ONLINE APPENDIX
The Impact of Telework on Local Consumption

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This Online Appendix provides supplementary material for the analysis presented in the main paper. It is organized into seven sections. Online Appendix A presents descriptive analyses of the mobile phone and card transaction data, including daily patterns of residents' presence and sectoral transaction activity within the Lyon Functional Urban Area. Online Appendix B provides supplementary statistics and robustness checks related to the construction of our daily telework measures, including telework trends from 2017 to 2024, the distribution of telework shares by occupation and residence, part-time workers' day-off patterns, and robustness checks with date fixed effects. Online Appendix C presents a comprehensive set of supplementary robustness checks and sensitivity analyses, including sector classification, alternative telework measures, omitted variable bias, bootstrapped standard errors, spatial heterogeneity tests, measurement error sensitivity (zone-specific shares, finer geographic resolution, and noise simulations), and an alternative identification strategy based on spatial variation in telework exposure. Online Appendix D provides supplementary figures on the net economic impact of telework, including day-specific counterfactual effects, correlates and spatial distribution of winners and losers, and bootstrap distributions for aggregated net effects and substitution rates. Online Appendix E extends the sectoral heterogeneity analysis of Section 4.3, presenting sector-specific net effect maps, bootstrap distributions, substitution rates, and municipality-level significance counts for Restaurants, Food Retail, Bars and Drinks, and General Retail. Online Appendix F complements the spatial spillover analysis of Section 5.1, presenting zone-group heterogeneity and aggregate net impact once spillovers are accounted for. Online Appendix G details an alternative, fine-grained approach to estimating daily telework rates at the Iris geographic level, including the model specification, raw estimates of inactive presence shares ($\widehat{\alpha}_i$) and daily telework rates ($\widehat{\beta}_{it}$), and the correction methods applied.

Throughout this Online Appendix, all tables and figures are numbered with the prefix "OA" (e.g., Table OA.1, Figure OA.1) to distinguish them from the main paper's tables and figures. References in the main paper to specific tables and figures in this Online Appendix follow the same convention.

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1 Online Appendix A: Descriptive Data Analysis

This section provides supplementary descriptive analyses of the mobile phone and card transaction data underlying our main analysis, complementing the summary statistics and municipality classification presented in Appendix A of the main paper.

1.1 Mobile Phone Data: Presence of Residents

This part examines the variation in the count of people present in their residential area during weekdays over working hours. We exploit mobile phone data to capture the daily presence patterns of residents, which provides a fine-grained proxy for how teleworking and commuting practices affect local population density.

We estimate the following linear model for the residents' presence share:

$$\text{Residents share}_{idt} = \alpha + \sum_{D} \beta_D \, \mathbb{1}(d \in D) + \varepsilon_{idt}, \tag{1}$$

where i indexes the geographic unit at the Iris level, d represents the specific date of observation, and t denotes 30-minute time slots during the morning working hours from 09:00 to 12:00. The variable $\text{Residents share}_{idt}$ measures the ratio of resident volumes during each time slot to the average resident volume observed during the reference period of 06:00–06:30 on the same day, thereby standardizing for daily baseline presence levels. Our analysis focuses on weekdays $D \in \{\text{Tuesday, Wednesday, Thursday, Friday}\}$, using Monday as the reference day. The parameter α captures the average share of residents present during working hours on Monday, establishing our baseline level of residential presence. For each subsequent weekday D, the coefficients β_D quantify the deviation in residential presence relative to this Monday baseline, allowing us to identify systematic intra-week variations in residential presence patterns while controlling for time-of-day effects through our normalization procedure.

To account for heterogeneity across Iris and interaction with teleworking practices, we extend the model as:

$$\begin{aligned} \text{Residents share}_{idt} = \alpha_i &+ \sum_{D} \beta_D \, \mathbb{1}(d \in D) \\ &+ \sum_{D} \gamma_D \, \mathbb{1}(d \in D) \times \text{TE}_i^{(\mathcal{H})} \\ &+ \varepsilon_{idt}, \end{aligned} \tag{2}$$

where $\text{TE}_i^{(\mathcal{H})}$ represents the share of residents who telework at least once per week in Iris i.

Table OA.1 presents the baseline daily patterns of residents' presence. Column (1) reports the simple day-of-week deviations, while Column (2) includes Iris fixed effects, capturing local heterogeneity. The results show systematic differences across weekdays, with lower presence on Tuesday and Thursday relative to Monday and slightly higher presence on Wednesday and Friday.

Table OA.1: Daily patterns of presence in the residence zone

	Residents share	
	(1)	(2)
Constant	64.2***	
	(0.271)	
Tuesday	-2.74***	-2.88***
	(0.051)	(0.056)
Wednesday	0.917***	1.10***
	(0.045)	(0.061)
Thursday	-3.21***	-3.35***
	(0.050)	(0.072)
Friday	1.42***	1.66***
	(0.045)	(0.082)
Fixed-effects		
Iris		✓
Fit statistics		
Observations	122,685	122,685
R^2	0.02118	0.66553
Within R^2		0.06866

Note: Signif. codes: ***: 0.01, **: 0.05, *: 0.1. Clustered standard-errors at the iris level in parentheses.

Table OA.2 introduces interactions with teleworking shares ($TE^{(\mathcal{H})}$). Positive and significant coefficients indicate that areas with higher shares of teleworkers experience larger fluctuations in resident presence across the week. We also account for interactions with the share of part-time workers among residents ($PT^{(\mathcal{H})}$), which show smaller yet occasionally significant effects. Importantly, including these controls does not alter the magnitude or significance of the coefficients associated with residents' telework shares, neither the goodness of fit, suggesting that weekly variations in home presence are primarily driven by teleworkers' mobility patterns.

Table OA.2: Daily variation in resident presence by $TE^{(\mathcal{H})}$ levels

	Residents share	
	(1)	(2)
Tuesday	-3.4***	-4.1***
	(0.17)	(0.40)
Wednesday	0.18	-0.81**
	(0.17)	(0.18)
Thursday	-3.9***	-4.6***
	(0.23)	(0.53)
Friday	-1.8***	-2.7***
	(0.23)	(0.36)
Tuesday $\times$ $TE^{(\mathcal{H})}$	0.03**	0.03**
	(0.009)	(0.009)
Wednesday $\times$ $TE^{(\mathcal{H})}$	0.05***	0.06***
	(0.008)	(0.010)
Thursday $\times$ $TE^{(\mathcal{H})}$	0.04**	0.04**
	(0.01)	(0.01)
Friday $\times$ $TE^{(\mathcal{H})}$	0.20***	0.20***
	(0.01)	(0.01)
Tuesday $\times$ $PT^{(\mathcal{H})}$		0.04
		(0.03)
Wednesday $\times$ $PT^{(\mathcal{H})}$		0.05**
		(0.01)
Thursday $\times$ $PT^{(\mathcal{H})}$		0.03
		(0.03)
Friday $\times$ $PT^{(\mathcal{H})}$		0.05***
		(0.010)
Iris fixed effects	✓	✓
Observations	119,690	119,690
R^2	0.66806	0.66812
Within R^2	0.07208	0.07224

Note: Signif. codes: ***: 0.01, **: 0.05, *: 0.1. Clustered standard-errors at the iris level in parentheses.

To make these results more interpretable, Table OA.3 reports the predicted deviations in resident presence for Iris with different teleworker shares (10%, 20%, and 30%). For example, in areas with 30% teleworkers, the share of residents present increases by over 4 percentage points on Friday relative to Monday, highlighting the substantial influence of teleworking on daily presence patterns.

Overall, these results demonstrate that the greater the share of teleworkers in a residential area, the larger the weekday variation in local presence, reflecting the structural impact of hybrid work on urban activity patterns.

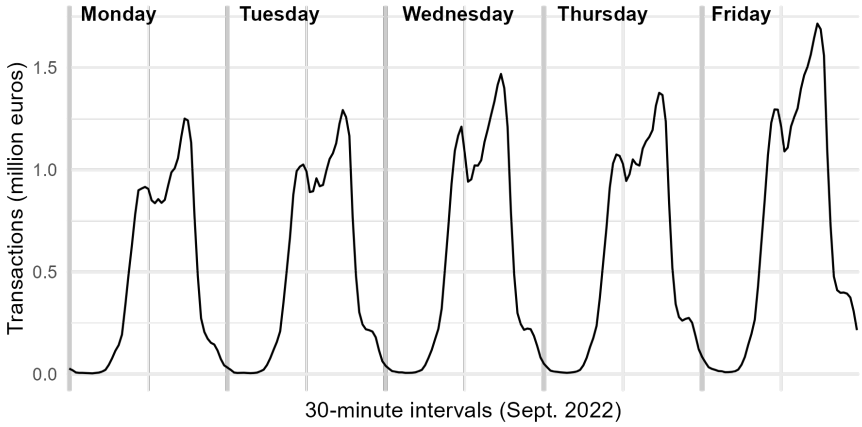
Table OA.3: Daily variation in resident presence by $TE^{(\mathcal{H})}$ levels

Day	$TE^{(\mathcal{H})}$ = 10%	$TE^{(\mathcal{H})}$ = 20%	$TE^{(\mathcal{H})}$ = 30%
Monday	ref	ref	ref
Tuesday	-3.07	-2.79	-2.51
Wednesday	0.71	1.24	1.78
Thursday	-3.58	-3.22	-2.85
Friday	0.21	2.18	4.15

Note: The table shows the expected daily variation in resident presence relative to Monday, by levels of $TE^{(\mathcal{H})}$, as predicted from the estimates in Table OA.2.

1.2 Card Daily Transactions and Spending in Lyon FUA

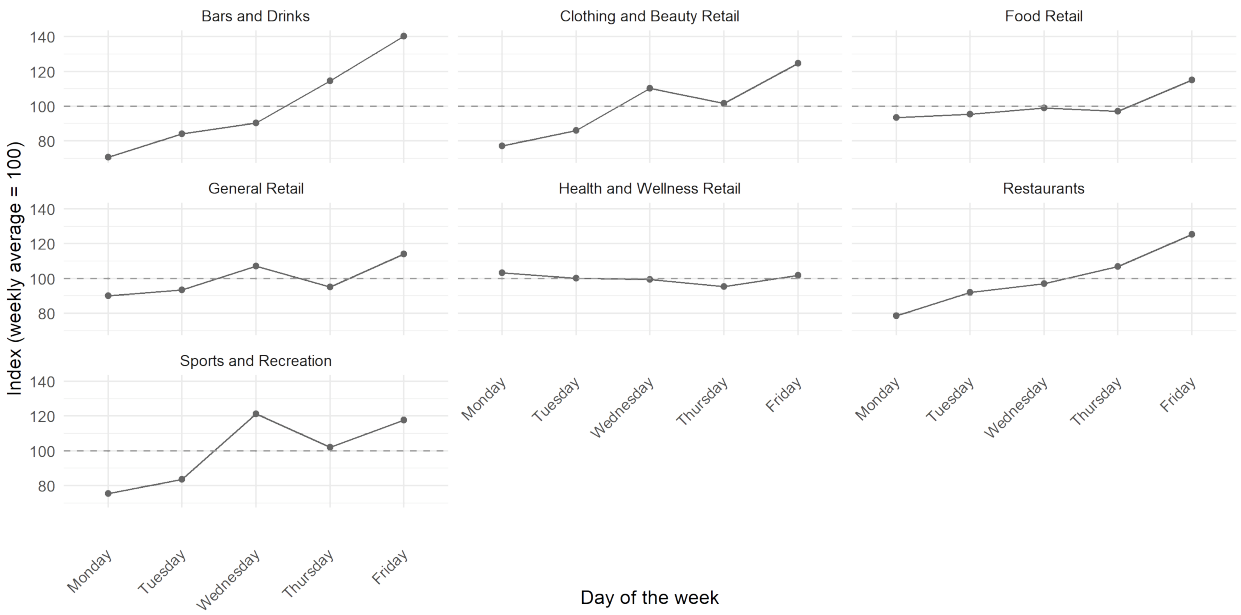
Figure OA.1 presents the daily total card spending in the Lyon Functional Urban Area (FUA) across a typical weekday in September 2022. This figure provides a snapshot of how spending varies by day of the week, highlighting patterns in consumer behavior and economic activity within the metropolitan area. It shows that consumer spending in the Lyon FUA is not uniform across weekdays, with notable peaks on Wednesdays and Fridays.



Note: The figure shows total daily card spending from our sample of observed transactions within the Lyon Functional Urban Area (FUA) across weekdays in September 2022.

Figure OA.1: Typical weekday card spending

Figure OA.2 depicts sectoral daily deviations from the weekly mean number of transactions in the Lyon FUA (indexed to 100). The figure illustrates how transaction activity varies across weekdays, highlighting sector-specific patterns in consumer behavior. Overall, transactions in the Lyon FUA are not uniform throughout the week. Peaks occur on Wednesdays and Fridays for sectors such as Clothing and Beauty Retail, Food Retail, Health and Wellness, Sports and Recreation, and General Retail. In contrast, Bars and Cafés, as well as Restaurants, show a more gradual increase in activity over the weekdays.



Note: The figure shows average daily deviations from the weekly mean (indexed to 100) in the number of transactions by sector, based on observed transactions in the Lyon FUA during weekdays in September 2022.

Figure OA.2: Average daily deviations from weekly transaction frequency averages, by sector

2 Online Appendix B: Supplementary Analysis of Telework Measurement

This section provides supplementary descriptive statistics and robustness checks related to the construction of our daily telework measures, complementing the analysis presented in Section 3 of the main paper.

2.1 Telework Statistics

Table OA.4 shows the evolution of the overall share of teleworkers among workers from 2017-2024, and by occupation. It shows that after the COVID-19 pandemic, telework practice persisted.

Table OA.4: Telework practice by aggregated professional category in France from 2017 to 2024

	2017	2021	2022	2023	2024
Teleworkers share (in %)					
Executives and Higher Intellectual Professions	11.1	55.4	51.7	49.5	47.9
Intermediate Professions	3.2	22.1	19.0	16.7	17.7
Administrative and Service Workers	1.4	9.7	8.8	7.7	7.5
Manual Workers	0.2	0.3	0.2	0.3	0.2
All	**3.0**	**21.7**	**19.2**	**18.4**	**18.3**
Average Telework Days per Week, Conditional on Teleworking					
Executives and Higher Intellectual Professions	-	3.4	2.7	2.5	2.5
Intermediate Professions	-	3.0	2.6	2.3	2.2
Administrative and Service Workers	-	3.1	2.7	2.3	2.4
Manual Workers	-	3.0	1.9	2.3	2.7
All	**1.9**	**3.3**	**2.7**	**2.4**	**2.4**

Note: The table displays the proportion of teleworkers among employed workers aged 15 and older, categorized by aggregated professional groups, from 2017 to 2024. Additionally, it provides the average number of telework days over a typical week, conditional on engaging in telework. Statistics for 2017 are from Hallepee et al. (2019), Table 1, which exploit data from *Dares-DGT-DGAFP* and *Enquête Sumer 2017*. The other statistics were derived from our calculations, using the *Enquête Emploi*, from 2021 to 2024.

2.2 Non-Working Part-Time Workers on Day-Off

To isolate the effect of telework on local consumption, it is essential to account for the presence of part-time workers who are not working on specific weekdays. These individuals may stay at home or engage in local activities on their days off, potentially confounding the estimated impact of telework on consumption patterns. Their presence could be mistakenly attributed to telework-induced home presence, leading to biased estimates of the telework effect. Figure OA.3 illustrates the daily variation in the share of part-time workers who are on their day off, broken down by occupation group and weekday (Monday to Friday).

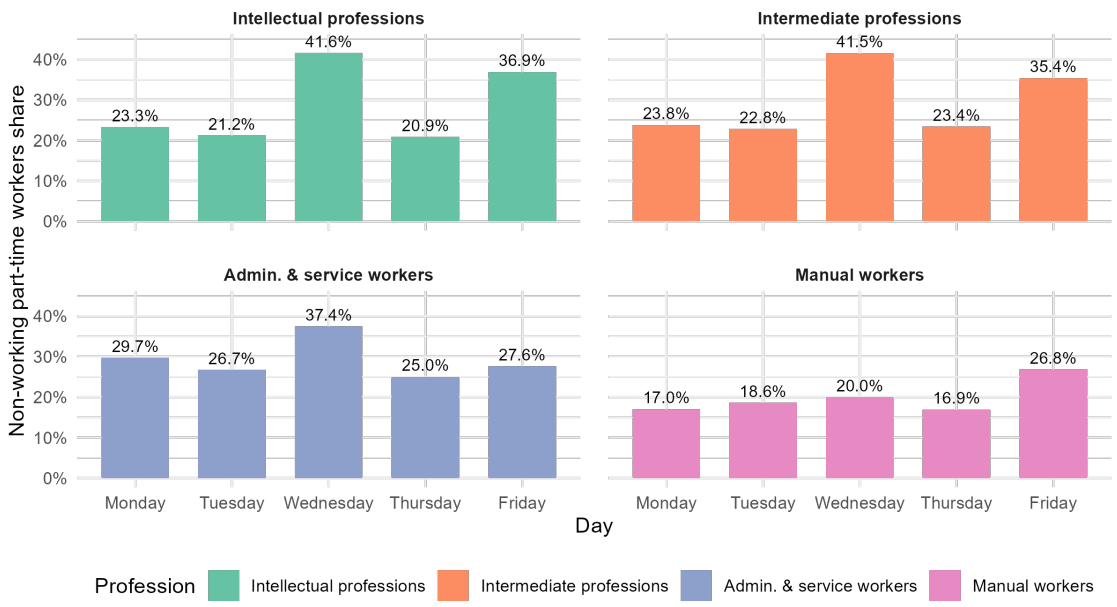
2.3 Daily Shares of Teleworkers Working From Home: Robustness Checks

Table OA.5 presents robustness checks of the results in Table 2 (main paper), which estimate the daily shares of teleworkers working from home, now including date fixed effects. The estimates remain stable, confirming their robustness.

Table OA.5: Estimated share of teleworkers working from home by weekday and municipality group

Dependent Variable:	Residents in their nighttime zone net of part-time workers on day off		
Model:	(1) All FUA	(2) Urban core	(3) Commuting zone
Variables			
Inactive population	0.9586***	0.9010***	1.028***
	(0.0336)	(0.0532)	(0.0575)
Teleworkers × Monday	0.4368***	0.6219***	0.4405
	(0.1432)	(0.1594)	(0.4242)
Teleworkers × Tuesday	0.2898*	0.4998***	0.0893
	(0.1519)	(0.1697)	(0.4278)
Teleworkers × Wednesday	0.5808***	0.7396***	0.6365+
	(0.1543)	(0.1709)	(0.4259)
Teleworkers × Thursday	0.2941**	0.5136***	0.1106
	(0.1438)	(0.1604)	(0.4253)
Teleworkers × Friday	0.7771***	0.9797***	0.6815+
	(0.1508)	(0.1650)	(0.4346)
Fixed-effects			
Date	✓	✓	✓
Number of teleworked days (reference = 2.428)			
Inferred from estimates ($\sum_t \widehat{\beta}_t$)	2.379	3.355	1.958
Fit statistics			
Observations	126,031	57,919	68,112
Within R^2	0.74479	0.60958	0.84063

Note: Signif. codes: ***: 0.01, **: 0.05, *: 0.1, +: 0.15. Clustered standard-errors at the Iris zone level in parentheses. Estimations include date fixed effects. The reference number of teleworked days (conditional on teleworking) reported in the table, used to validate our results, is calculated from the Q4 2022 Labor Force Survey (*Enquête Emploi*) for the Auvergne-Rhône-Alpes region, which encompasses the Lyon FUA.



Note: The table reports the proportion of part-time workers on their day off among all part-time workers (employed individuals aged 15 and over), by occupation and day of the week. Estimates are computed from the *Enquête Emploi*, fourth quarter of 2022, for Functional Urban Areas (FUAs) in the Auvergne–Rhône-Alpes region.

Figure OA.3: Figure: Share of part-time workers on day-off per weekday and occupation

3 Online Appendix C: Supplementary Robustness Checks and Sensitivity Analyses

This section provides supplementary robustness checks and sensitivity analyses complementing those retained in the main appendix (Appendix C: multicollinearity diagnostics via condition numbers, the residential/workplace divergence test, two-way clustering of standard errors, and the shift-share instrumental variable strategy).

3.1 Business Sectors and Aggregate Groups

Table OA.6 maps NAF codes (Nomenclature d'Activités Française) to the aggregated sector categories used to examine how telework affects different types of businesses in the Lyon Functional Urban Area (FUA).

Table OA.6: Classification of Retail and Service Activities

Food Retail	General Retail	Clothing and Beauty Retail	Health and Wellness Retail
4711A: Retail sale of frozen products	4726Z: Retail sale of tobacco products	4771Z: Retail sale of clothing	4773Z: Retail sale of pharmaceutical products
4711B: Retail sale in general stores	4741Z: Retail sale of computers	4772A: Retail sale of footwear	4774Z: Retail sale of medical and orthopedic goods
4711C: Convenience stores	4742Z: Retail sale of telecommunications equipment	4772B: Retail sale of leather goods	4778A: Retail sale of optical goods
4711D: Supermarkets	4743Z: Retail sale of audio and video equipment	4775Z: Retail sale of perfumes and cosmetics	
4711E: Mixed retail stores	4751Z: Retail sale of textiles	4777Z: Retail sale of watches and jewelry	
4711F: Hypermarkets	4752A: Retail sale of hardware (small stores)		
4719A: Department stores	4752B: Retail sale of hardware (large stores)		
4719B: Other non-specialized retail	4753Z: Retail sale of carpets and floor coverings		
4721Z: Retail sale of fruit and vegetables	4754Z: Retail sale of household appliances		
4722Z: Retail sale of meat and meat products	4759A: Retail sale of furniture		
4723Z: Retail sale of fish and seafood	4759B: Retail sale of other household equipment		
4724Z: Retail sale of bread and pastries	4761Z: Retail sale of books		
4725Z: Retail sale of beverages	4762Z: Retail sale of newspapers and stationery		
4729Z: Other food retail	4763Z: Retail sale of music and video recordings		
	4764Z: Retail sale of sporting goods		
	4765Z: Retail sale of games and toys		
	4776Z: Retail sale of flowers, plants, and pet supplies		
	4778B: Retail sale of coal and fuels		
	4778C: Other specialized retail trade		
	4779Z: Retail sale of second-hand goods		
Restaurants	**Bars and Drinks**	**Arts and Entertainment**	**Museums and Cultural Sites**
5610A: Traditional restaurants	5630Z: Beverage serving activities	9001Z: Performing arts	9102Z: Operation of museums
5610B: Cafeterias and self-service restaurants		9002Z: Support activities for performing arts	9103Z: Operation of historical sites
5610C: Fast food restaurants		9003A: Artistic creation in visual arts	9104Z: Operation of botanical and zoological gardens
5621Z: Catering services		9003B: Other artistic creation	
5629A: Contract catering		9004Z: Operation of arts facilities	
5629B: Other food service activities			
Gambling	**Sports and Recreation**	**Accommodations**	**Automotive**
9200Z: Gambling and betting activities	9311Z: Operation of sports facilities	5510Z: Hotels and similar accommodation	4511Z: Sale of cars and light motor vehicles
	9312Z: Activities of sports clubs	5520Z: Holiday and short-stay accommodation	4519Z: Sale of other motor vehicles
	9313Z: Fitness and physical well-being activities	5530Z: Camping grounds and recreational vehicle parks	4520A: Maintenance and repair of light motor vehicles
	9319Z: Other sports activities	5590Z: Other accommodation	4532Z: Retail sale of motor vehicle parts and accessories
	9321Z: Amusement and theme park activities		4540Z: Sale and repair of motorcycles
	9329Z: Other amusement and recreation activities		4730Z: Retail sale of automotive fuel

Note: The table maps NAF codes (*Nomenclature d'Activités Française*) of physical stores, businesses, restaurants, and cafés included in our sample of card transactions within the Lyon Functional Urban Area to aggregated sector categories.

3.2 Alternative Telework Measure: Telecommuters Only

As a complement to the residential/workplace divergence test retained in the main appendix, we construct an alternative telework measure that focuses exclusively on telecommuters—workers who commute to offices located outside their municipality of residence on specific days—explicitly excluding the potential teleworkers who both live and work in the same municipality (Section 3.1 of the main paper), thereby eliminating any risk of double-counting. Table OA.7 shows exceptional stability in coefficient estimates when using this alternative specification, supporting that our main findings are not artifacts of measurement construction.

Table OA.7: Transaction count and value responses to telecommute shares

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: Transaction count							
$WFH^{(\mathcal{H})}_{telecommuters}$	1.07***	1.01***	1.08***	1.08***	1.07***	1.02***	1.01***
	(0.260)	(0.287)	(0.258)	(0.259)	(0.261)	(0.268)	(0.286)
$WFH^{(\mathcal{W})}_{telecommuters}$	-1.08***	-0.936***	-1.07***	-1.07***	-1.08***	-1.03***	-0.931***
	(0.274)	(0.275)	(0.274)	(0.274)	(0.275)	(0.273)	(0.276)
Fit statistics							
Observations	10,640	10,640	10,640	10,640	10,640	10,640	10,640
Inferred work-to-home consumption substitution rate							
$\lvert\frac{\theta_1}{\theta_2}\rvert$	0.802	0.657	0.81	0.808	0.802	0.747	0.664
Panel B: Transaction value							
$WFH^{(\mathcal{H})}_{telecommuters}$	0.886***	0.705***	0.891***	0.891***	0.885***	0.791***	0.707***
	(0.181)	(0.175)	(0.178)	(0.178)	(0.180)	(0.181)	(0.173)
$WFH^{(\mathcal{W})}_{telecommuters}$	-1.11***	-1.07***	-1.10***	-1.10***	-1.10***	-1.06***	-1.07***
	(0.308)	(0.298)	(0.307)	(0.307)	(0.302)	(0.278)	(0.290)
Fit statistics							
Observations	10,640	10,640	10,640	10,640	10,640	10,640	10,640
Inferred work-to-home consumption substitution rate							
$\lvert\frac{\theta_1}{\theta_2}\rvert$	0.998	1.082	1.007	1.005	0.997	0.988	1.09

Note: Signif. codes: ***: 0.01, **: 0.05, *: 0.1. Clustered standard-errors at the municipality level in parentheses. All specifications include municipality and date-by-zone type fixed effects. Columns follow the same progressive control structure as Table 2 in the main paper. Standard errors of the inferred work-to-home consumption substitution rate are computed using the Delta Method.

3.3 Omitted Variable Bias: Detailed Discussion

A potential source of bias arises from the correlation between telework shares and the regression error term, which may distort the estimates of θ_1 and θ_2. To mitigate this, we control for the daily share of part-time workers who are on a day off, as their preferred days off often coincide with the days teleworkers choose to work from home. We distinguish between their place of residence (where they are likely to be present when not working), $PT^{(\mathcal{H})}_{it}$, and their place of work (where they are expected to be absent), $PT^{(\mathcal{W})}_{it}$. We additionally control for two types of events that may limit mobility, including the decision to work from home, and modify consumption behaviors: (1) rainy days and rain intensity; and (2) disruptions in the local public transport network (TCL) during morning commuting hours.

Interesting results arise: part-time workers on their day off contribute significantly to local consumption. For example, the share of part-time workers at home increases from 3.43% on Tuesday to 5.89% on Wednesday, a change associated with a 4.2% rise in transactions. This effect remains below the 5.7% increase linked to the rise in home-based telework (from 3.95% to 9.61% over the same period), even though part-time workers have more free time for local spending than teleworkers working from home. This gap could reflect income differences: part-time workers tend to earn less than the average teleworker, who is often an executive.

Rain reduces transactions by about 1% on average (significant at the 5% level), with stronger effects under heavier rainfall. Including this control leaves the estimated telework coefficients unchanged, suggesting limited confounding from weather conditions. Public transport disruption do not have a statistically significant direct effect on local consumption levels. However, their interaction with telework shares reveals an interesting pattern: disruptions amplify both the positive effect of telework at place of residence and its negative effect at the workplace, consistent

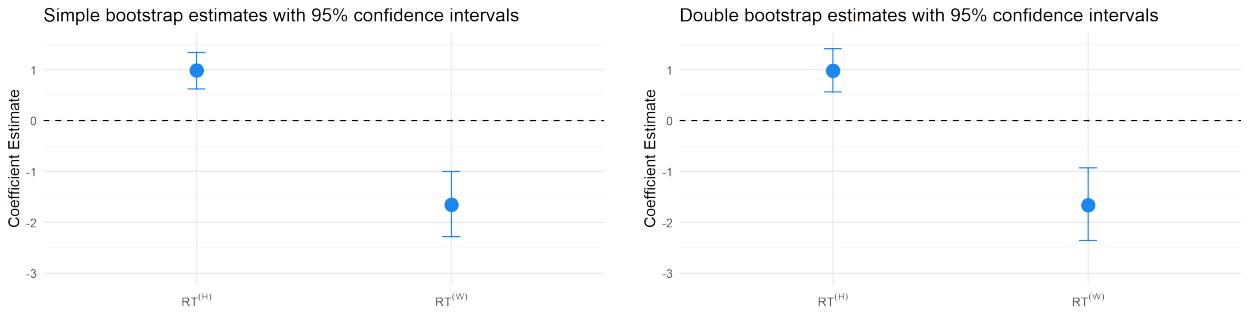
with the idea that transport disruptions reinforce the spatial reallocation of consumption when commuting is more difficult.

3.4 Bootstrapped Standard Errors: Accounting for Generated Regressors

Given that our explanatory variables are generated using parameters estimated in a prior OLS regression step, conventional standard errors may underestimate the true uncertainty in our estimates. This concern is particularly relevant for our identification strategy, where the construction of generated regressors could introduce additional variability not captured by standard inference procedures.

Our bootstrap procedure follows a rigorous multi-stage process. We randomly resample clusters of municipalities with replacement, re-estimate the first-step coefficient (β_t) that captures the daily share of teleworkers working from home, reconstruct the generated telework regressors, and re-estimate the complete model, repeating this entire process across 1,000 iterations. This methodology follows established best practices for inference with multi-step estimation (Horowitz, 2001).

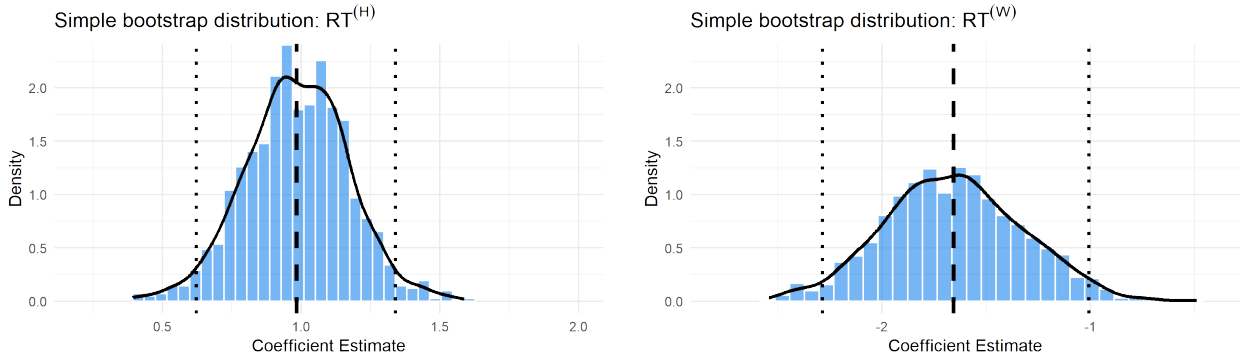
Figures OA.4 and OA.5 present the results. As theoretically expected, the double bootstrap procedure (accounting for uncertainty in both estimation steps) yields wider confidence intervals than the simple bootstrap. Crucially, despite these appropriately wider intervals, our coefficients remain statistically significant in both cases.



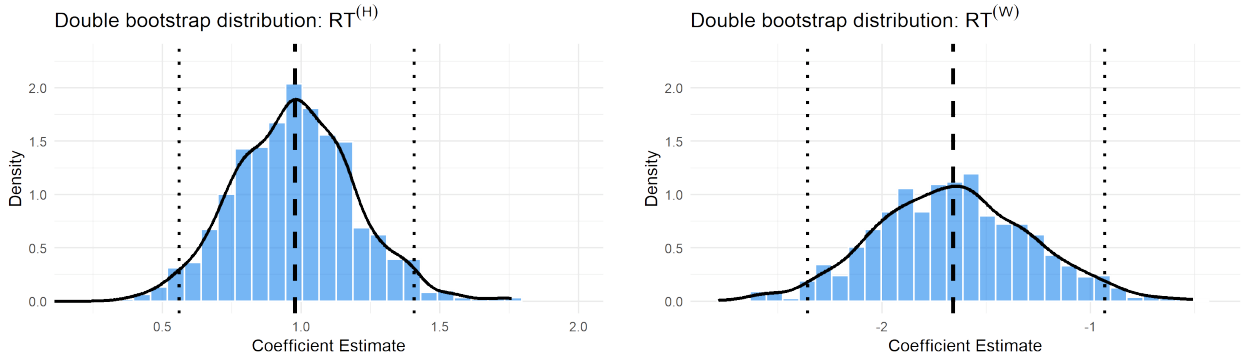
(a) Simple (b) Double

Note: This figure presents the estimates of a one percentage point increase in $\text{WFH}^{(\mathcal{H})}$ and $\text{WFH}^{(\mathcal{W})}$, using both simple and double bootstrap procedures, with 95% confidence intervals computed using standard-errors clustered at the municipality level. The simple bootstrap applies to Equation (4) of the main paper, with 1,000 re-samplings with replacement of municipalities. The double bootstrap extends this procedure by also re-estimating the daily telework share model within each iteration.

Figure OA.4: Comparison of bootstrapped coefficients and confidence intervals



(a) Simple WFH$^{(\mathcal{H})}$ (b) Simple WFH$^{(\mathcal{W})}$



(c) Double WFH$^{(\mathcal{H})}$ (d) Double WFH$^{(\mathcal{W})}$

Note: Distribution of the estimates across bootstrap iterations, with mean value (bold dashed line) and 95% confidence intervals (fine dashed lines).

Figure OA.5: Distribution of bootstrapped coefficients across iterations

3.5 Spatial Heterogeneity in Marginal Effects

To verify that our core results are not sensitive to specific geographic configurations, we test for statistically significant differences in the impact of telework across zone groups by interacting telework shares with zone-group indicators. Table OA.8 shows that the semi-elasticity coefficients are not statistically significantly different across zone groups, supporting the spatial robustness of our main results.

Table OA.8: Test of spatial heterogeneity: Transaction count and value responses to telework shares by zone group

	Transaction count (1)	Transaction value (2)
$WFH^{(\mathcal{H})}$	1.61***	0.469
	(0.587)	(0.750)
$WFH^{(\mathcal{W})}$	-2.77**	-1.95
	(1.18)	(1.27)
$WFH^{(\mathcal{H})}$ × Rest of the core	-0.565	0.751
	(0.700)	(0.886)
$WFH^{(\mathcal{H})}$ × Urban commuting zone	-1.05	0.132
	(0.713)	(0.858)
$WFH^{(\mathcal{H})}$ × Rural commuting zone	-0.168	1.19
	(0.878)	(0.971)
$WFH^{(\mathcal{W})}$ × Rest of the core	0.822	0.364
	(1.39)	(1.52)
$WFH^{(\mathcal{W})}$ × Urban commuting zone	1.55	0.907
	(1.25)	(1.37)
$WFH^{(\mathcal{W})}$ × Rural commuting zone	1.17	0.457
	(1.41)	(1.50)
Fit statistics		
Observations	10,640	10,640

Note: Signif. codes: ***: 0.01, **: 0.05, *: 0.1. Clustered standard-errors at the municipality level in parentheses. All specifications include municipality and date-by-zone type fixed effects, and controls for part-time workers, rain, and public transport disruption.

3.6 Sensitivity to Measurement Error: Alternative Telework Specifications

To assess the robustness of our findings to measurement error in our constructed telework variables, we implement two distinct approaches that intentionally introduce varying degrees of measurement error.

First approach: spatial heterogeneity in telework measurement. We construct alternative telework measures using zone-specific estimates $\widehat{\beta_{gt}}$ (share of teleworkers working from home in zone group g on day t, rather than a single FUA-wide estimate). Table OA.9 shows that estimated coefficients remain consistent with our baseline findings.

Table OA.9: Transaction count and value responses to alternative telework shares (using $\widehat{\beta_{gt}}$)

	Transaction count			Transaction value		
	(1)	(2)	(3)	(4)	(5)	(6)
$\text{WFH}^{(\mathcal{H})}_{\widehat{\beta_{gt}}}$	0.81***	0.67***	0.68***	0.73***	0.73**	0.73***
	(0.19)	(0.21)	(0.21)	(0.24)	(0.28)	(0.28)
$\text{WFH}^{(\mathcal{W})}_{\widehat{\beta_{gt}}}$	-1.32***	-1.35***	-1.33***	-0.98***	-1.09***	-1.07***
	(0.35)	(0.36)	(0.36)	(0.35)	(0.37)	(0.36)
Inferred work-to-home consumption substitution rate						
$\lvert\frac{\theta_1}{\theta_2}\rvert$	0.6141***	0.4986***	0.5092***	0.7451***	0.6675***	0.6795***
Fit statistics						
Observations	10,640	10,640	10,640	10,640	10,640	10,640

Note: Signif. codes: ***: 0.01, **: 0.05, *: 0.1. Clustered standard-errors at the municipality level in parentheses. All specifications include municipality and date-by-zone type fixed effects.

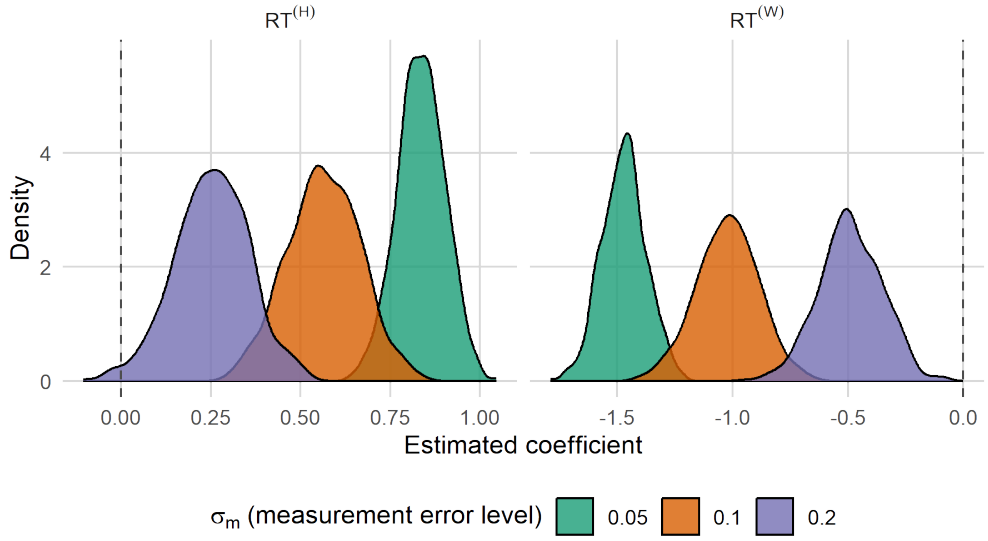
Second approach: controlled measurement error introduction. We compute daily telework rates at the finer Iris geographic level (rather than municipality level), which introduces additional estimation noise (see Section OA.7). Table OA.10 compares telework effects using alternative measures with systematically varying levels of measurement error: the "scaled $\beta^{(1)}$" specification contains higher measurement error than "scaled $\beta^{(2)}$." As expected, higher measurement error brings estimated coefficients closer to zero, though they maintain their expected signs and remain statistically significant—confirming that our baseline estimates represent a conservative lower bound.

Table OA.10: Sensitivity to measurement error: Transaction count and value responses to alternative telework specifications

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Transaction count						
$\text{WFH}^{(\mathcal{H})}_{\text{scaled } \beta^{(1)}}$	0.14	0.15	0.15*			
	(0.10)	(0.09)	(0.09)			
$\text{WFH}^{(\mathcal{W})}_{\text{scaled } \beta^{(1)}}$	-0.28	-0.44*	-0.42*			
	(0.26)	(0.26)	(0.26)			
$\text{WFH}^{(\mathcal{H})}_{\text{scaled } \beta^{(2)}}$				0.20**	0.22**	0.23**
				(0.10)	(0.10)	(0.10)
$\text{WFH}^{(\mathcal{W})}_{\text{scaled } \beta^{(2)}}$				-0.22	-0.41	-0.39
				(0.30)	(0.31)	(0.30)
Inferred work-to-home consumption substitution rate						
$\lvert\frac{\theta_1}{\theta_2}\rvert$	0.1993***	0.1788***	0.1839***	0.2457***	0.2251***	0.2311***
Fit statistics						
Observations	10,640	10,640	10,640	10,640	10,640	10,640
Panel B: Transaction value						
$\text{WFH}^{(\mathcal{H})}_{\text{scaled } \beta^{(1)}}$	0.13	0.10	0.10			
	(0.10)	(0.11)	(0.11)			
$\text{WFH}^{(\mathcal{W})}_{\text{scaled } \beta^{(1)}}$	-0.69***	-0.61***	-0.59***			
	(0.18)	(0.18)	(0.18)			
$\text{WFH}^{(\mathcal{H})}_{\text{scaled } \beta^{(2)}}$				0.23**	0.21*	0.20*
				(0.11)	(0.11)	(0.11)
$\text{WFH}^{(\mathcal{W})}_{\text{scaled } \beta^{(2)}}$				-0.85***	-0.76***	-0.72***
				(0.26)	(0.26)	(0.26)
Inferred work-to-home consumption substitution rate						
$\lvert\frac{\theta_1}{\theta_2}\rvert$	0.1816***	0.1617***	0.1673***	0.2760***	0.2692***	0.2799***
Fit statistics						
Observations	10,640	10,640	10,640	10,640	10,640	10,640

Note: Signif. codes: ***: 0.01, **: 0.05, *: 0.1. Clustered standard-errors at the municipality level in parentheses. All specifications include municipality and date fixed effects.

Systematic sensitivity analysis: controlled noise simulation. We further implement a controlled simulation approach that systematically introduces normally distributed random noise to our telework variables, at three error levels ($\sigma_m = 0.05, 0.10, 0.20$), across 500 iterations. Figure OA.6 shows a clear systematic attenuation pattern: for $\text{WFH}^{(\mathcal{H})}$, the mean coefficient decreases from 0.836 ($\sigma_m = 0.05$) to 0.252 ($\sigma_m = 0.20$); for $\text{WFH}^{(\mathcal{W})}$, from -1.47 to -0.490 in absolute value. All coefficients maintain their expected signs and remain statistically significant even at the highest error level, consistent with our baseline estimates representing conservative lower bounds.



Note: Empirical distribution of estimated coefficients from 500 simulations at three measurement error levels. Normally distributed noise proportional to σ_m was added to the telework variables, and the model was re-estimated.

Figure OA.6: Impact of measurement error on estimated coefficients for $\text{WFH}^{(\mathcal{H})}$ and $\text{WFH}^{(\mathcal{W})}$

3.7 Alternative Identification Strategy: Spatial Variation in Telework Exposure

As a complement to our daily-variation identification strategy and to our shift-share IV approach (retained in the main appendix), we implement an alternative strategy relying solely on time-invariant spatial variation in telework exposure across municipalities:

$$Y_{it} = \exp\left[\theta_1 \text{TE}_i^{(\mathcal{H})} + \theta_2 \text{TE}_i^{(\mathcal{W})} + \theta_3 \log(\text{Pop}_i) + \theta_4 \log(\text{Workers}_i) + \delta_g + \gamma_t + \epsilon_{it}\right]. \tag{3}$$

Table OA.11 presents the results. Coefficients for $\text{TE}_i^{(\mathcal{H})}$ and $\text{TE}_i^{(\mathcal{W})}$ are directionally consistent with our main analysis, with the expected signs and significance, though with larger standard errors reflecting the trade-off between precision and robustness when using cross-sectional rather than daily temporal variation.

Table OA.11: Spatial variation analysis: Transaction count and value responses to telework potential

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: Transaction count							
$TE^{(\mathcal{H})}$	4.10	2.36	2.36	2.36*			
	(3.47)	(1.51)	(1.51)	(1.29)			
$TE^{(\mathcal{W})}$	19.3***	-3.97**	-3.97**	-4.17**			
	(3.06)	(1.90)	(1.90)	(2.11)			
$WFH^{(\mathcal{H})}$					3.92	3.96*	1.15***
					(2.55)	(2.12)	(0.226)
$WFH^{(\mathcal{W})}$					-6.35**	-6.95**	-1.74***
					(2.72)	(3.37)	(0.383)
Fixed-effects							
Date			✓		✓		
Date-zone type				✓		✓	✓
Municip							✓
Fit statistics							
Observations	10,680	10,680	10,680	10,680	10,680	10,680	10,640
Panel B: Transaction value							
$TE^{(\mathcal{H})}$	2.47	1.35	1.35	2.95*			
	(3.39)	(1.71)	(1.71)	(1.61)			
$TE^{(\mathcal{W})}$	18.6***	-4.80**	-4.80**	-5.24**			
	(2.94)	(2.30)	(2.30)	(2.50)			
$WFH^{(\mathcal{H})}$					1.98	4.84*	1.06***
					(2.85)	(2.63)	(0.269)
$WFH^{(\mathcal{W})}$					-6.85**	-8.53**	-1.36***
					(3.20)	(3.97)	(0.391)
Fixed-effects							
Date			✓		✓		
Date-zone type				✓		✓	✓
Municip							✓
Fit statistics							
Observations	10,680	10,680	10,680	10,680	10,680	10,680	10,640

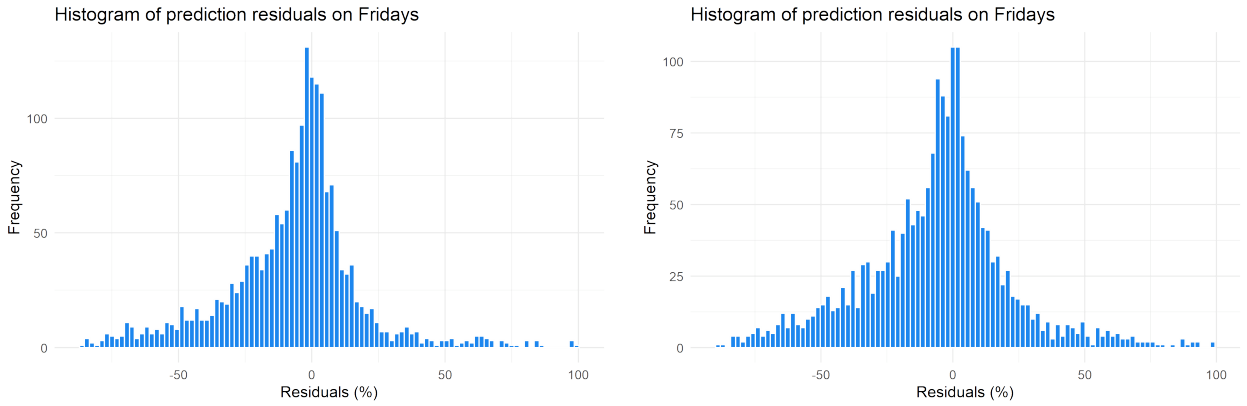
Note: Signif. codes: ***: 0.01, **: 0.05, *: 0.1. Clustered standard-errors at the municipality level in parentheses.

4 Online Appendix D: Supplementary Figures on the Net Economic Impact of Telework

This section provides supplementary day-by-day counterfactual figures and bootstrap distribution plots, complementing the bootstrap methodology and headline tables (aggregated effects with confidence intervals, substitution rates with confidence intervals, and municipality-level significance counts) retained in the main appendix.

4.1 Day-Specific Counterfactual Effects

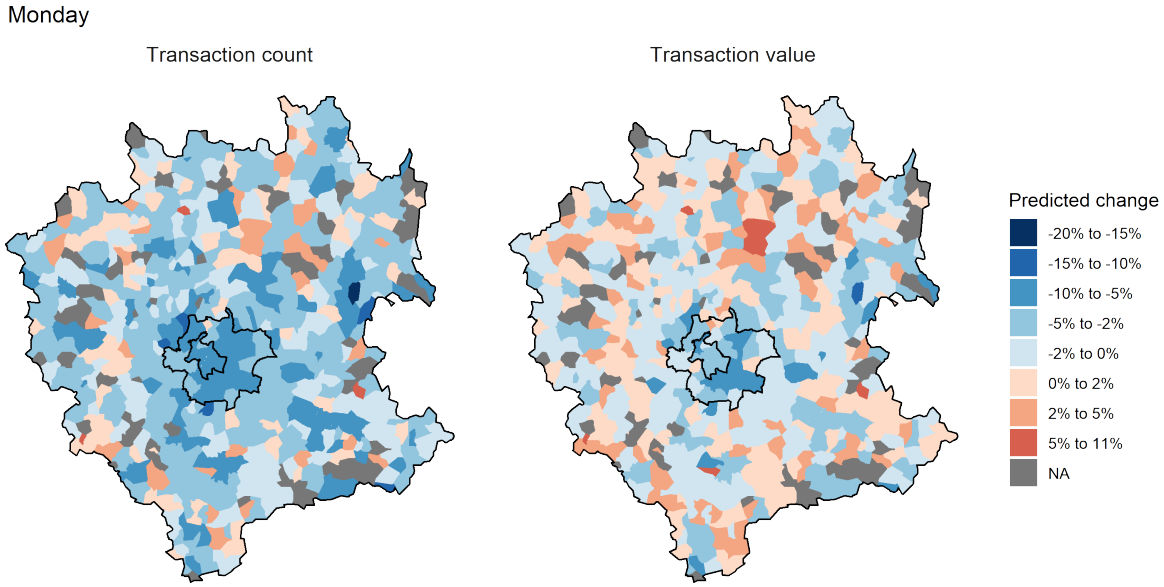
The figures below present the average daily effect of telework on transaction counts and values for each weekday separately, complementing the pooled results in Table 3 of the main paper. The patterns correspond to documented variations in telework intensity across the workweek, with Friday typically showing the most pronounced effects due to higher telework adoption rates at the end of the workweek.



(a) Transaction count model (b) Transaction value model

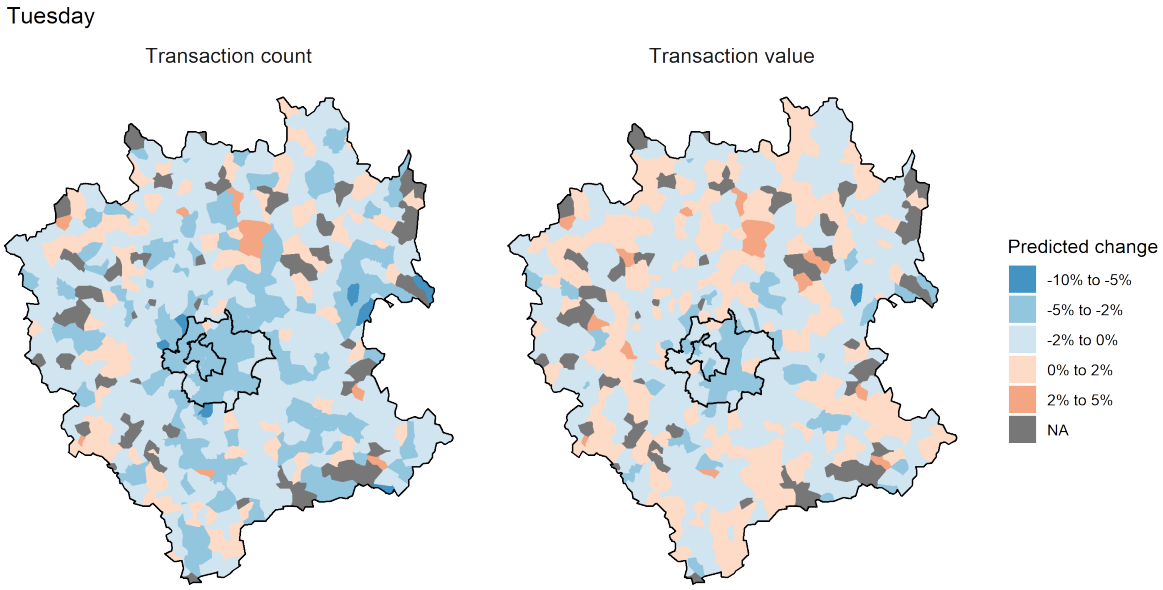
Note: This figure presents the distribution of the prediction error in percentage for the Poisson Maximum Likelihood specifications, with the full set of controls and fixed effects for municipality and date-by-zone type.

Figure OA.7: Residuals distribution on Fridays



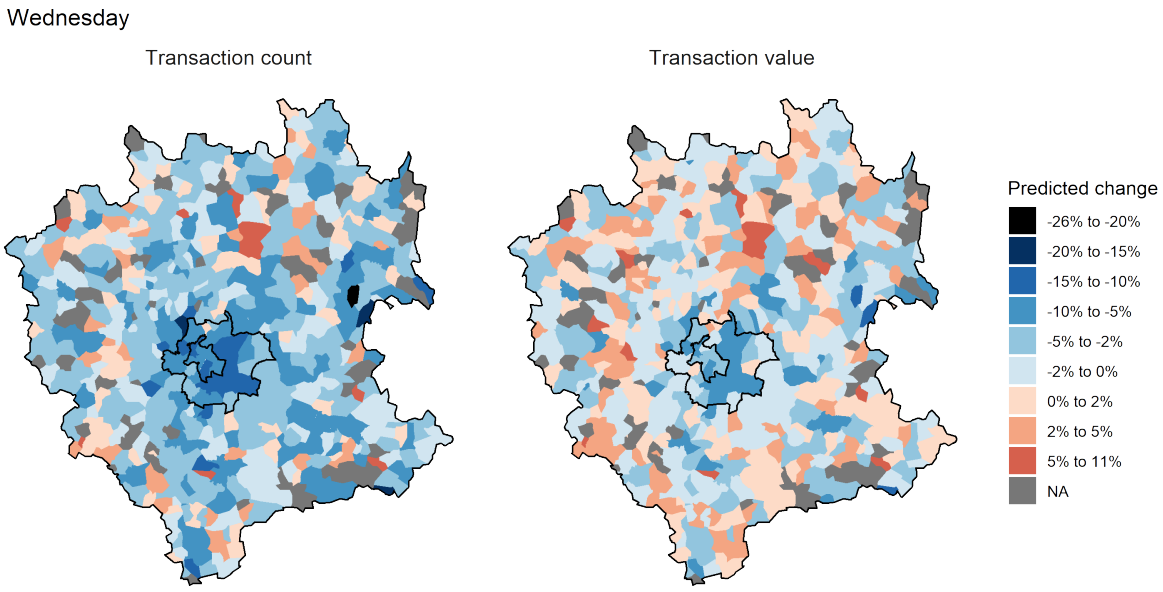
Note: Average effect of telework on Mondays, measured as $(\hat{y}_i - \hat{y}_i^0)/\hat{y}_i^0$, where $\hat{y}_i$ denotes model-predicted values averaged over Mondays, and $\hat{y}_i^0$ denotes counterfactual predicted values under a zero-telework scenario, also averaged over Mondays.

Figure OA.8: Average effect of telework on Monday



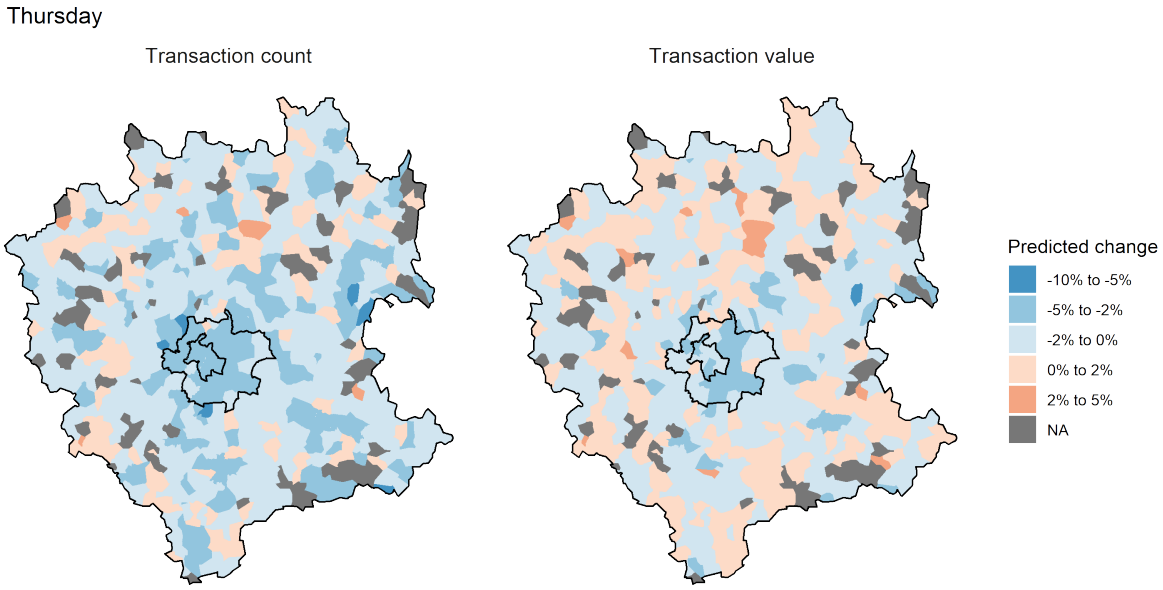
Note: Average effect of telework on Tuesdays, computed analogously to Figure OA.8.

Figure OA.9: Average effect of telework on Tuesday



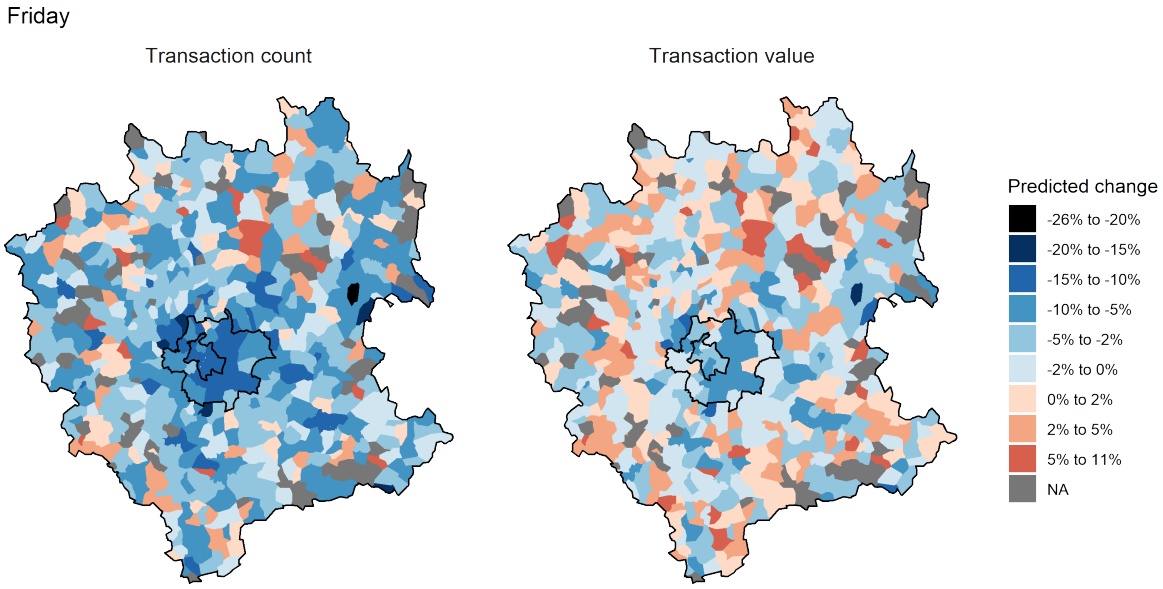
Note: Average effect of telework on Wednesdays, computed analogously to Figure OA.8.

Figure OA.10: Average effect of telework on Wednesday



Note: Average effect of telework on Thursdays, computed analogously to Figure OA.8.

Figure OA.11: Average effect of telework on Thursday



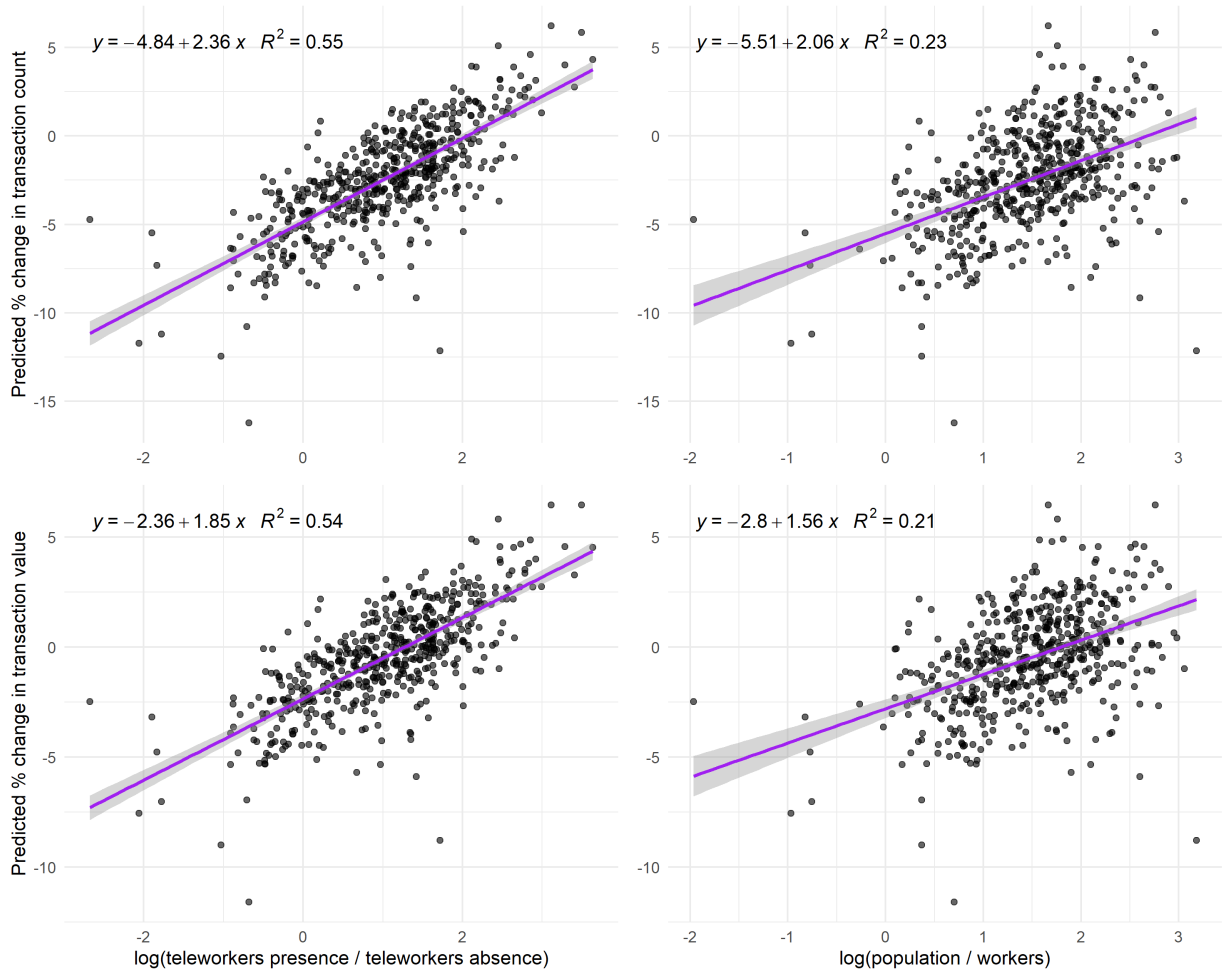
Note: Average effect of telework on Fridays, computed analogously to Figure OA.8.

Figure OA.12: Average effect of telework on Friday

4.2 Winners and Losers: Correlates and Spatial Distribution

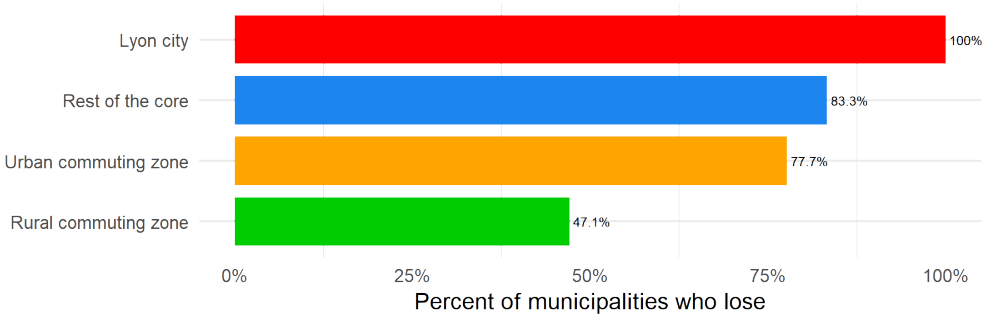
Figure OA.13 examines how predicted consumption changes relate to municipalities' demographic characteristics, and Figure OA.14 shows the spatial distribution of economic winners and losers

across zone groups.



Note: Relationship between the predicted percentage change in transactions and two municipal characteristics: (i) the ratio of resident teleworkers to employed teleworkers, and (ii) the ratio of total population to employed workers. Municipalities with a higher ratio of resident teleworkers relative to employed teleworkers tend to experience larger predicted increases—or smaller declines—in transaction counts and values, consistent with the model's results.

Figure OA.13: Predicted transaction change in relation to municipalities' demographics



Note: Percentage of municipalities within each zone group of the Lyon FUA predicted to experience a decline in transaction values from telework.

Figure OA.14: Percent of municipalities who lose, per zone group within the FUA

4.3 Distribution of Bootstrap Estimates: Descriptive Statistics

Table OA.12 reports descriptive statistics of the bootstrapped consumption substitution rates and net telework effects across all 500 iterations (see main appendix for the full bootstrap procedure and the headline tables reporting means and 90% confidence intervals). No outliers are observed.

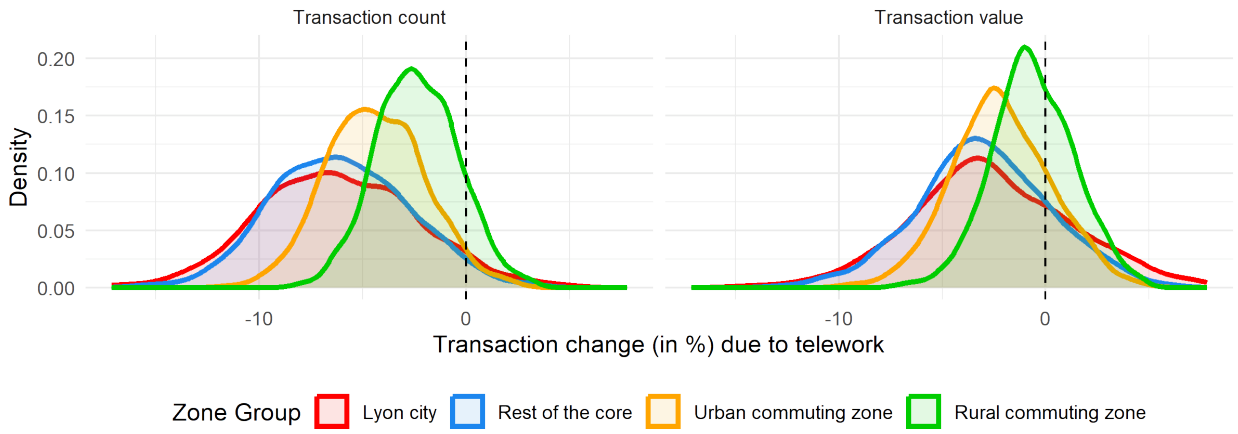
Table OA.12: Descriptive statistics of estimates over all iterations

Variable	Min.	1st Qu.	Median	Mean	3rd Qu.	Max.	N
Panel A: Transaction frequency							
CSR in pp	0.18	0.50	0.59	0.61	0.70	1.33	500
CSR in units	0.20	0.52	0.62	0.64	0.72	1.38	500
Δ_i%	-27.46	-4.26	-1.91	-2.13	0.29	11.93	168,149
Δ_g%	-17.15	-6.86	-4.41	-4.75	-2.46	5.01	2,000
Δ%	-14.43	-7.37	-5.33	-5.23	-3.13	3.46	500
Panel B: Transaction value							
CSR in pp	0.21	0.62	0.74	0.78	0.90	2.23	500
CSR in units	0.23	0.64	0.77	0.82	0.93	2.14	500
Δ_i%	-23.44	-2.21	-0.13	-0.29	1.85	15.07	168,149
Δ_g%	-14.83	-3.97	-2.02	-2.09	-0.07	7.81	2,000
Δ%	-11.92	-4.28	-2.52	-2.37	-0.34	5.46	500

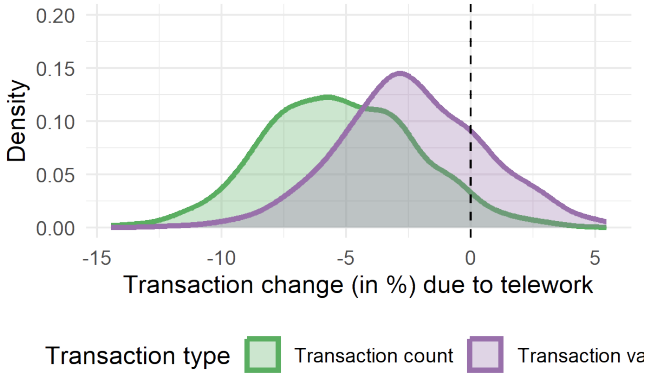
Note: The table reports the bootstrap distribution (500 iterations) of the estimated consumption substitution rates—expressed in percentage points of workers and in teleworker levels—together with the estimated net telework effect (in percent) at the municipality, municipality-group, and Lyon FUA levels.

4.4 Bootstrap Distribution Figures

Figure OA.15 displays the bootstrap distributions of the aggregated net effect estimates reported in the main appendix's Table on aggregated effects, and Figure OA.16 displays the bootstrap distributions of the substitution rate estimates reported in the main appendix's substitution rate table.



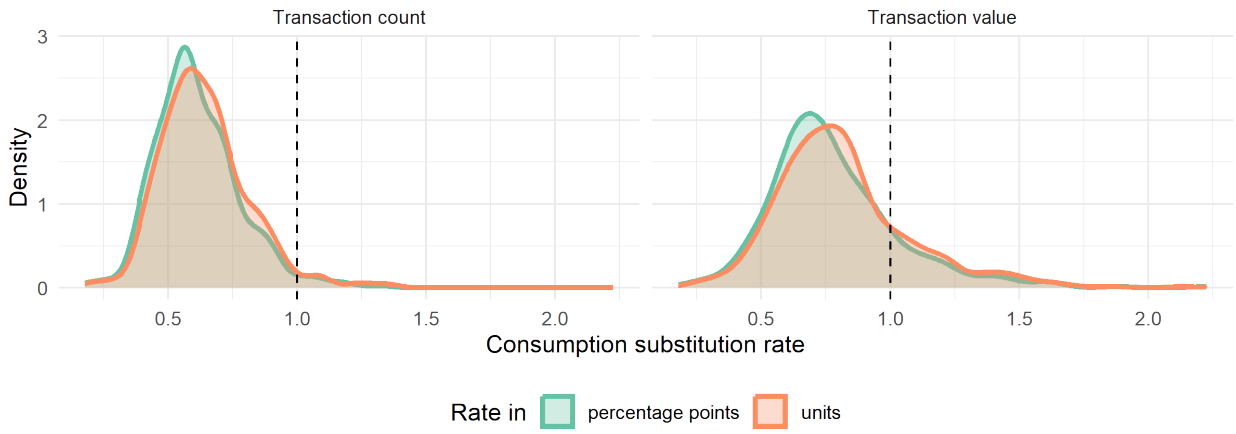
(a) By municipalities' group



(b) Over the Lyon FUA

Note: Bootstrap distribution (500 iterations) of the estimated net telework effects (in percent) on transaction frequency and value within each municipality-group (top) and for the Lyon FUA as a whole (bottom).

Figure OA.15: Bootstrap distribution of the average daily aggregated effect of telework



Note: Bootstrap distributions of work-to-home consumption substitution rates (transaction count and value), expressed both in percentage points of workers and in teleworker levels, computed over 500 iterations.

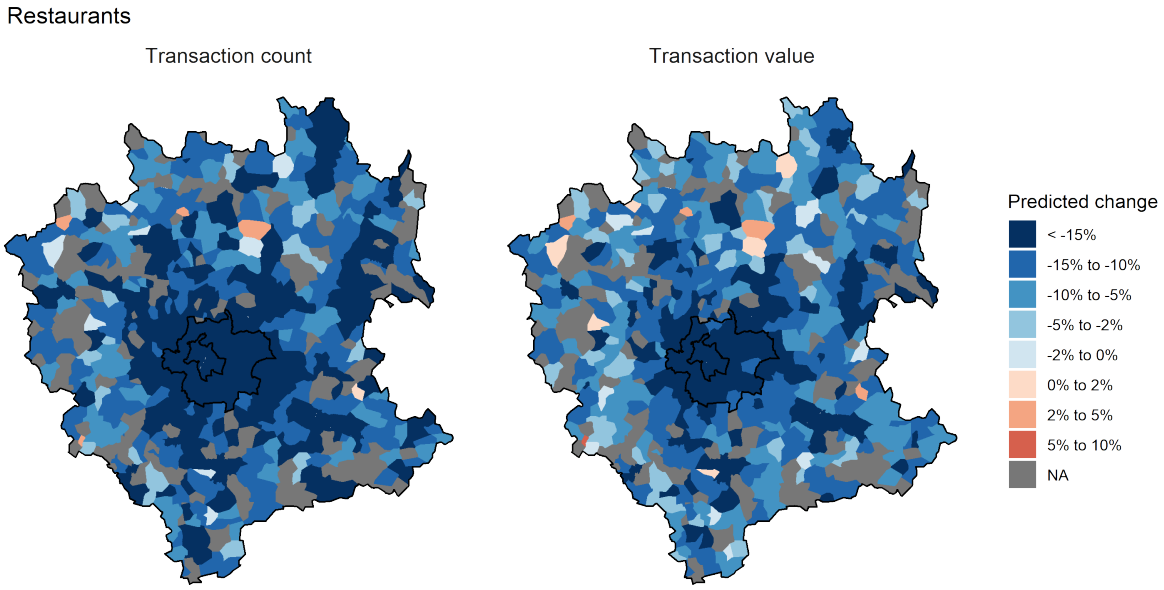
Figure OA.16: Bootstrap distribution of the average municipalities' consumption substitution rate

5 Online Appendix E: Sectoral Heterogeneity in Telework Effects

This section extends the sectoral analysis of Section 4.3 in the main paper, examining how the economic impacts of telework vary across different economic sectors.

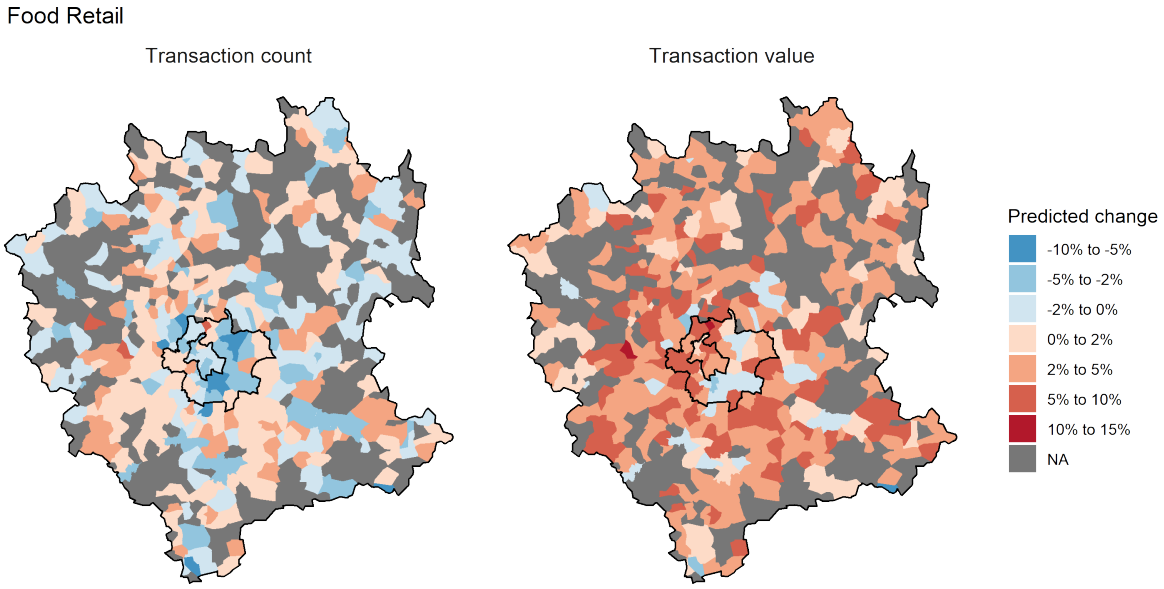
5.1 Net Effects of Telework by Sector

Figures OA.17 through OA.20 present the estimated effects of telework on transaction counts and values for four key sectors.



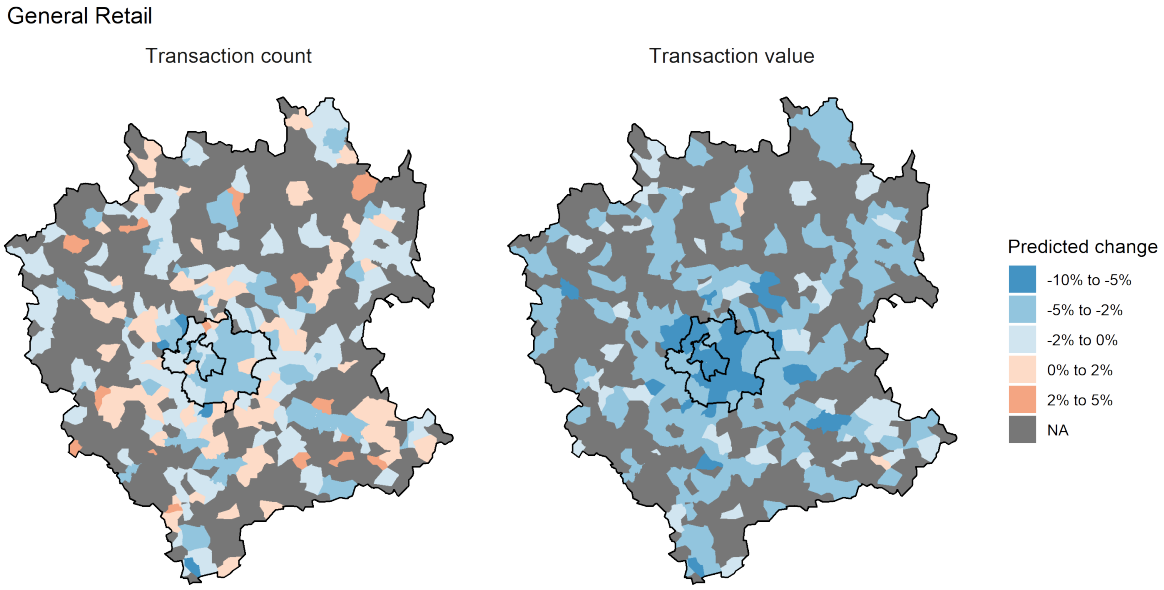
Note: Effect of telework on transaction counts and values in the Restaurants sector, computed as the weekly average of the ratio between model-predicted values and counterfactual predicted values under a zero-telework scenario, averaged over weekdays. Predictions from a model including municipality fixed effects, date-by-zone-type fixed effects, and the full set of controls.

Figure OA.17: Effect of telework in Restaurants



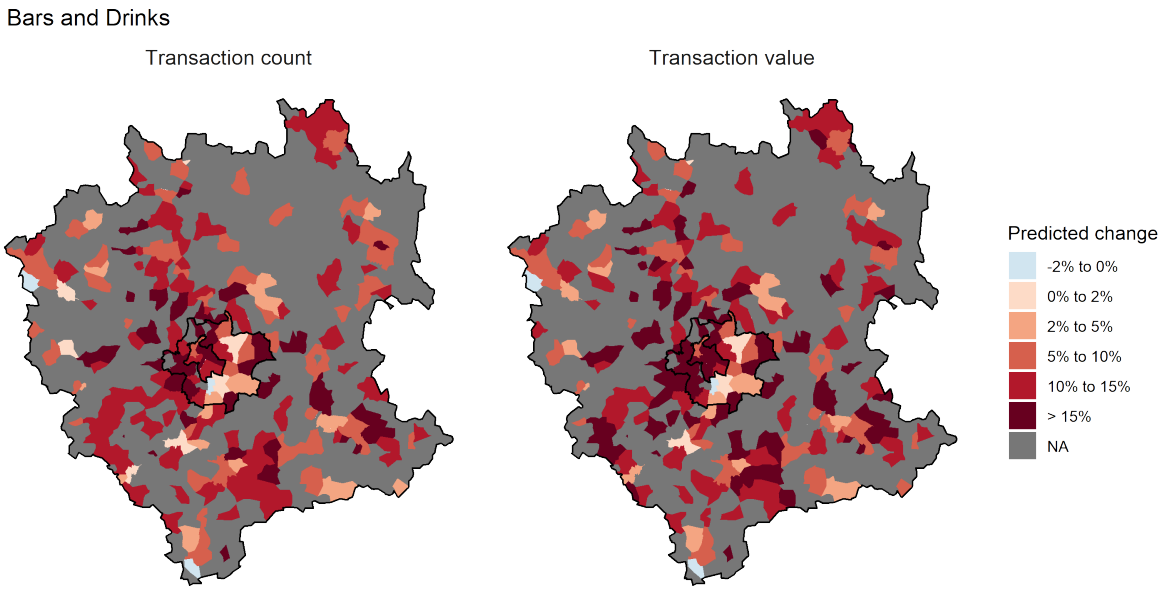
Note: Effect of telework on transaction counts and values in the Food Retail sector, computed analogously to Figure OA.17.

Figure OA.18: Effect of telework in Food Retail



Note: Effect of telework on transaction counts and values in the General Retail sector, computed analogously to Figure OA.17.

Figure OA.19: Effect of telework in General Retail



Note: Effect of telework on transaction counts and values in the Bars and Drinks sector, computed analogously to Figure OA.17.

Figure OA.20: Effect of telework in Bars and Drinks

5.2 Significance of the Aggregated Sectoral Results

Table OA.13 reports descriptive statistics of the bootstrap distribution (500 iterations) of consumption substitution rates and net telework effects, by sector.[1]

[1] To limit the influence of outliers arising from nonlinear transformations of estimated coefficients, we winsorize the bootstrap distributions within each municipality.

Table OA.13: Descriptive statistics of estimates over all iterations, by sector

Variable	Min.	1st Qu.	Median	Mean	3rd Qu.	Max.	N
Panel A: Transaction frequency							
Panel A1: Restaurants							
CSR in pp	0.00	0.20	0.27	0.27	0.33	0.72	500
CSR in units	0.00	0.22	0.29	0.29	0.35	0.75	500
Δ_i%	-54.46	-19.16	-13.94	-14.44	-9.18	17.45	145,367
Δ_g%	-46.11	-26.98	-21.32	-21.65	-15.97	-0.96	2,000
Δ%	-41.80	-28.37	-24.44	-24.42	-20.78	-6.14	500
Panel A2: Food Retail							
CSR in pp	0.37	0.75	0.86	0.95	1.06	3.82	500
CSR in unit	0.36	0.81	0.95	1.05	1.15	4.66	500
Δ_i%	-16.56	-1.26	0.92	0.79	3.03	18.18	113,070
Δ_g%	-13.86	-2.54	-0.50	-0.42	1.71	14.30	2,000
Δ%	-10.64	-2.91	-1.02	-0.66	1.66	10.62	500
Panel A3: Bars and Drinks							
CSR in pp	0.02	0.98	1.41	3.68	2.28	487.66	500
CSR in units	0.02	1.08	1.55	4.07	2.51	516.67	500
Δ_i%	-46.39	3.63	11.09	12.32	19.60	128.34	68,641
Δ_g%	-42.23	3.37	12.09	13.64	21.66	105.43	2,000
Δ%	-35.37	3.22	14.14	15.49	25.38	87.93	500
Panel A4: General Retail							
CSR in pp	0.02	0.54	0.77	1.88	1.06	482.04	500
CSR in units	0.02	0.61	0.88	2.12	1.19	540.14	500
Δ_i%	-21.95	-3.31	-0.53	-0.63	1.99	31.89	83,755
Δ_g%	-18.72	-4.67	-1.43	-1.70	1.15	19.67	2,000
Δ%	-15.11	-5.17	-1.75	-2.02	0.98	14.54	500
Panel B: Transaction value							
Panel B1: Restaurants							
CSR in pp	0.00	0.25	0.34	0.34	0.42	0.94	500
CSR in units	0.00	0.27	0.36	0.36	0.44	0.99	500
Δ_i%	-56.36	-16.45	-11.37	-11.84	-6.76	23.04	145,367
Δ_g%	-46.44	-23.29	-17.67	-18.19	-12.61	4.56	2,000
Δ%	-40.40	-24.52	-20.45	-20.34	-16.19	0.43	500
Panel B2: Food Retail							
CSR in pp	0.41	0.92	1.23	2.03	1.88	53.60	500
CSR in units	0.40	1.01	1.33	2.23	2.06	54.91	500
Δ_i%	-19.92	1.20	4.47	4.56	7.77	53.43	113,070
Δ_g%	-14.49	0.34	3.78	4.30	7.90	44.31	2,000
Δ%	-10.57	-0.12	3.57	3.96	7.92	30.11	500
Panel B3: Bars and Drinks							
CSR in pp	0.10	1.03	1.44	10.78	2.40	3264.67	500
CSR in units	0.12	1.15	1.62	13.10	2.60	4187.47	500
Δ_i%	-38.90	4.72	12.64	14.13	21.87	134.45	68,641
Δ_g%	-28.68	4.90	13.84	15.85	24.60	106.17	2,000
Δ%	-22.25	4.89	15.44	17.44	28.39	79.29	500
Panel B4: General Retail							
CSR in pp	0.00	0.29	0.53	0.98	0.85	34.14	500
CSR in units	0.00	0.33	0.60	1.10	0.98	38.24	500
Δ_i%	-27.33	-6.04	-3.19	-3.30	-0.46	24.81	83,755
Δ_g%	-24.29	-7.86	-4.43	-4.64	-1.39	17.51	2,000
Δ%	-18.69	-8.03	-4.89	-4.89	-1.79	11.53	500

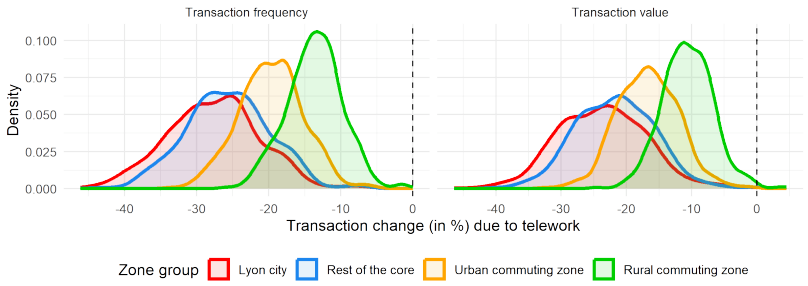
Note: For sectors experiencing statistically significant telework-induced demand shocks, the table reports the bootstrap distribution (500 iterations) of the estimated consumption substitution rates and net telework effect (in percent) at the municipality, municipality-group, and Lyon FUA levels.

Table OA.14 shows that the only sector experiencing an aggregate telework effect significantly different from zero is Restaurants (net decline of 24% in transaction frequency, 20% in sales), with effects significant across all municipality groups and increasing with centrality.

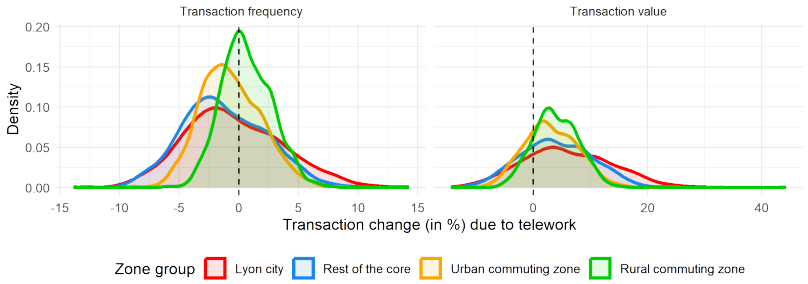
Table OA.14: Bootstrap aggregated effects of telework by sector (% change in transactions)

	Mean	90% CI
Panel A: Transaction frequency		
Panel A1: Restaurants		
Lyon city	-27.631	[-38.125; -17.348]
Rest of the core	-25.637	[-35.040; -16.345]
Urban commuting zone	-19.677	[-27.048; -12.438]
Rural commuting zone	-13.638	[-20.289; -7.452]
All FUA	-24.417	[-33.999; -15.388]
Panel A2: Food Retail		
Lyon city	-0.437	[-6.897; 6.570]
Rest of the core	-1.224	[-6.718; 4.755]
Urban commuting zone	-0.673	[-4.578; 3.676]
Rural commuting zone	0.653	[-2.634; 4.372]
All FUA	-0.661	[-5.652; 4.789]
Panel A3: Bars and Drinks		
Lyon city	19.093	[-12.309; 60.055]
Rest of the core	13.374	[-12.731; 44.895]
Urban commuting zone	9.337	[-8.343; 30.612]
Rural commuting zone	12.757	[-2.944; 31.06]
All FUA	15.494	[-10.033; 47.403]
Panel A4: General Retail		
Lyon city	-1.692	[-11.799; 8.875]
Rest of the core	-2.829	[-11.293; 5.568]
Urban commuting zone	-1.952	[-8.315; 4.547]
Rural commuting zone	-0.343	[-5.511; 5.062]
All FUA	-2.021	[-9.602; 5.918]
Panel B: Transaction value		
Panel B1: Restaurants		
Lyon city	-23.693	[-33.98; -12.894]
Rest of the core	-21.735	[-30.952; -12.435]
Urban commuting zone	-16.715	[-23.744; -9.424]
Rural commuting zone	-10.598	[-16.88; -4.296]
All FUA	-20.340	[-29.168; -11.237]
Panel B2: Food Retail		
Lyon city	5.967	[-6.221; 18.720]
Rest of the core	4.084	[-5.876; 14.418]
Urban commuting zone	3.160	[-4.117; 10.765]
Rural commuting zone	3.971	[-2.304; 10.481]
All FUA	3.961	[-4.836; 12.770]
Panel B3: Bars and Drinks		
Lyon city	22.226	[-11.774; 63.770]
Rest of the core	15.510	[-11.227; 47.891]
Urban commuting zone	11.233	[-7.853; 32.723]
Rural commuting zone	14.428	[-2.149; 33.897]
All FUA	17.438	[-9.192; 49.384]
Panel B4: General Retail		
Lyon city	-5.862	[-16.442; 4.358]
Rest of the core	-5.700	[-13.977; 2.814]
Urban commuting zone	-4.249	[-10.486; 2.170]
Rural commuting zone	-2.746	[-8.686; 2.523]
All FUA	-4.895	[-12.628; 2.845]

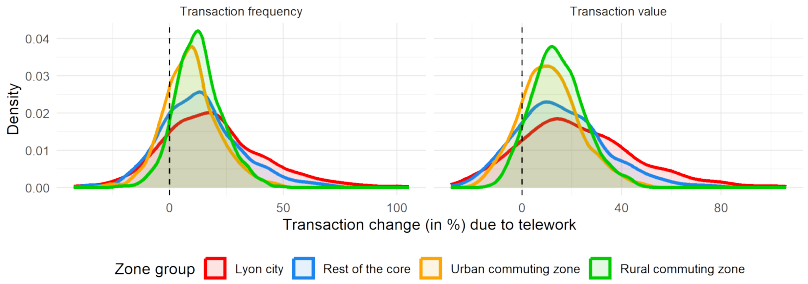
Note: For sectors experiencing statistically significant telework-induced demand shocks, the table reports the bootstrap aggregated average effect of telework on transaction frequency and value, by municipality group and for the entire Lyon FUA, with 90% confidence intervals.



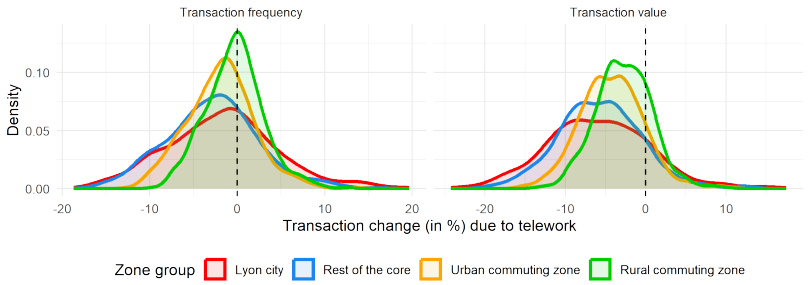
(a) Restaurants



(b) Food Retail



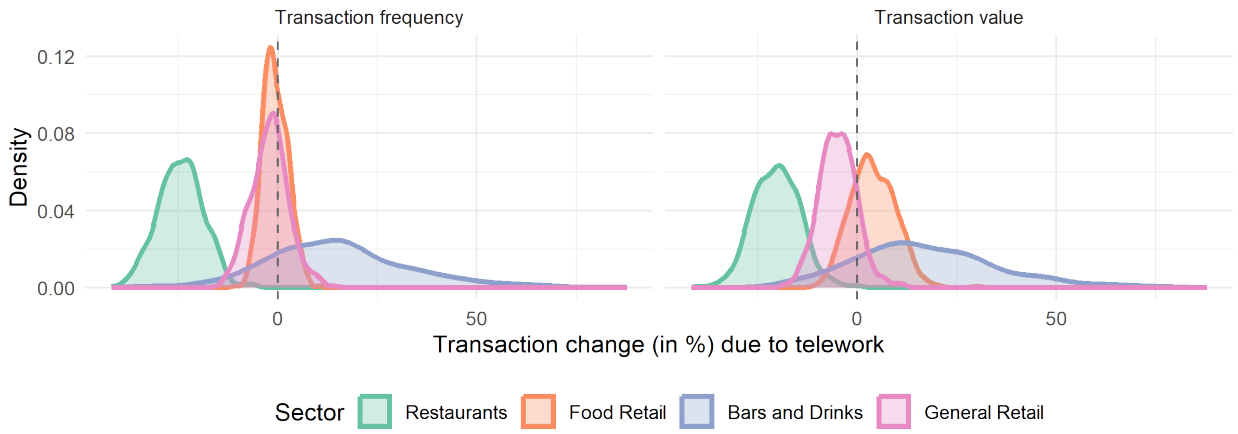
(c) Bars and Drinks



(d) General Retail

Note: Bootstrap distribution (500 iterations) of the estimated net telework effects (in percent) on transaction frequency and value within each municipality-group, by sector.

Figure OA.21: Bootstrap distribution of the average daily aggregated effect of telework, by municipalities' group and sector



Note: Bootstrap distribution (500 iterations) of the estimated net telework effects (in percent) on transaction frequency and value over the entire Lyon FUA, by sector.

Figure OA.22: Bootstrap distribution of the average daily aggregated effect of telework, by sector

Table OA.15 shows that only the Restaurant sector exhibits a municipal consumption substitution rate significantly below unity: for one additional worker teleworking at home, only 36.4% (90% CI: [11.8%; 62.0%]) of restaurant spending is preserved relative to the presence of a worker at the workplace.

Table OA.15: Consumption substitution rates by sector

	Mean	90% CI
Panel A: Transaction frequency		
Panel A1: Restaurants		
percentage points	0.268	[0.084; 0.441]
units	0.287	[0.093; 0.470]
Panel A2: Food Retail		
percentage points	0.953	[0.605; 1.560]
units	1.046	[0.654; 1.736]
Panel A3: Bars and Drinks		
percentage points	3.685	[0.538; 7.188]
units	4.066	[0.616; 8.437]
Panel A4: General Retail		
percentage points	1.875	[0.173; 2.182]
units	2.115	[0.200; 2.451]
Panel B: Transaction value		
Panel B1: Restaurants		
percentage points	0.340	[0.107; 0.575]
units	0.364	[0.118; 0.620]
Panel B2: Food Retail		
percentage points	2.032	[0.67; 5.237]
units	2.233	[0.721; 5.994]
Panel B3: Bars and Drinks		
percentage points	10.778	[0.632; 10.862]
units	13.097	[0.717; 11.898]
Panel B4: General Retail		
percentage points	0.977	[0.046; 2.825]
units	1.103	[0.053; 3.326]

Note: For sectors experiencing statistically significant telework-induced demand shocks, the table reports the bootstrap average work-to-home consumption substitution rates, computed over 500 iterations, with 90% confidence intervals.

Tables OA.16 and OA.17 document the spatial heterogeneity in the sectoral impact of telework at the municipality level, and Figure OA.23 maps statistically significant effects.

Table OA.16: Distribution of municipalities' average telework effect by sector (All vs Significant)

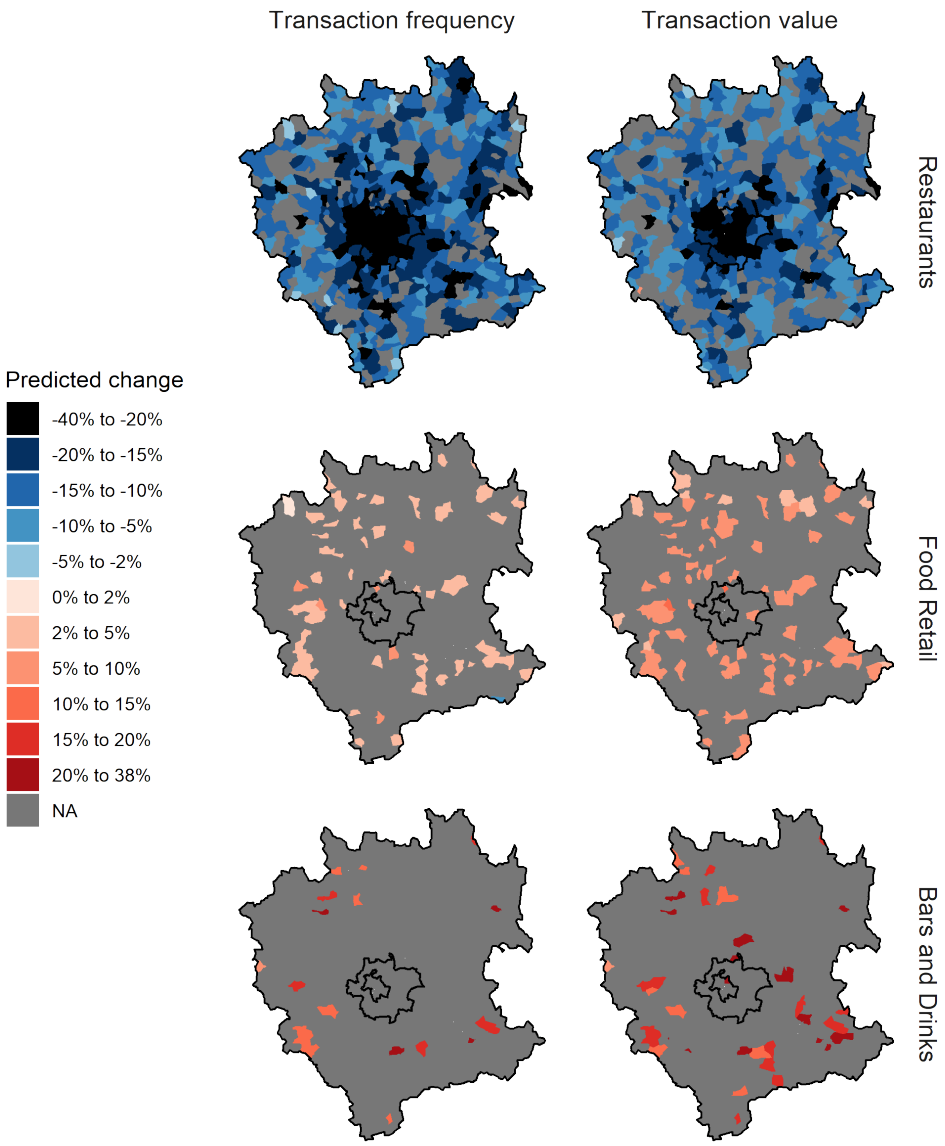
Sample	Min	Q1	Median	Q3	Max	N
Panel A: Transaction frequency						
Panel A1: Restaurants						
All	-39.854	-18.266	-14.431	-10.403	4.904	460
Significant negative	-39.854	-18.478	-14.846	-11.182	-3.405	431
Panel A2: Food Retail						
All	-7.935	-0.673	1.007	2.238	7.199	357
Significant positive	1.859	3.256	3.814	4.307	7.199	57
Significant negative	-7.935	-7.935	-7.935	-7.935	-7.935	1
Panel A3: Bars and Drinks						
All	0.388	8.497	12.531	15.321	32.730	217
Significant positive	8.545	13.443	15.321	20.000	23.017	17
Panel A4: General Retail						
All	-5.769	-1.682	-0.413	0.473	4.500	265
Panel B: Transaction value						
Panel A1: Restaurants						
All	-36.702	-15.493	-11.780	-8.020	7.146	460
Significant positive	7.146	7.146	7.146	7.146	7.146	1
Significant negative	-36.702	-16.464	-12.995	-10.017	-4.614	383
Panel A2: Food Retail						
All	-4.683	2.788	4.831	6.417	13.787	357
Significant positive	3.239	5.710	6.918	7.936	13.787	85
Panel A3: Bars and Drinks						
All	0.778	9.764	14.489	17.469	37.085	217
Significant positive	9.488	15.124	17.677	22.013	37.085	38
Panel A4: General Retail						
All	-7.931	-4.197	-3.081	-2.352	0.993	265
Significant negative	-5.031	-5.031	-5.031	-5.031	-5.031	1

Note: The table reports the bootstrap distribution of average telework effects across municipalities by sector. "Significant positive/negative" indicate the subset of municipalities where the effect is statistically significant at the 10% level.

Table OA.17: Distribution of municipalities with significant average telework effect, by sector

	Transaction frequency			Transaction value		
		Significant			Significant	
	All	> 0	< 0	All	> 0	< 0
Panel A: Restaurants						
Lyon city	9 (100%)	0	9 (100%)	9 (100%)	0	9 (100%)
Rest of the core	30 (100%)	0	30 (100%)	29 (96.7%)	0	29 (96.7%)
Urban commuting zone	143 (99.3%)	0	143 (99.3%)	138 (95.8%)	0	138 (95.8%)
Rural commuting zone	249 (89.9%)	0	249 (89.9%)	208 (75.1%)	1 (0.4%)	207 (74.7%)
Panel B: Food Retail						
Lyon city	0	0	0	0	0	0
Rest of the core	1 (3.3%)	1 (3.3%)	0	2 (6.7%)	2 (6.7%)	0
Urban commuting zone	9 (6.5%)	9 (6.5%)	0	18 (12.9%)	18 (12.9%)	0
Rural commuting zone	48 (26.8%)	47 (26.3%)	1 (0.6%)	65 (36.3%)	65 (36.3%)	0
Panel C: Bars and Drinks						
Lyon city	0	0	0	1 (11.1%)	1 (11.1%)	0
Rest of the core	0	0	0	0	0	0
Urban commuting zone	2 (2.2%)	2 (2.2%)	0	6 (6.5%)	6 (6.5%)	0
Rural commuting zone	15 (16.3%)	15 (16.3%)	0	31 (33.7%)	31 (33.7%)	0

Note: Number of municipalities exhibiting a statistically significant average telework effect by zone group and sector (10% level). Panel A: Restaurants, Panel B: Food Retail, Panel C: Bars and Drinks. Percentages relative to the total number of municipalities within each zone group.



Note: Municipalities with statistically significant average telework effects on transaction frequency (left) and transaction value (right), by sector (Restaurants, Food Retail, Bars & Drinks). Only municipalities with significant effects at the 10% level are colored. Grey municipalities exhibit non-significant effects.

Figure OA.23: Statistically significant telework effect on transaction frequency and value by sector

6 Online Appendix F: Spatial Spillover Model — Heterogeneity and Aggregate Impact

This section complements the spatial spillover analysis of Section 5.1 in the main paper (Result 7) with zone-group heterogeneity and the aggregate net impact once spillovers are accounted for.

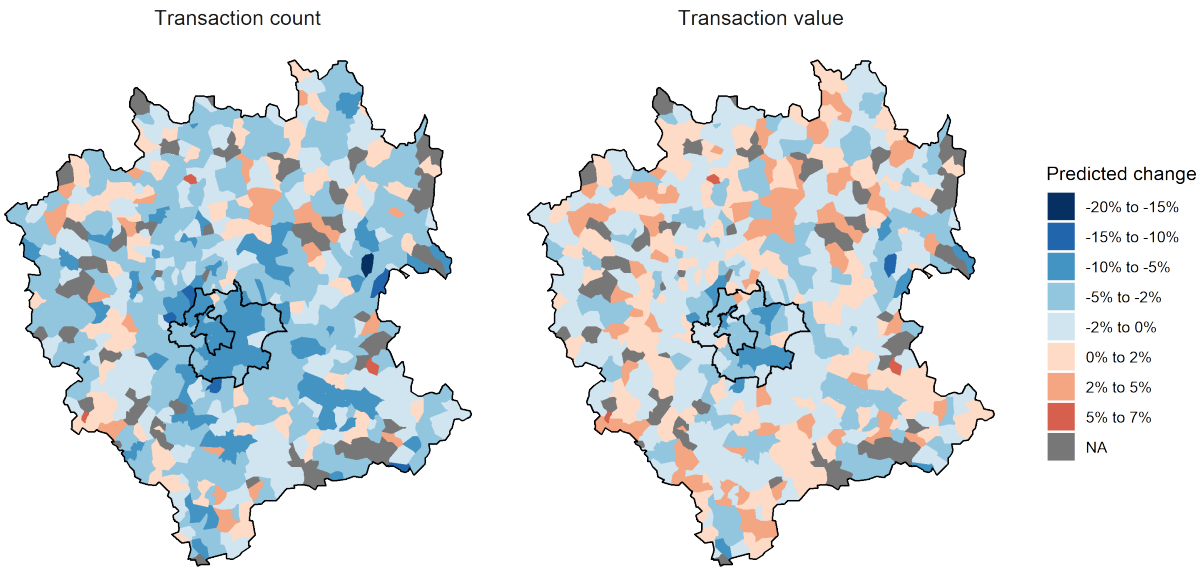
Table OA.18 extends the baseline spillover model by interacting telework indicators with zone-group dummies. The direct positive effects of residential telepresence are statistically significant only in Lyon city and the rest of the urban core, whereas the negative effects of workplace absence are evident across all zones, with the strongest impacts in Lyon. Indirect effects from telepresence in neighboring municipalities are significant only for Lyon city, suggesting higher consumption mobility among its residents.

Table OA.18: Spatial spillovers, heterogeneity by zone group

	Transaction count		Transaction value	
	(1)	(2)	(3)	(4)
$WFH^{(\mathcal{H})}$ × Lyon city	2.35***	2.01***	1.10**	0.876**
	(0.850)	(0.736)	(0.514)	(0.421)
$WFH^{(\mathcal{H})}$ × Rest of the core	1.14***	0.990**	1.24***	1.11***
	(0.431)	(0.414)	(0.419)	(0.387)
$WFH^{(\mathcal{H})}$ × Urban commuting zone	0.585	0.707	-0.248	0.079
	(0.483)	(0.492)	(0.550)	(0.560)
$WFH^{(\mathcal{H})}$ × Rural commuting zone	1.42	1.44	2.16**	2.24**
	(0.906)	(0.886)	(1.01)	(0.974)
$WFH^{(\mathcal{W})}$ × Lyon city	-4.06***	-3.49***	-3.26***	-2.69***
	(1.05)	(0.977)	(0.794)	(0.697)
$WFH^{(\mathcal{W})}$ × Rest of the core	-1.54**	-1.42**	-1.17	-1.03
	(0.629)	(0.614)	(0.758)	(0.727)
$WFH^{(\mathcal{W})}$ × Urban commuting zone	-1.16***	-1.06**	-1.47**	-1.44**
	(0.424)	(0.444)	(0.585)	(0.613)
$WFH^{(\mathcal{W})}$ × Rural commuting zone	-1.50**	-1.51**	-1.21	-1.42*
	(0.754)	(0.749)	(0.788)	(0.777)
$WFH^{(\mathcal{H})}_{\text{neighbors}}$ × Lyon city	2.23**	2.06**	2.44***	2.36***
	(0.980)	(0.879)	(0.534)	(0.424)
$WFH^{(\mathcal{H})}_{\text{neighbors}}$ × Rest of the core	0.911	0.769	1.82	1.48
	(1.08)	(1.01)	(1.38)	(1.24)
$WFH^{(\mathcal{H})}_{\text{neighbors}}$ × Urban commuting zone	0.375	0.044	1.27	0.899
	(0.768)	(0.724)	(0.835)	(0.759)
$WFH^{(\mathcal{H})}_{\text{neighbors}}$ × Rural commuting zone	1.09	0.948	-0.505	-0.576
	(1.50)	(1.44)	(1.67)	(1.60)
$WFH^{(\mathcal{W})}_{\text{neighbors}}$ × Lyon city	-4.93**	-4.35**	-5.01***	-4.67***
	(2.34)	(2.21)	(1.40)	(1.12)
$WFH^{(\mathcal{W})}_{\text{neighbors}}$ × Rest of the core	-1.47**	-1.63**	-2.12**	-2.22**
	(0.708)	(0.756)	(0.967)	(1.03)
$WFH^{(\mathcal{W})}_{\text{neighbors}}$ × Urban commuting zone	-0.259	-0.471	0.168	0.230
	(0.631)	(0.581)	(0.924)	(0.849)
$WFH^{(\mathcal{W})}_{\text{neighbors}}$ × Rural commuting zone	-1.73	-1.64	-0.912	-0.624
	(1.59)	(1.52)	(1.66)	(1.61)
Fit statistics				
Observations	10,640	10,640	10,640	10,640

Note: Signif. codes: ***: 0.01, **: 0.05, *: 0.1. Clustered standard-errors at the municipality level in parentheses. All specifications include municipality and date-by-zone type fixed effects, and controls for part-time workers, rain, and public transport disruption.

Figure OA.24 visualizes the average daily effects of telework incorporating spatial spillovers, and Table OA.19 quantifies the net total effects by zone group once spillovers are accounted for—revealing a larger aggregate decline (-6.22% in transaction counts FUA-wide, versus -5.75% in the baseline model without spillovers), consistent with the additional negative spillovers from workplace absence in neighboring municipalities documented in Result 7.



Note: Average daily effect of telework on transaction counts and values, incorporating average telework shares of contiguous municipalities, together with municipality fixed effects, date-by-zone-type fixed effects, and the full set of controls.

Figure OA.24: Average daily effect of telework (spatial spillover model)

Table OA.19: Aggregate Impact of Telework Incorporating Spillovers: Predicted Percentage Change in Transactions by Spatial Zone

		Transaction count			Transaction value		
	N_g	$\sum_g y_{ig}$	Δ_g %	Δ_g	$\sum_g y_{ig}$	Δ_g %	Δ_g €
Lyon city	9	227,074	-8.08	-18,342	6,195,465	-2.38	-147,585
Rest of the core	30	190,564	-7.55	-14,386	6,944,555	-2.55	-177,377
Urban commuting zone	166	254,930	-4.53	-11,538	10,467,588	-0.88	-92,499
Rural commuting zone	327	58,652	-2.05	-1,205	2,331,438	0.87	20,193
All	532	731,220	-6.22	-45,471	25,939,046	-1.53	-397,269

Note: Column 1 reports the number of municipalities in each group. Columns 2/5 give total daily transactions/value. Columns 3/6 present the estimated aggregate percentage change attributable to telework, incorporating spillovers from neighboring municipalities; Columns 4/7 show the corresponding change in levels.

7 Online Appendix G: Alternative Measures of Telework — Fine-Grained Daily Rates

7.1 Model

As an alternative to the municipality-day telework model presented in Section 3.2 of the main paper, we develop a method to estimate the daily telework rate at the finer Iris geographic level, accounting for the daily share of part-time workers on day-off who may remain within their residential area:

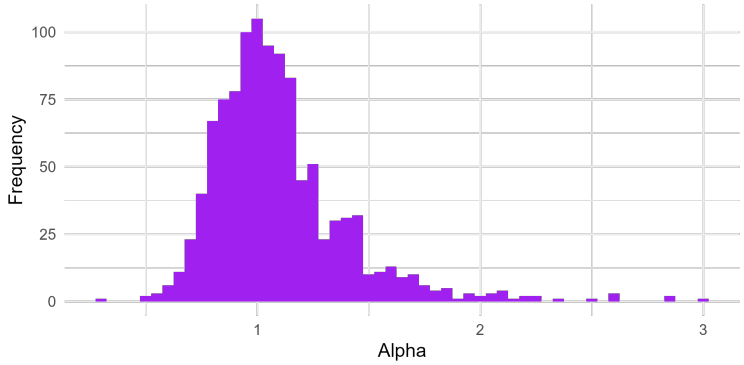
$$\text{Residents}_{it} = \widehat{\alpha}_i \times \text{Inactives}_i + \sum_k \gamma_{gkt} \times \text{Part-time workers}_{ik} + \widehat{\beta_{it}} \times \text{Teleworkers}_i \tag{4}$$

where $\widehat{\alpha}_i$ and $\widehat{\beta}_{it}$ are estimated under two constraints: (1) the share of inactives present at home does not vary daily, and (2) teleworkers work remotely on average 2.4 days per week (Labor Force Survey benchmark). This allows us to compute daily telework shares at home ($\text{WFH}_{it}^{(\mathcal{H})}$) and workplace ($\text{WFH}_{jt}^{(\mathcal{W})}$) levels by combining $\widehat{\beta_{it}}$ with location-and-occupation-based telework potentials and population census data.

7.2 Estimates for α_i and β_{it}

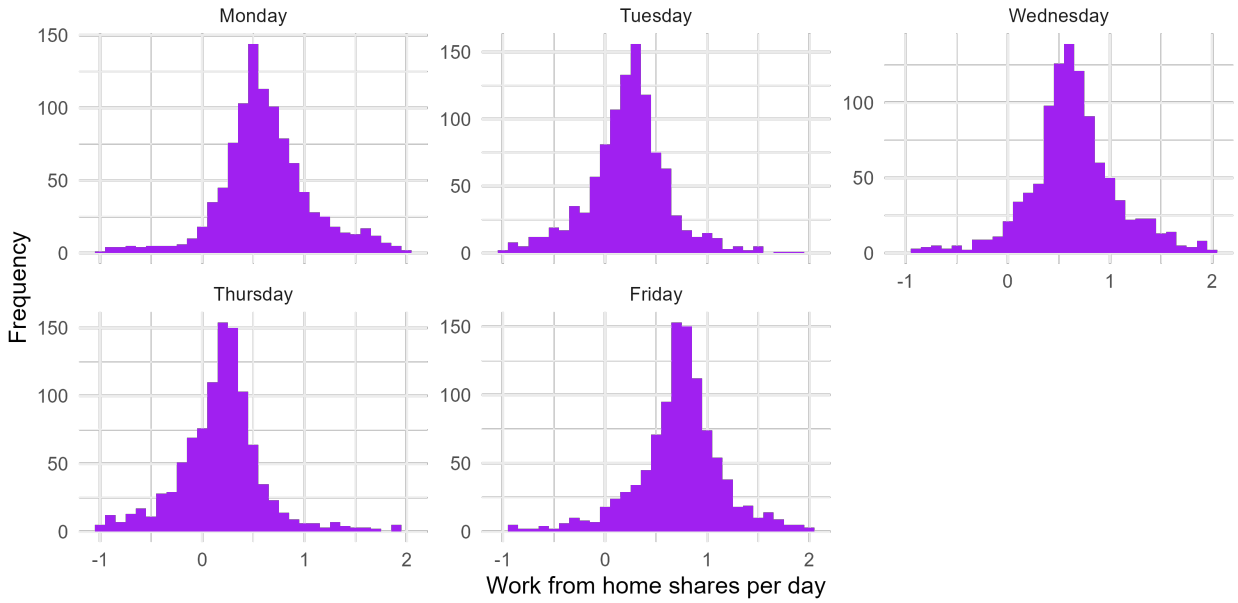
Figure OA.25 shows the distribution of the computed share of inactive people, $\widehat{\alpha_i}$. Figure OA.26 shows the distribution of the raw computed shares of teleworkers working from home each day, $\widehat{\beta_{it}}$; some values fall outside $[0, 1]$, which is a problem for interpretability.

Correction methods. We suggest two correction methods for $\widehat{\beta_{it}}$: (1) a min-max normalization under the constraint that the weekly sum equals 2.4 (Figure OA.27); (2) the same normalization applied only to Iris zones with at least one out-of-bound observation (Figure OA.28). Both methods ensure shares lie within $[0, 1]$ while preserving the relative ranking of coefficients across days; both may introduce non-classical measurement error, which is precisely the concern explored as a robustness check in Online Appendix C.4 (Sensitivity to Measurement Error).



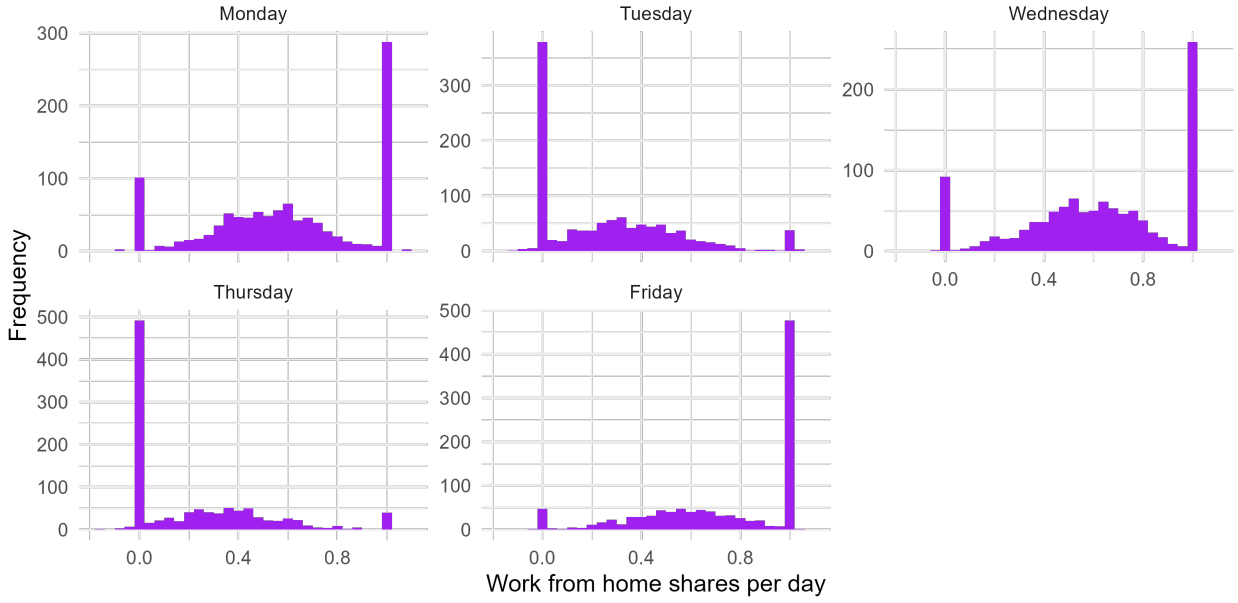
Note: Distribution of the computed share of inactive residents in their residence zone during working hours on weekdays.

Figure OA.25: Alpha



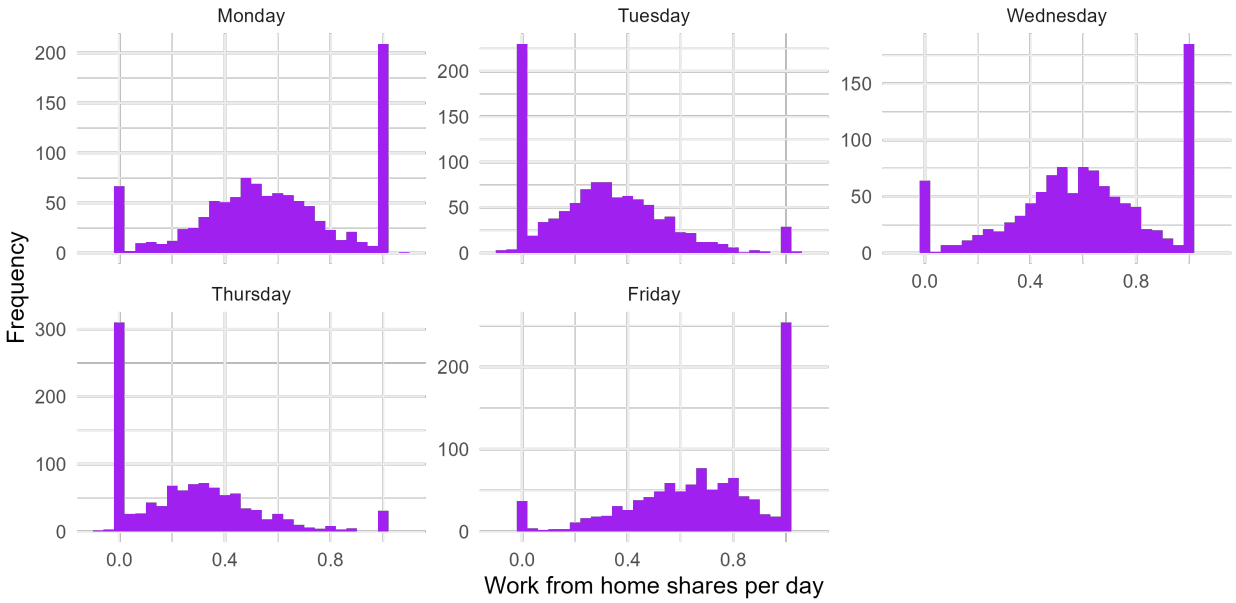
Note: Distribution of the computed share of resident teleworkers in their residence zone (working from home) during working hours, each weekday.

Figure OA.26: Raw Beta



Note: Distribution of the normalized and rescaled share of resident teleworkers, each weekday.

Figure OA.27: Scaled Beta (Method 1)



Note: Distribution of the computed share of resident teleworkers, each weekday. When at least one observation for an Iris zone falls outside $[0, 1]$, all weekday observations for that Iris zone are normalized and rescaled.

Figure OA.28: Scaled Beta (Method 2, selected observations)