The Impact of Telework on Consumption

Evidence from Mobile Phone and Transaction Data

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LEMNA seminar

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Telework changes where people are during the day

- **Telework as a major structural transformation for cities and labor markets**
  - 3% of workers pre-Covid $\rightarrow$ 20% post-Covid (Enquête Emploi)
  - 98% of teleworkers work from home (Dares, 2023)
  - Large implications for the spatial organization of economic activity
- **Mechanisms**
  - Spatial
    - Residence-workplace median distance: 12km
    - Teleworkers jobs in city centers, residences dispersed
  - Temporal
    - 2.4 days/week working from home (France)
  - This generates **daily demand shocks**:
    - where people consume (home $\leftrightarrow$ workplace)
    - what they consume
    - how much they consume

How does telework reshape daily demand in cities?

- **What do we know?**
  - Local spending increases with teleworking population (Alipour et al., 2025)
    - German context, DID, residence telework exposure $\times$ post-COVID
  - Local spending decreases with teleworking jobs (Althoff et al., 2022)
    - US context, DID, workplace telework exposure $\times$ post-COVID

  $\Rightarrow$ Telework relocates consumption from workplaces to residential areas

- **Literature gap**
  - No unified framework for estimating net reallocation of demand
  - Is telework a **pure spatial redistribution** of spending?
  - Or does it also change **what and how much people consume**?

Main contributions

Our paper:

- **Estimates unified framework for daily demand reallocation**
  - First study simultaneously estimating the dual effect of telework:
    - Presence at home → positive demand shock
    - Absence from workplace → negative demand shock
  - Recovers spatial reallocation of consumption
  - Infers total consumption effects
- **Leverages and combines high-frequency big data for identification**
  - Payment card data (*Cartes Bancaires)* + Mobile phone data (*Orange)*
- **Innovates in terms of telework measurement**
  - Move beyond occupation-based teleworkability indices (Dingel & Neiman 2020), labor force survey
  - Finer geographic resolution than Google Mobility

What do we find? (*spoilers*)

- **Spatial reallocation of offline consumption**
  - Spending shifts from workplaces to residences, from urban cores to residential areas
- **Context-dependent consumption behavior**
  - At home: higher spending in food retail (more time to cook lunch)
  - At work: higher spending in restaurants

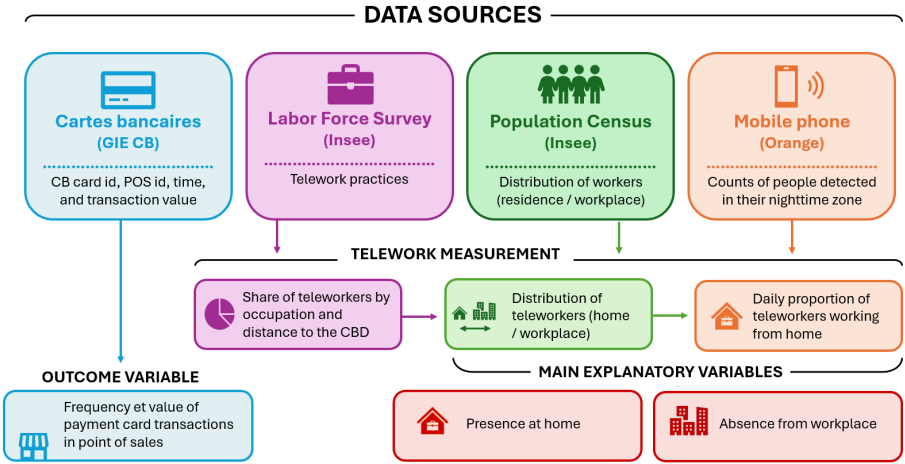
  $\Rightarrow$ Telework leads a sectoral shift from restaurants to food retail
- **Non-significant negative effect in total in-store spending**
  - Despite a significant negative effect on in-store visit frequency

Data

Data

- **Spatial context**
  - Lyon Functional Urban Area (2nd largest in France) » see
  - Monocentric city
  - 560 municipalities, 2.7M residents, 1.2M workers, 220k teleworkers
- **Period**
  - September 5 – October 2, 2022 (post-Covid)
- **Outcome** (daily, municipality level)
  - Number and value of card transactions at points of sale
    → measured with payment card transactions data (*Cartes Bancaires*)
  - ≈ 800K transactions, 26M euros
- **Main explanatory variables** (daily, municipality level)
  - Teleworkers' home presence and workplace absence
    → measured with mobile phone data (*Orange*) + labor force survey + census

Data



$\Rightarrow$ Produced variables are at the municipality $\times$ weekday level (4 weeks, September 2022)

Working from home exposure

Daily WFH intensity $\times$ **Spatial exposure**

Home exposure
Teleworkers present at home

$$WFH_{it}^{(H)} = \widehat{\beta}_t \times \frac{\sum_{jk} \tau_{kg(i)} \text{Workers}_{ijk}}{\sum_{jk} \text{Workers}_{ijk}}$$

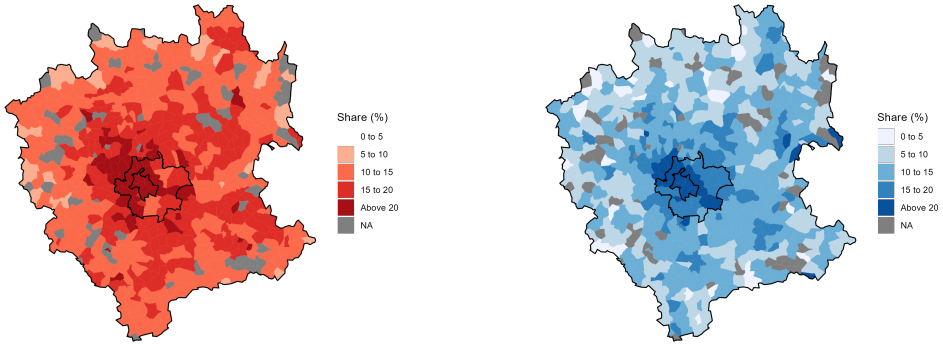
Workplace exposure
Teleworkers absent from work

$$WFH_{jt}^{(W)} = \widehat{\beta}_t \times \frac{\sum_{ik} \tau_{kg(i)} \text{Workers}_{ijk}}{\sum_{ik} \text{Workers}_{ijk}}$$

- Workers_{ijk}: workers living in i, working in j, occupation k
  Population Census (2021)
- $\tau_{kg(i)}$: WFH share by occupation k and residence urban group $g(i)$ see
  Labor Force Survey, Q4 2022
- $\widehat{\beta}_t$: share of teleworkers WFH on day t
  Estimated from mobile phone data, Orange, Sep. 2022

$\rightarrow$ **The same teleworker simultaneously generates a positive presence shock at home and a negative absence shock at work.** see residence–workplace imbalance map

Spatial distribution of teleworkers



(a) home (b) workplace

Figure 1: Share of teleworkers among workers

Notes: *Telework rates by occupation and distance to city center (LFS 2022) mapped onto the population census residence–workplace matrix*

Daily share of teleworkers working from home

$$\text{Residents}_{i,t} = \sum_d \widehat{\beta_d}\ \text{Teleworkers}_i + \widehat{\alpha}\ \text{Inactives}_i + \sum_{kg} \gamma_{d(t),k,g(i)}\ \text{Part-time workers}_{i,k} + \lambda_t + \epsilon_{i,t} \quad (1)$$

- $\text{Residents}_{i,t}$: number of individuals present in their residential zone i on weekday t, during working hours (9:00–12:00)
  Source: Mobile phone data, Orange (September 2022)
- Teleworkers_i: estimated residents who regularly work from home
  Source: Labor Force Survey (Q4, 2022) + Population Census (2021)
- $\widehat{\beta_d}$: estimated share of teleworkers working from home on weekday $d(t)$
- $\gamma_{d,k,g}$: share of part-time workers not working on day $d(t)$, socio-professional category k, and residential zone group $g(i)$ within the FUA see
  Source: Labor Force Survey (Q4, 2022)
- Inactives, part-time workers
  Source: Population Census (2021)

Estimated daily telework practice $\widehat{\beta_d}$

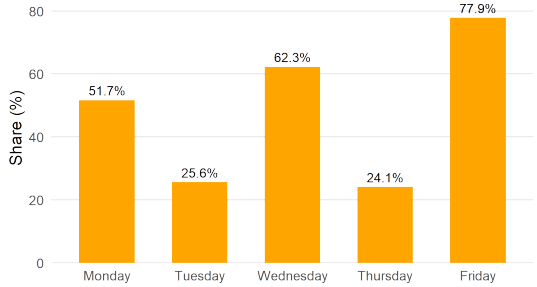


Figure 2: Average daily shares of teleworkers working from home[1]

- External validation
  - Labour Force Survey: 2.4 WFH days per teleworker (weekly average)
  - Onsite attendance audit, Paris-based public institution see

[1]Note: The coefficients for Monday, Wednesday, and Friday are statistically significant at the 1% level, while those for Tuesday and Thursday are significant at the 10% level.

Identification strategy

Empirical model

Poisson model estimated by the Pseudo-Maximum Likelihood method:

$$Y_{it} = \exp\left[\theta_1 \text{WFH}_{it}^{(\mathcal{H})} + \theta_2 \text{WFH}_{it}^{(\mathcal{W})} + \beta X_{it} + \delta_i + \gamma_{gt} + \epsilon_{it}\right]$$

- Y_{it} : transactions (frequency and value) in municipality i on date t (Sept. 2022)
- $\text{WFH}_{it}^{(\mathcal{H})}$: daily teleworkers home-presence (% of workers living in i)
- $\text{WFH}_{it}^{(\mathcal{W})}$: daily teleworkers workplace-absence (% of workers working in i)
- δ_i: municipality fixed effects
- γ_{gt}: date $\times$ municipality-group fixed effects
- X_{it}: weather, public transportation disruptions, part-time workers on day-off

Identification

- **Two sources of variation**
  - Cross-sectional heterogeneity in exposure to telework
  - Within-municipality daily variation in telework intensity
- **Main source of identification**
  - Cross-sectional heterogeneity in exposure
  - Daily variation in telework intensity is common across municipalities
- **Identification assumption**
  - Conditional on fixed effects and controls, telework exposure is orthogonal to residual local demand shocks

Threats to identification

1. **Measurement error**
   - Exposure combines estimates from multiple data sources, each subject to measurement error
   - $\Rightarrow$ Instrumental variable strategy
2. **Reverse causality**
   - Local demand and retail composition may affect telework patterns
   - $\Rightarrow$ Instrumental variable strategy

Instruments

$$\underbrace{\left(\widehat{\beta}_t - \gamma_{t,k=\text{Executives}}\right)}_{\text{daily unexpected home presence}} \times \underbrace{\frac{\sum_{jk} \tau_{k,2017} \text{Workers}_{ijk,1999}}{\sum_{ijk} \text{Workers}_{ijk,1999}}}_{\text{historic telework exposure}}$$

IV estimation: two-stage residual inclusion (2SRI), suited to the nonlinear PPML specification.

Results

Semi-elasticities

- **Average effects of teleworkers**
  - +1 p.p. teleworkers at home → +1%*** local transactions and value
  - +1 p.p. workplace absence → -1.7%*** transactions, -1.3%*** value
  - Consumption shifts from the workplace to home
- **Incomplete consumption substitution**
  - Average substitution rate at the municipality level for +1 teleworker at home vs -1 teleworker at the workplace:

$$\left| \frac{\exp(\widehat{\theta}_1 / \overline{\text{Workers}^{(\mathcal{H})}}) - 1}{\exp(\widehat{\theta}_2 / \overline{\text{Workers}^{(\mathcal{W})}}) - 1} \right| \approx \left| \frac{\widehat{\theta}_1}{\widehat{\theta}_2} \right|$$

  - +1 teleworker at home offsets **60%** of the workplace loss in transaction frequency ($CI_{90\%}$: [41%; 93%])
  - The corresponding substitution rate is **76%** for transaction value ($CI_{90\%}$: [47%; 136%])

⇒ **Telework shifts consumption homeward, but does not fully replace workplace consumption, although the estimated substitution is not statistically different from 100%.**

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IV results

	Baseline	IV
Transaction frequency		
Home exposure	+1.0%	+1.3%
Workplace exposure	-1.7%	-2.3%
Substitution rate	60%	53%
	[41%; 93%]	[34%; 105%]
Transaction value		
Home exposure	+1.0%	+1.4%
Workplace exposure	-1.3%	-2.2%
Substitution rate	76%	66%
	[47%; 136%]	[27%; 177%]

- **IV estimates are larger in magnitude.**
  → Consistent with measurement error.
- **First-stage residuals are weakly to not statistically significant.**
  → weak evidence of endogeneity, consistent with measurement error.
- **Similar incomplete substitution.**
  → aggregate results are robust.

Local net effect of telework

$$\Delta_i\% = \frac{100}{T}\sum_t \left(\exp(\widehat{\theta}_1 \text{WFH}_{it}^{(\mathcal{H})} + \widehat{\theta}_2 \text{WFH}_{it}^{(\mathcal{W})}) - 1\right)$$

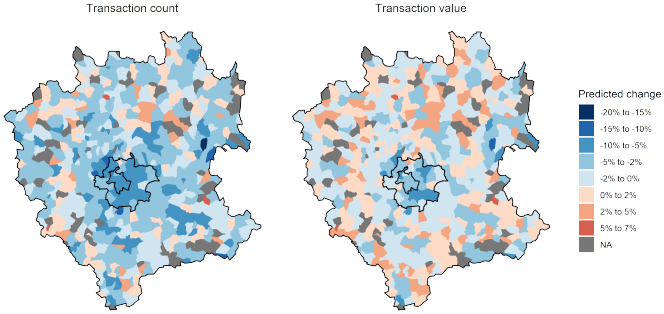


Figure 3: Telework effect on local consumption

→ **Consumption is reallocated spatially:** residential areas ↑, workplace areas ↓ (city center ↓↓)

Local net (significant) effect of telework

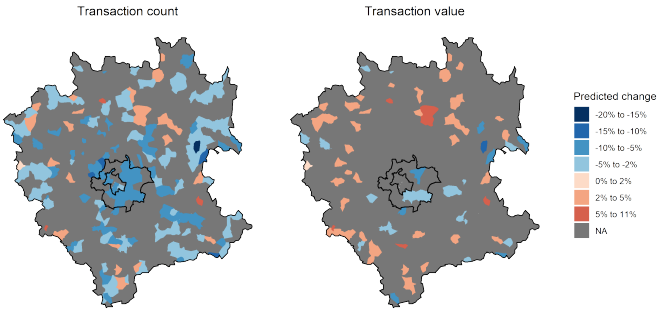


Figure 4: Significant telework effects on transaction frequency and value

Note: Colored municipalities have significant telework effects at the 10% level; grey municipalities are not significant.

Aggregate and sectoral effect of telework

- **Aggregate effects**
  - **-6%*** in transaction frequency (-42k transactions per weekday)
  - **-3%** in transaction value (-€700k per weekday, not statistically significant)

  ⇒ **Results are consistent with a pure spatial reallocation of spending.**

- **Sectoral reallocation**
  - No significant effect on durable goods
  - Strong effects in proximity services:
    - Restaurants: **-25%***** in transactions, **-21%***** in value
    - Food retail: **-2%** in transactions, **+3%** in value
    - Bars and drinks: **+15%** in transactions and value

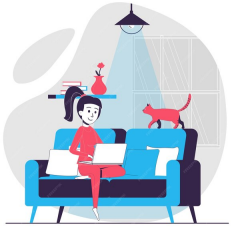
  ⇒ **Telework reallocates spending across proximity services, from restaurant consumption to more home-oriented spending.**

*Note: *** significant at the 1% level, * significant at the 10% level.*

Conclusion: telework changes where and what people consume but not how much they consume

1. **WHERE**: Consumption shifts from workplace municipalities to residential municipalities.
2. **WHAT**: Sectoral substitution from restaurants to food retail and bars
3. **HOW MUCH**: Fewer transactions overall, but no statistically significant reduction in total spending.
4. **Extensions**
   - What is the effect on business activity and employment? » see
   - Are the results generalizable? » see

Thank you for your attention ! ☺



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Case study

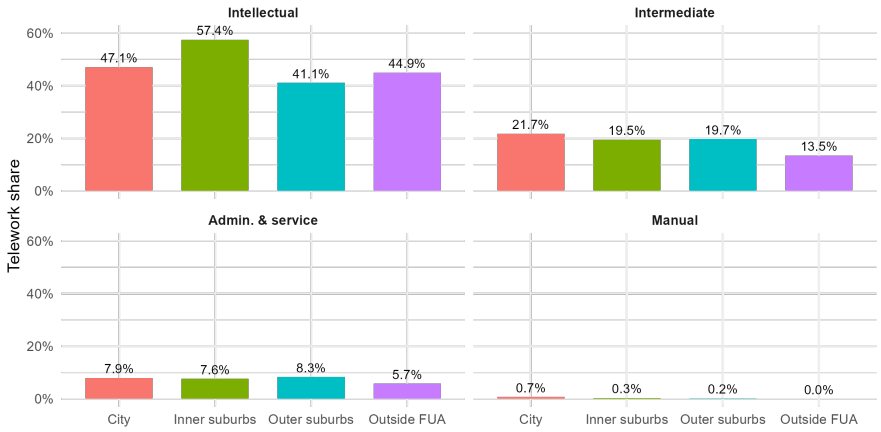
back

Lyon Functional Urban Area

- 560 municipalities, 2.7 million residents, 1.2 million workers, 220K teleworkers
- Urban core + commuting zone
- Ideal spatial setting to study residence–workplace mobility and consumption reallocation

Telework by occupation and FUA location

back



Non-working part-time workers

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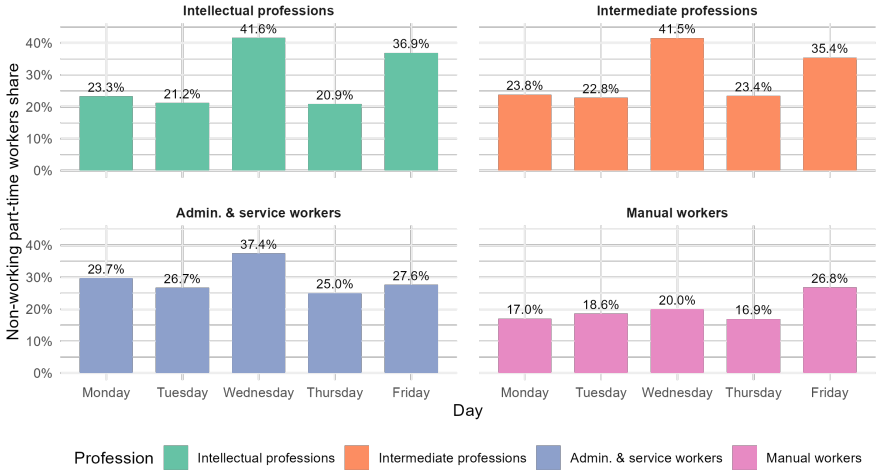

Teleworkers residence-workplace imbalance

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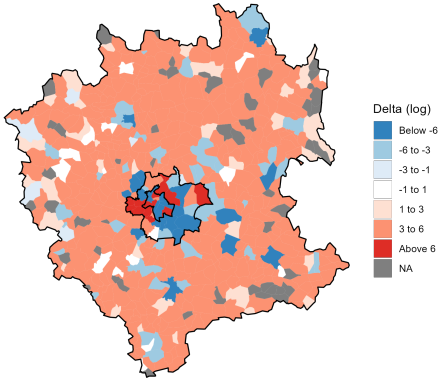

Figure 5: Teleworkers residential-employment imbalance

Note: The figure maps the signed logarithmic transformation of the difference between resident teleworkers and workplace-based teleworkers, defined as $\text{sign}(x)\log(1+|x|)$, where $x = \text{Teleworkers}_i^{(\mathcal{H})} - \text{Teleworkers}_i^{(\mathcal{W})}$

Instrumental variable strategy

back

Instruments: shift-share style

$$\text{IV}_{it}^{(\mathcal{H})} = (\widehat{\beta}_t - \gamma_{t,k=\text{Executives}}) \times \frac{\sum_{jk} \tau_{k,2017} \text{Workers}_{ijk,1999}}{\sum_{ijk} \text{Workers}_{ijk,1999}} \tag{2}$$

$$\text{IV}_{jt}^{(\mathcal{W})} = (\widehat{\beta}_t - \gamma_{t,k=\text{Executives}}) \times \frac{\sum_{ik} \tau_{k,2017} \text{Workers}_{ijk,1999}}{\sum_{ijk} \text{Workers}_{ijk,1999}} \tag{3}$$

Two-stage residual inclusion (2SRI)

- Include first-stage residuals as regressors in second stage
- Suited for nonlinear models like Poisson.

External validation to telework daily intensity

back

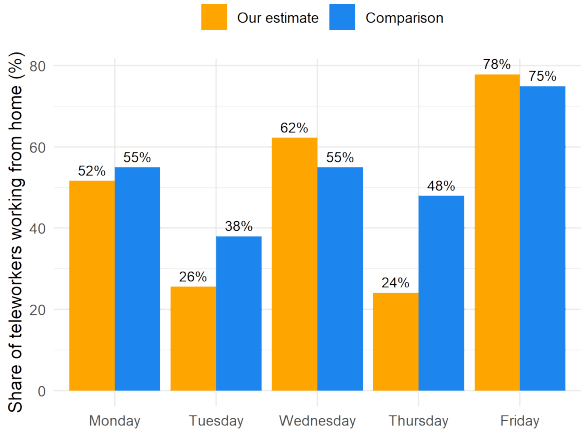

Figure 6: Paris-based public institution external validation

IV results

back

Dependent Variables:	$RT^{(\mathcal{H})}$	$RT^{(\mathcal{W})}$	$RT^{(\mathcal{H})}$	$RT^{(\mathcal{W})}$	Transaction count			Transaction value		
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Relevance test		First-stage		Baseline	Second-stage	Redundancy	Baseline	Second-stage	Redundancy
	OLS	OLS	OLS	OLS	Poisson	Poisson	Poisson	Poisson	Poisson	Poisson
Variables										
$IV^{(\mathcal{H})}_{1999}$	3.90***	1.00*	3.52***	-0.735			-0.429			0.778
	(1.11)	(0.534)	(1.03)	(0.583)			(1.61)			(1.84)
$IV^{(\mathcal{W})}_{1999}$	-2.42***	0.342	-2.55***	1.42***			-0.595			-1.60
	(0.754)	(0.392)	(0.738)	(0.492)			(1.08)			(1.19)
$RT^{(\mathcal{H})}$				0.445***	1.15***	1.25***	1.13***	1.06***	1.44***	0.944***
				(0.045)	(0.226)	(0.357)	(0.259)	(0.269)	(0.412)	(0.283)
$RT^{(\mathcal{W})}$			0.386***		-1.74***	-2.34***	-1.45***	-1.36***	-2.19***	-1.04***
			(0.044)		(0.383)	(0.411)	(0.344)	(0.391)	(0.640)	(0.366)
$Residuals^{(\mathcal{H})}$						0.336			0.022	
						(0.499)			(0.616)	
$Residuals^{(\mathcal{W})}$						1.02**			1.16	
						(0.424)			(0.777)	
Fit statistics										
Observations	10,600	10,600	10,600	10,600	10,600	10,600	10,600	10,600	10,600	10,600
BIC	-70,030.1	-68,517.3	-72,020.7	-70,507.8	166,527.7	166,376.4	166,376.4	5,428,850.1	5,418,952.6	5,418,952.6
R^2	0.96932	0.95623	0.97459	0.96375						
Within R^2	0.04086	0.01824	0.20576	0.18704						
Wald stat	6.2	9.1	30.8	40.1						

Table 1: 2SRI results, 1999 instruments

What impact on firms and workers? back

- **Difference-in-differences design**
  - Treatments: zero before COVID-19 and equals the municipality's telework exposures from 2022 onwards (source: census + labor force survey)
  - Outcomes: number of establishments, number of workers, workers per establishment (source: SIRUS, 2017–2023)

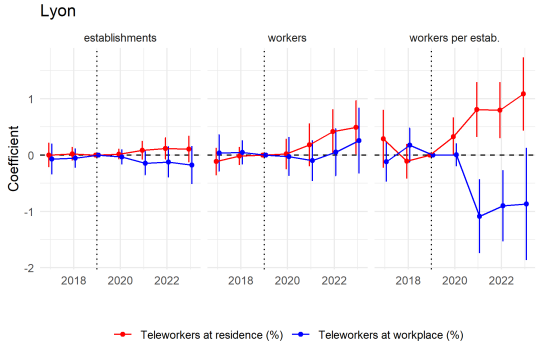

Figure 7: DiD estimates of the effect of telework exposure on firm activity and employment

Are the results generalizable?

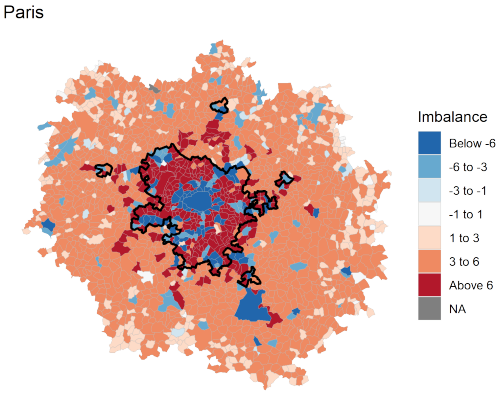

Figure 8: Telework imbalance index in Paris FUA

Are the results generalizable?

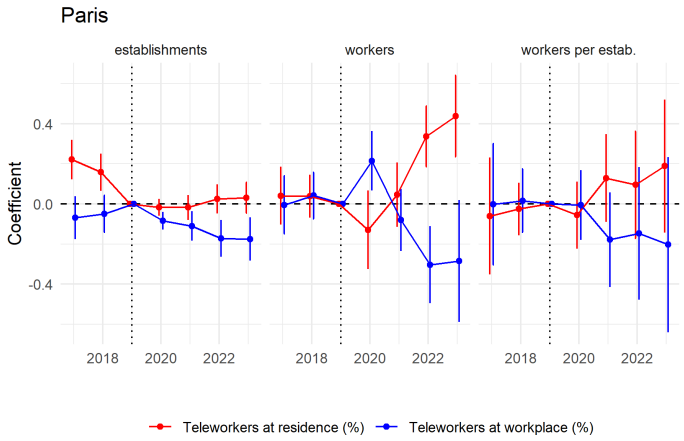

Figure 9: DiD estimates for Paris FUA

Are the results generalizable?

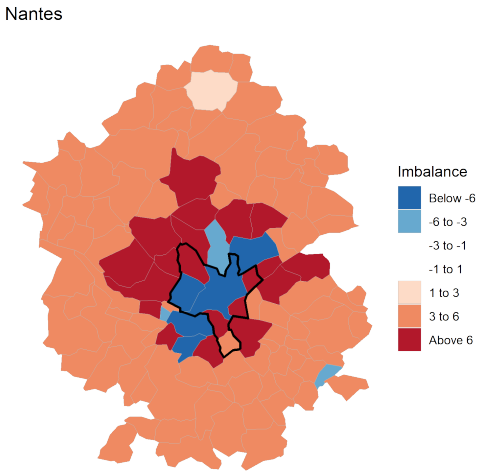

Figure 10: Telework imbalance index in Nantes FUA

Are the results generalizable?

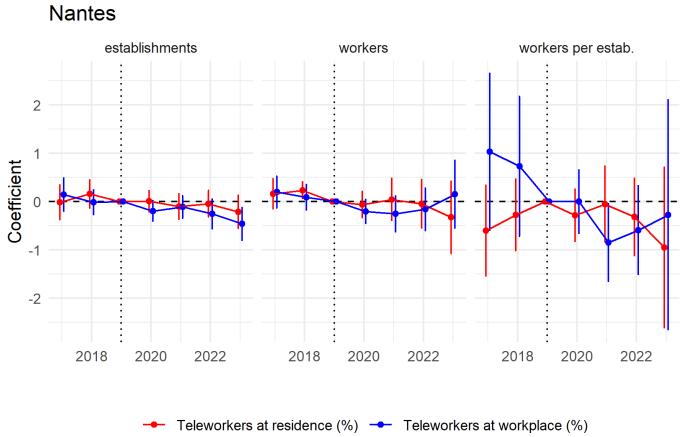

Figure 11: DiD estimates for Nantes FUA

Are the results generalizable?

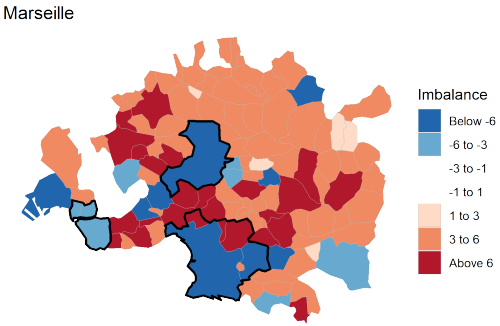

Figure 12: Telework imbalance index in Marseille FUA

Are the results generalizable? back

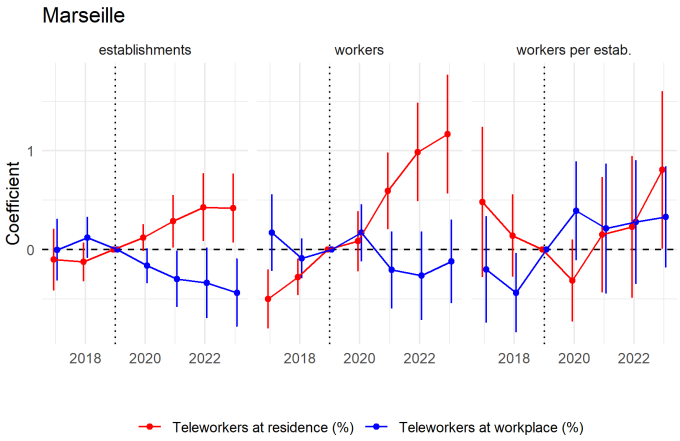

Figure 13: DiD estimates for Marseille FUA