)		-0.949***		-0.827**
		(0.358)		(0.421)
Observations	376,508	366,211	369,661	359,527
Controls	YES	YES	YES	YES
NACE 4-digit FE	YES	YES	YES	YES
TTWA FE	YES	YES	NO	NO
TTWAxArea FE	NO	NO	YES	YES
K-Papp F-stat	28.5	42	37.7	43.6

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▸ Essential vs Non-Essential ▸ Young vs Old ▸ Large vs Small
▸ Buffer ▸ No E-commerce ▸ Residential areas

ICTs Results

	(1)	(2)	(3)	(4)
	Extensive margin		Intensive margin	
VARIABLES	Δ log(Sales)	Δ log(Sales)	Δ log(Sales)	Δ log(Sales)
WFH	0.252	-0.457**	-0.478*	-0.531*
	(0.685)	(0.206)	(0.271)	(0.301)
WFH * Laptops	-0.505		0.167**	
	(0.638)		(0.0654)	
WFH * Servers		0.227		0.143**
		(0.170)		(0.0561)
Observations	124,572	125,162	123,890	123,705
Controls	YES	YES	YES	YES
TTWA FE	YES	YES	YES	YES
NACE 4-digit FE	YES	YES	YES	YES
K-Papp F-stat	16.3	33.7	21.7	22.8

Conclusions

- Fully-remote 'forced' WFH had a negative impact on small firms' performance
- Pre-pandemic investments in ICTs helped companies in effectively shifting to fully-remote WFH
- Work-in-progress: Acquire new firm-level data to expand further our set of robustness

Appendix

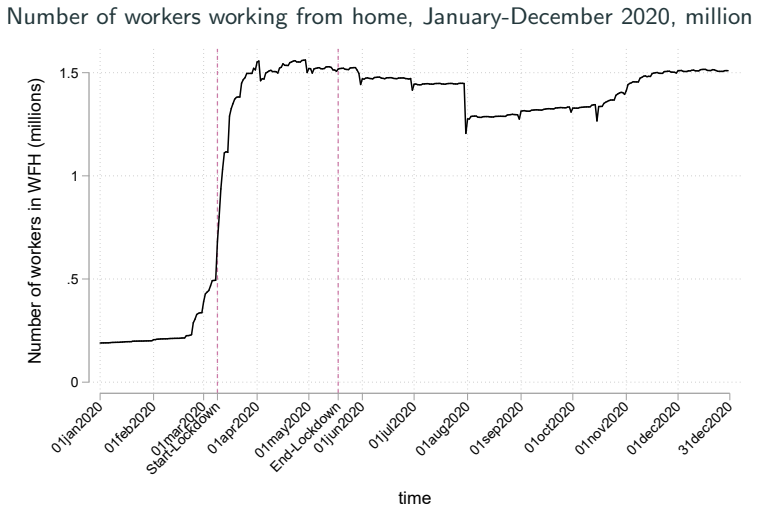
Contribution to the literature

- Firms' resilience during the COVID-19 pandemic
  - WFH (+) Bai et al. (2021); Panikolaou & Schmidt (2022)
  - Managerial practices (+) Lamorgese, Schivardi et al. (2021)
  - Technological sophistication (+) Comin et al. (2022)
  - Digital capabilities (+) Cariolle & Leon (2022); Pierri & Timmer (2023); Oikonomou, Pierri, & Timmer (2023)
  - Digital infrastructure (+) Doerr et al. (2021)

- Impact of remote work on workers and productivity
  - (+) Bloom et al. (2015); Choudhury et al. (2021); Choudhury et al. (2022); Angelici & Profeta (2023)
  - (−) Emanuel & Harrington (2021); Gibbs et al. (2023); Atkin et al. (2023)

- Impact of broadband internet on firms
  - Asymmetric Digital Subscriber Line (ADSL) Size and productivity Canzian et al. (2019); De Stefano et al. (2014); De Stefano et al. (2018); trade Kneller & Timmis (2016); Malgouyres et al. (2021)
  - Fibre technology De Stefano et al. (2020)

WFH Adoption in Italy (Crescenzi, Giua & Rigo, 2021)



Summary statistics on WFH, 1-digit NACE

Ateco 1-digit	Description	Sh firms in total	Sh firms in WFH	Sh Employees in total	Sh Employees in WFH
C	Manufacturing	17.6	15.8	34.5	15.3
D	Electricity, gas, steam & air conditioning supply	1.1	7.8	0.8	52.1
E	Water supply; sewerage, waste management	0.7	15.9	1.9	15.0
F	Construction	13.4	3.8	7.6	5.5
G	Wholesale & retail	23.0	7.2	18.5	11.6
H	Transportation & storage	3.9	8.6	8.9	15.1
I	Accommodation & food service activities	7.1	1.4	6.4	1.5
J	Information & communication	5.6	25.7	5.3	67.9
K	Financial & insurance	1.4	18.8	0.8	47.9
L	Real estate activities	12.4	2.1	0.8	16.1
M	Professional, scientific & technical activities	8.7	17.8	4.8	46.9
N	Administrative & support service activities	5.1	11.3	9.8	18.7

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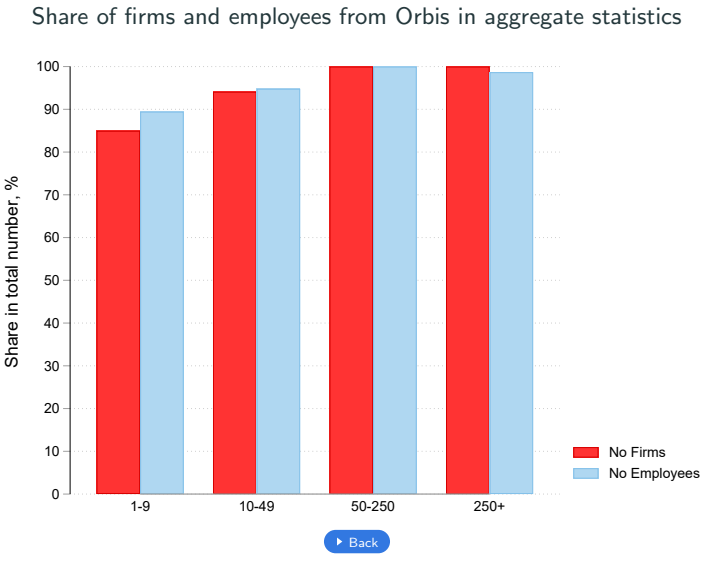
Validation Orbis



Summary statistics

Variables	Mean	St. Dev.	Median	Min	10pct	90pct	Max	Obs
Firm Variables								
Δ Sales	-0.18	0.57	-0.11	-13.61	-0.69	0.25	13.18	369776
No. Employees	17	112	6	1	1	29	16016	369776
Age	16	14	12	1	2	36	119	369776
log(Sales/Employees)	12	1	12	-2	11	13	19	369776
Avg. Wage	32150	49252	30134	0	10857	51830	385770	369776
WFH Variables								
WFH (dummy)	0.14	0.35	0	0	0	1	1	369776
WFH (share)	0.08	0.23	0	0	0	0.22	1	369776
ICT Variables								
No. Laptops	3	16	1	0	1	5	3567	124540
No. Servers	2	71	0	0	0	2	23621	124540
Cloud (dummy)	0.58	0.49	1	0	0	1	1	36514

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Example Census Areas

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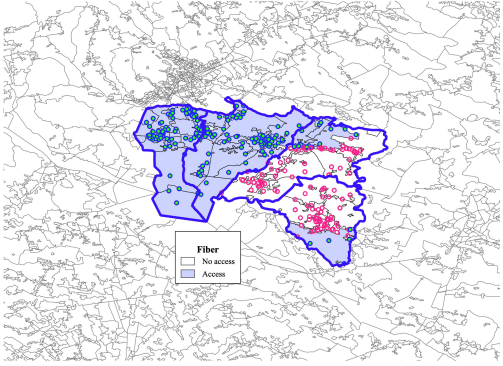
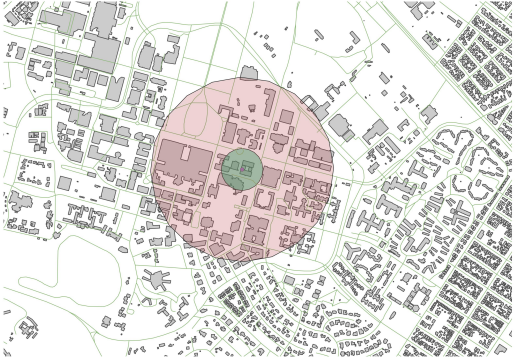
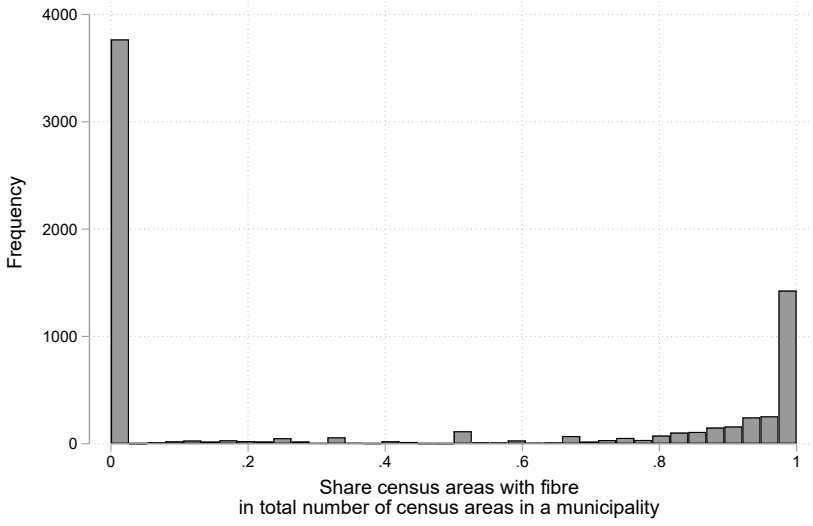




Share Fibre Within Italian Municipalities



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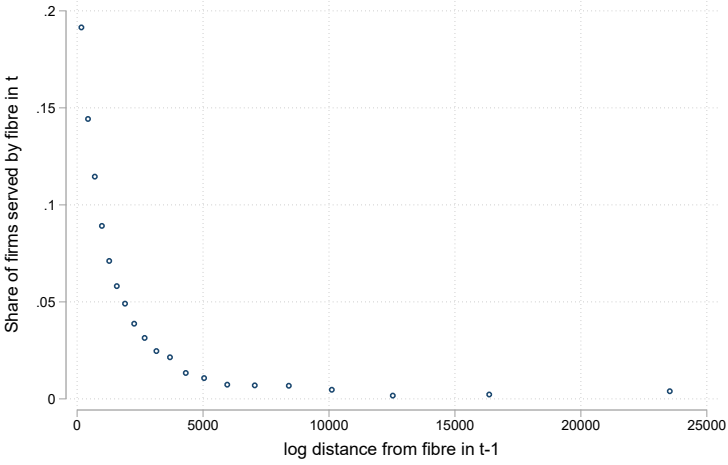
Probability of being served by fibre technology



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Share of firms with access to fibre, 2019

	All	Micro	Small	Medium	Large
All	0.87	0.87	0.84	0.84	0.89
Region (1-digit)					
South	0.86	0.85	0.85	0.85	0.87
Center	0.88	0.88	0.85	0.85	0.90
North	0.87	0.87	0.83	0.83	0.89
Industry (1-digit)					
Manufacturing	0.79	0.80	0.77	0.76	0.83
Energy	0.82	0.80	0.83	0.89	0.83
Construction	0.84	0.83	0.82	0.84	0.87
Non-financial services	0.89	0.89	0.89	0.90	0.90
Type of location					
Residential area	0.90	0.92	0.88	0.90	0.88
Mountain area	0.66	0.73	0.64	0.65	0.66
Industrial area	0.79	0.81	0.76	0.81	0.78
Rural area	0.64	0.67	0.63	0.64	0.63

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First-stage Results

VARIABLES	(1) Extensive WFH (dummy)	(2) Intensive WFH (share)
Fibre	0.0112***	0.00887***
	(0.00210)	(0.00137)
Observations	376,508	366,211
R-squared	0.233	0.227
Controls	YES	YES
TTWA FE	YES	YES
NACE 4-digit	YES	YES
K-Papp F-stat	28.5	42

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Balancing Tests

VARIABLES	(1) log(Sales)	(2) log(Employees)	(3) log(Age)	(4) log(VA/Employees)	(5) log(Avg Wage)	(6) Laptops/Employees	(7) Servers/Employees
Fibre	-0.0172	-0.0203**	-0.0236***	-0.0105	0.00541	0.00126	0.0174
	(0.0128)	(0.00837)	(0.00743)	(0.00747)	(0.00702)	(0.00393)	(0.0180)
Observations	376,508	376,508	376,508	335,797	376,508	124,572	124,572
R-squared	0.259	0.193	0.149	0.227	0.126	0.029	0.026
TTWA FE	YES	YES	YES	YES	YES	YES	YES
NACE 4-digit FE	YES	YES	YES	YES	YES	YES	YES

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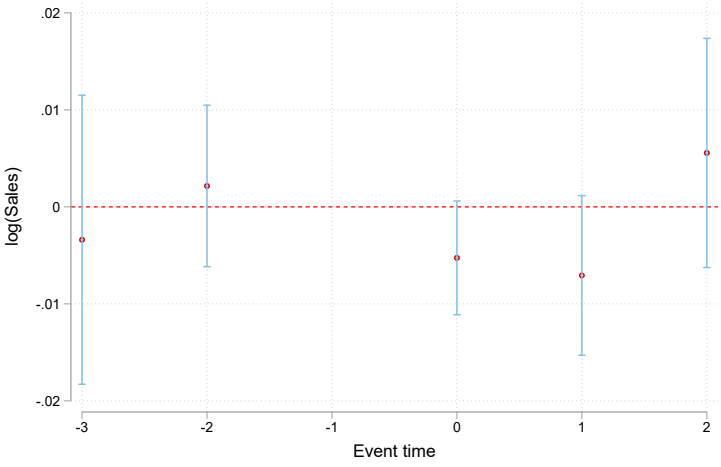
Fibre Adoption and Firms' Sales



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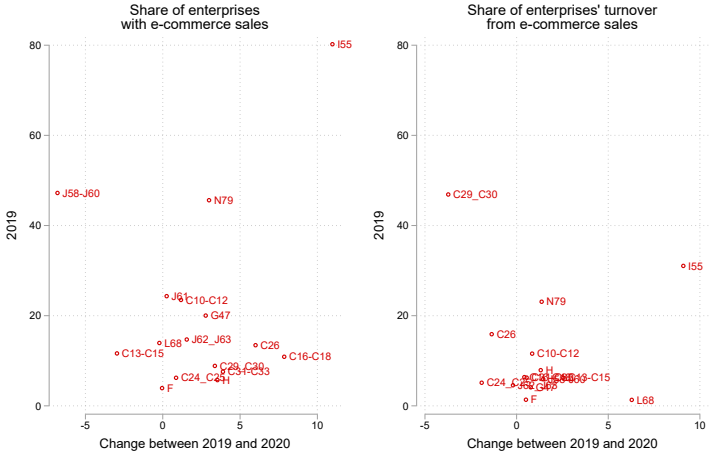
E-commerce Adoption in Italy



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Essential vs Non-essential industries

VARIABLES	(1) Essential Δ log(Sales)	(2) Non Essential Δ log(Sales)	(3) Essential Δ log(Sales)	(4) Non Essential Δ log(Sales)
WFH (dummy)	-0.586	-0.976***		
	(0.395)	(0.360)		
WFH (share)			-0.711	-1.863***
			(0.506)	(0.642)
Observations	161,780	218,010	157,967	211,417
Controls	YES	YES	YES	YES
NUTS-3 FE	YES	YES	YES	YES
NACE 4-digit FE	YES	YES	YES	YES
K-Papp F-stat	23.7	10.3	17.8	13.8

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High vs. Low WFH Potential

VARIABLES	(1) High WFH Δ log(Sales)	(2) Low WFH Δ log(Sales)	(3) High WFH Δ log(Sales)	(4) Low WFH Δ log(Sales)
WFH (dummy)	0.0281	-1.705*		
	(0.174)	(0.965)		
WFH (share)			-0.183	-3.067*
			(0.168)	(1.647)
Observations	100,609	150,275	96,358	146,993
Controls	YES	YES	YES	YES
NUTS-3 FE	YES	YES	YES	YES
NACE 4-digit FE	YES	YES	YES	YES
K-Papp F-stat	22.7	7.5	17.9	11.4

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Manufacturing Firms

VARIABLES	(1) Δ log(Sales)	(2) Δ log(Sales)
WFH (dummy)	-0.432**	
	(0.200)	
WFH (share)		-0.844**
		(0.344)
Observations	88,815	87,881
Controls	YES	YES
NUTS-3 FE	YES	YES
NACE 4-digit FE	YES	YES
K-Papp F-stat	28	30.9

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Young vs. Old Firms

VARIABLES	(1) Young firms Δ log(Sales)	(2) Old firms Δ log(Sales)	(3) Young firms Δ log(Sales)	(4) Old firms Δ log(Sales)
WFH (dummy)	-1.216**	-0.548*		
	(0.567)	(0.294)		
WFH (share)			-1.454**	-0.996**
			(0.649)	(0.432)
Observations	145,506	234,238	139,931	229,408
Controls	YES	YES	YES	YES
NUTS-3 FE	YES	YES	YES	YES
NACE 4-digit FE	YES	YES	YES	YES
K-Papp F-stat	10.1	30.1	8.5	31.2

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Small vs. Large Firms

VARIABLES	(1) Small firms Δ log(Sales)	(2) Large firms Δ log(Sales)	(3) Small firms Δ log(Sales)	(4) Large firms Δ log(Sales)
WFH (dummy)	-0.737**	-0.223		
	(0.310)	(0.305)		
WFH (share)			-1.147***	-0.0632
			(0.429)	(0.615)
Observations	360,636	19,102	350,272	19,061
Controls	YES	YES	YES	YES
NUTS-3 FE	YES	YES	YES	YES
NACE 4-digit FE	YES	YES	YES	YES
K-Papp F-stat	27.8	4.5	24.5	6.1

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Excluding E-commerce Intensive Industries

VARIABLES	(1) Δ log(Sales)	(2) Δ log(Sales)
WFH (dummy)	-2.008*	
	(1.171)	
WFH (share)		-2.148*
		(1.121)
Observations	105,353	103,019
Controls	YES	YES
TTWA FE	YES	YES
NACE 4-digit FE	YES	YES
K-Papp F-stat	5.1	17.6

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Only Firms in Residential Areas

VARIABLES	(1) Δ log(Sales)	(2) Δ log(Sales)
WFH (dummy)	-0.733*	
	(0.398)	
WFH (share)		-0.910**
		(0.450)
Observations	337,488	328,022
Controls	YES	YES
TTWA FE	YES	YES
NACE 4-digit FE	YES	YES
K-Papp F-stat	34.6	41.3

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Buffer Around the Firm

VARIABLES	(1) Δ log(Sales)	(2) Δ log(Sales)
WFH (dummy)	-1.372***	
	(0.469)	
WFH (share)		-1.628***
		(0.598)
Observations	379,790	369,384
Controls	YES	YES
NUTS-3 FE	YES	YES
NACE 4-digit FE	YES	YES
K-Papp F-stat	18.9	16.7

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OLS Results

VARIABLES	(1) Δ log(Sales)	(2) log(Sales)	(3) Δ log(Sales)	(4) log(Sales)
WFH (dummy)	0.101***	0.112***		
	(0.00596)	(0.00230)		
WFH (share)			0.113***	0.126***
			(0.00598)	(0.00364)
Observations	376,508	753,016	366,211	732,426
R-squared	0.153	0.965	0.179	0.969
Controls	YES	NO	YES	NO
TTWA FE	YES	NO	YES	NO
NACE 4-digit FE	YES	NO	YES	NO
Firm FE	NO	YES	NO	YES

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