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Working From Home and Corporate Real Estate*

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Abstract

We examine how corporate real estate market participants adjust to the take-off of teleworking. We develop an indicator of the exposure of counties to teleworking in France by combining teleworking capacity with incentives and frictions to its deployment. We study how this indicator relates to prices and quantities in the corporate real estate market. We find that for offices in counties more exposed, the Covid-19 crisis has led to (1) higher vacancy rates, (2) less construction, (3) lower prices. Our findings reveal that teleworking has already an impact on the office market. Furthermore, forward-looking indicators suggest that market participants are anticipating the shift to teleworking to be durable.

JEL classification: G11, G14, G23, J60, R33
Keywords: corporate real estate, commercial real estate, teleworking

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1 Introduction

One of the main hysteresis of the COVID-19 pandemic on the organization of work is probably the dramatic take-off of telework. This type of work arrangement was relatively uncommon before 2020. In France, only 3% of the workforce worked from home at least once a week in 2017 (Hallépée and Mauroux, 2019). Forced by circumstances, employers and employees had to implement, often improvisationally, new ways of working remotely to limit physical interactions during the acute stages of the outbreak. This experience has helped to eliminate some prejudices about the feasibility of telework and to establish a more appropriate legal framework, but also to convince companies to invest more in computer equipment and to adapt their management practices. For this reason, teleworking has already become a standard practice for many workers and is likely to stick in the future. For instance, Barrero et al. (2021) estimate that one out of five workdays will now be spent working from home in the US for 50% of the working population.

Many of the potential long-run macroeconomic effects of such a structural change in the organization of labor have been the subject of recent studies. Scholars have been interested in analyzing its effect on productivity (OECD, 2020; Criscuolo et al., 2021; Barrero et al., 2021; Gibbs et al., 2021; Bergeaud and Cette, 2021; Bergeaud et al., 2021), on labor market reallocation (Eyméoud et al., 2021b), on digitalization (Consolo et al., 2021), or on urbanization (De Fraja et al., 2020). In this paper, we analyze its effects on corporate real estate, a question which remains largely overlooked essentially due to the lack of data.

Corporate real estate dynamics are important for at least three reasons. First, real estate is an important asset class for firms and serves multiple functions either as a productive asset or as a collateral for raising external finance (Chaney et al., 2012; Fougère et al., 2019). It is also an important source of friction that limits capital adjustments and employment dynamics of firms (Bergeaud and Ray, 2021). Second, it constitutes a central class of assets in financial markets, and any imbalance in this sector tends to decrease financial stability. Bank commercial real estate exposures have for instance been identified as the primary source of bank fragility in the 2008 crisis (Cole and White, 2012; Antoniades, 2021). Finally, commercial and residential real estate compete for land which gives rise to strong interactions between both markets (Gyourko, 2009; Davis et al., 2020; Ferrière and Henricot, 2021).

Corporate real estate market participants are directly exposed to the consequences of the generalization of teleworking. Studying how they adapt to this new paradigm not only gives us a better understanding of how real estate markets operate, but it also allows us to assess to what extent this shift is likely to be permanent. As office users seek to adjust their demand for space to the new normal, office owners may experience an increase in vacancy rates, and downward pressure on office rents. Developers may also incur losses as prospective new tenants become scarce. In reaction, the development of new projects may stall, as past construction projects designed in and for a world with almost no telework struggle to meet demand.[1] All this should ultimately result in a decline of real estate asset prices, with the adjustment of construction helping to stabilize expected revenues in the medium run. In any case, as prices are forward-looking, any price adjustment may hint at the permanence of the teleworking shock.

Our first contribution is to build a county-level indicator for the propensity of teleworking in France.[2] We rely on Dingel and Neiman (2020)'s assessment of the "teleworkability" of each occupation, and apply it to local labor markets in France. It provides us with a measure of the teleworking capacity by county. We augment this measure with information on local incentives and frictions to teleworking to assess the actual propensity to telework. These frictions and incentives are aggregated from a range of demographic (share of high-skill workers with a child under 18) and geographic (share of households connected to optical fiber, and median travel time to office) characteristics. Our final indicator has a large level of heterogeneity across counties, that we leverage to identify the effect of working from home. We confirm that it captures well the propensity of each county to telework, by showing that it correlates with proxies for the observed level of teleworking at the county-level.

We then provide evidence that working from home is spreading and is already factored in by market participants. In counties most exposed, office vacancy rates increased by 3.4 percentage points (pp) in 2020, against 0.7 pp in less "teleworkable" areas. This suggests that firms have already been able to adapt their demand for office space. We also show that construction of new offices has halted in areas most exposed to teleworking. While it may hamper future price declines through a decrease in supply growth, this prompt reaction of developers suggests teleworking is here to stay. At the county level, the value of offices in areas most exposed declined more. These findings hold controlling for changes in unemployment and thus cannot

[1]The overreaction of construction to real estate shocks due to the lag before a projects' completion is well-documented in the literature (see e.g. Glaeser et al., 2008).

[2]Throughout, we call county a French *département*. There are 94 *départements* in mainland France (excluding Corsica) with an average population of about 700,000 inhabitants in 2019.

be attributed only to the heterogeneity of activity shocks during the pandemic. In parallel, we observe a drop in county-level prices and to a lower extent of construction in the most teleworkable areas for the retail segment. The spread of teleworking could indeed spill over from offices to retail since the drop in office attendance may affect neighboring outlets. However, macro data are not detailed enough to adequately disentangle between the dynamics of offices and retails. Hence, we turn to an alternative source of granular data on commercial real-estate: investment fund holdings at the building-level. We find that within county, funds are more likely to downgrade the valuation of their office buildings than their retail buildings, all the more that these buildings are located in areas more exposed to telework. Since prices are forward-looking, part of this decline may be interpreted as an anticipation of a downturn in the corporate real-estate market due to a rise in telework.

Our paper contributes to several strands of the literature. First, we contribute to the literature on the measurement of teleworking that has received considerable attention since the pandemic started in 2020. Using occupation level data and employment composition, Dingel and Neiman (2020) estimate that 37% of American jobs could switch to full teleworking with heterogeneity across sectors, skill level, and space (Sostero et al., 2020 find a similar share in Europe). Gottlieb et al. (2020) and Hensvik et al. (2020) provide some detailed results by occupation and estimate that while more than 75% of managers could work from home, this share is much lower in some other occupations and reach 0% for some specific jobs like motor vehicle operators. Eyméoud et al. (2021a) confirm this heterogeneity using population survey data on the actual use of telework during the crisis, and highlight its role in preventing job destruction in the US. Brynjolfsson et al. (2020) report that 34% of American workers declare that they used to commute and now telework (as of April 2020). Finally, Baker (2020) and Mongey and Weinberg (2020) identify the types of occupation that cannot be done at home and their geographical distribution, enabling the characterization of counties that are likely to be strongly impacted by the intensification of teleworking. We contribute to this literature by constructing a local indicator of teleworking that does not only capture the theoretical potential for teleworking, but also accounts for incentives and frictions that prevent this theoretical level to be achieved.

Second, our work speaks to the literature analyzing the effect of pandemics, and the Covid-19 in particular, on commercial real estate. Francke and Korevaar (2021) show that historical outbreaks of the plague led to steep but temporary house price declines attributable to a rise in uncertainty. Xie and Milcheva (2020) and Ling et al. (2020) study the correlation between exposure to the COVID-19 pandemic, and commercial real estate prices through the lens of Real Estate Investment Trust (REIT) stock returns. Hoesli and Malle (2021) provide a different picture by also studying the impact on sectoral price indices. Milcheva (2021) focuses on the differences between REIT performance in Asia and in the US during the ongoing pandemic. While we share some similarities with these studies, our access to building-level data allows us to assess directly how real estate asset managers anticipate the shift to teleworking.

Finally, a nascent literature has explored the links between teleworking and house prices. For instance, Delventhal et al. (2021) and Gupta et al. (2021) model the expected impact of teleworking on urban geography, and predict increases in periphery real estate prices associated with declines in city cores. Liu and Su (2021) observe a reduced demand for density driven by a lower need of living near jobs. However, these papers do not consider corporate real estate as a separate class while their is a strong relationship between telework and corporate real estate that has its own drivers. Indeed, our paper shows that corporate real estate is disproportionately affected by the rise of teleworking, which warrants the explicit incorporation of this asset class in future modeling exercises.

The remainder of this paper is organized as follows: section 2 presents our data and telework index. Section 3 presents our results and section 4 concludes.

2 Data

To measure corporate real-estate market dynamics, we rely on three different datasets presented in section 2.1: i) county-level appraisal-based indicators, ii) granular data on construction, iii) granular data of Real Estate Investment Funds' (REIF) non-financial assets. Section 2.2 presents how we construct our synthetic teleworking indicator, and assesses its external validity.

2.1 Measuring corporate real estate market dynamics

2.1.1 Appraisal-based indicators

We use yearly time series of French county-level indicators for commercial real estate (price and market rental value growth, vacancy rate) produced by MSCI, over 1998-2020. This dataset is based on a granular data collection by MSCI among its contributors and covers around 45% of the French market as of 2020 (MSCI, 2021). The perimeter is that of the commercial real estate market i.e., assets held and managed by professionals. Prices are appraisal-based which raises several challenges such as over-smoothing and lagging (Delfim and Hoesli, 2021). Still, these indices provide a representative view of the evolution of real estate prices. Descriptive statistics are available in Table I.

TABLE I. Descriptive statistics of MSCI data

Segment	Indicator	Obs	Dep	Min	Q1	Median	Mean	Q3	Max
Office	Δ Price	581	42	-21.49	-2.01	0.83	1.03	4.25	17.50
	Δ Rent	478	38	-13.34	-1.03	0.08	0.58	2.15	25.59
	Vacancy	584	43	0.00	5.49	9.18	10.89	14.11	74.75
Retail	Δ Price	957	71	-25.86	-2.69	1.17	2.47	6.11	37.61
	Δ Rent	722	67	-31.70	-2.02	0.24	0.58	2.76	86.97
	Vacancy	982	73	0.00	1.33	4.42	6.00	8.55	44.51

Notes: Descriptive statistics on the variation of prices, rents and vacancy rates (all in %). Obs is the number of observations, Dep is the number of counties (*"département"*). Time period: 1998-2020.

2.1.2 Construction

To follow the evolution of commercial real estate construction, we use administrative data on building permits. In France, developers planning greenfield projects or large asset transformations are legally bound to file for a building permit at the relevant municipality. The *Sitadel2* database provides comprehensive information on all building permits granted to moral entities at the monthly frequency. This includes the characteristics of the buyers (legal classification, personal identifier), the type of activities that the building will serve (office, retail, warehouses...), its surface and location. The database provides several dates, the date of administrative authorization (DPC), the date of construction commencement (DOC) or project abandonment, and the date of completion of the project (DAACT), at which compliance with the initial project is verified. We rely here on DPCs which react first to economic shocks. Finally, we restrict our analysis to buildings that are not intended for the public sector, and being in our sample in 2014 when the data collection procedure was harmonized throughout the country.

2.1.3 Real estate investment funds' buildings

Granular data on real estate prices are difficult to access by nature, as they are only observable during rare transactions - which become even rarer in crisis periods. Thus, we rely on a Banque de France regulatory reporting providing the valuation of all real estates assets owned by REIFs (*OPC Titres*). This dataset provides quarterly information on real estate assets of 426 French REIF from June 2016 to December 2020. By the end of 2019, total net asset of REIF in our sample stood at €91B (more than two-thirds of the total capitalization of all French REIF according to AMF, 2020). These funds can take two legal forms, SCPI (*Sociétés Civiles de Placement Immobilier* - real estate investment companies) or OPCI (*Organismes de Placement Collectif en Immobilier* - undertakings for collective investment in real estate).

We identify 15,506 buildings in the dataset for which we know the price, the country, the county (for French buildings), and the segment or purpose (i.e., office, retail, industry or residential). Their total values add up to €64B at end-2019. Offices are worth half of the total and retail buildings a quarter (see Table II for more details). Almost all buildings are located in continental France (97.9%), and are spread in its 94 counties.

TABLE II. Real estate assets - descriptive statistics (end-2019)

		Industrial	Office	Residential	Retail	Other	Total
All assets	€B	4.9	34.0	4.3	17.3	3.6	64.2
	Nb buildings	496	2843	878	4664	382	9263
French assets	€B	4.4	32.9	4.3	16.9	3.4	62.1
	Nb buildings	440	2806	877	4573	374	9069

Notes: Real estate assets owned by French REIF in our dataset by segment and location. In the remainder of the paper, we focus on buildings located in France which represent 97.9% of the total buildings.

2.2 Measuring teleworking

In this section we present our measure of teleworking. We start from the seminal work of Dingel and Neiman (2020). In this recent paper, the authors use the detailed occupation characteristics from the O*NET database to estimate whether the task contents of each occupation can be done at home. We use their classification and a crosswalk from the International Standard Classification of Occupations to the French "Professions et catégories socioprofessionnelles" (PCS) taking from Le Barbanchon and Rizzotti (2020). This latter classification references about 300 different jobs. We then use the weight of each of these occupations in every county to construct a measure between 0 (no one can telework in the county) and 1 (everyone can theoretically telework). These weights are taken from the Labor Force Survey ("*Enquête Emploi*") as an average between 2014 and 2017. We take this first measure as an estimate of the maximal local potential of teleworking in the absence of any type of friction.

While this measure has been used extensively in the literature (see e.g. Mongey et al., 2021; Cajner et al., 2020), it only captures a predicted maximum number of workers that can work from home but does not take into account the potential frictions and incentives to actually resort to this type of work arrangement. For this reason, we complement this measure with different local characteristics that would influence the intensity of telework, on top of the occupational composition. Intuitively, we expect workers with young children, more connected to the internet and with longer commutes to be more willing to work from home. Hence we use the following measures at the county-level:

- The share of households that are connected to the optical fiber. This share is measured in 2019 and is taken from the ARCEP, the French agency in charge of regulating telecommunications.
- The share of high skill workers with a child under 18, taken from the Labor Force Survey.
- The median travel time between the place of residence and the place of work, taken from the Observatoire des territoires. This measure is available for high-skill workers and for all workers. We use the former, but using the latter would not alter our results.

As expected these variables are positively correlated with each other, but not perfectly as they capture different local characteristics that are *a priori* all relevant for the intensity of the use of teleworking (see Table III). They are also all correlated with population density, which we plot directly in Figure A1. While population density constitutes a direct incentive to teleworking (Liu and Su, 2021), it may also correlate with confounding factors such as the intensity of the pandemic. Thus, we will control for population density throughout our analysis and measure the effect of teleworking on top of density-driven effects.[3]

A synthetic indicator

We combine all these measures into one indicator. We use Principal Component Analysis (PCA) between the three local characteristics: commuting time, percentage of

[3] Controlling for density reduces the predictive power of our measure of teleworking as part of the variance of teleworking comes from cross county variations in density while it is not clear whether density itself has a direct impact on real estate developments after the pandemics.

TABLE III. Correlation between the different measures of teleworking

	Dingel and Neiman (2020)	Fiber	Share young children	Commuting Time	Density (log)
Dingel and Neiman (2020)	1				
Fiber	0.6163	1			
Share young children	0.3762	0.3970	1		
Commuting Time	0.6487	0.6809	0.6371	1	
Density (log)	0.7872	0.7373	0.3955	0.7455	1

Notes: This table presents the correlation matrix between the different local measures that are expected to influence teleworking, the Dingel and Neiman (2020) indicator aggregated a the county (*"département"*) level and the logarithm of density (see Section 2.2 for more details). The correlations are calculated over 91 counties of mainland France (out of 94) for which they can be measured. Missing counties are *"département"* 05, 48 and 55. Observations are not weighted.

high-skill workers with children under 18, and share of households connected to the internet through optical fiber. We then extract the first eigenvector that we scale to be constrained between 0 (less incentive to telework) and 1 (more incentive to telework) using an inverse logit transformation. This value is then multiplied by the Dingel and Neiman (2020) indicator. The results can be found in Table A1 in Appendix A and in Figure I.[4]

To assess the validity of this new indicator, we confront it with various actual measures of teleworking at the county-level. The first such measure is taken from the wave 2021 of the "enquête sur la durée des équipements", an annual survey on how manufacturing firms use their production factor (see Gerardin et al., 2021). In 2021, a representative sample of 1,600 firms was specifically asked to report the share of their workforce that was working from home at least one day a week, respectively in 2019 and in September 2020.[5] We use their responses and the weights of the survey to construct an aggregate share for each county. The second measure that we use comes from the Covid-19 Community Mobility Reports from Google. Based on mobile data, Google evaluates the variation in workplace occupancy at a detailed geographical level compared to a benchmark period on a daily basis. We take the average value by county in two specific periods, September 2020 and June 2021, during which there were no specific restrictions and obligations regarding working from home (see Figure A3 in Appendix A).

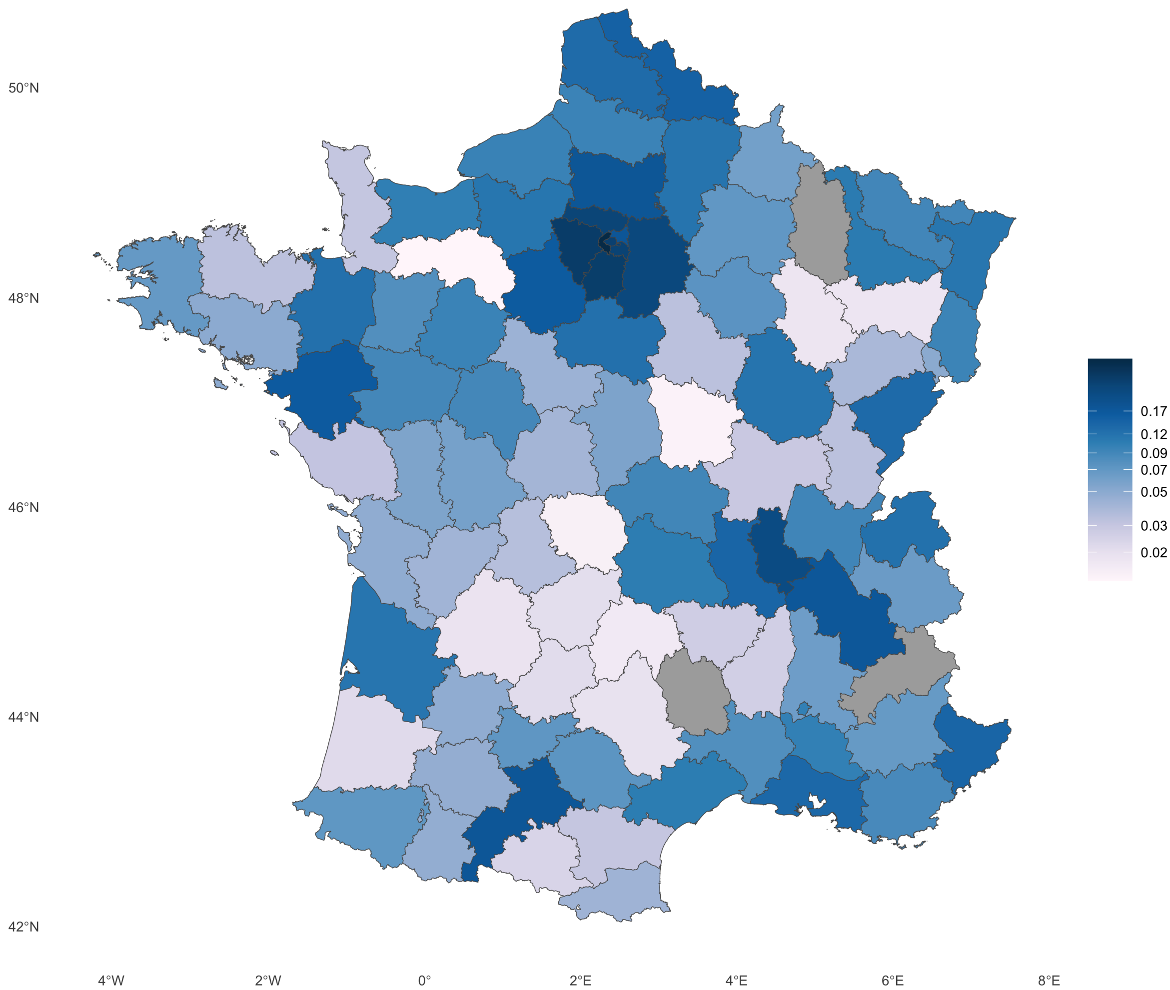
Based on these four measures and our synthetic indicator for teleworking, we estimate the following simple cross-sectional model:

$$Y_d = \alpha + \beta X_d + \gamma \log(density_d) + \varepsilon_d \qquad (1)$$

[4] Figure I confirms the intuition that the areas with the largest probability to telework are also the more densely populated and more urban counties. In Appendix A, we plot a similar map but for the residual of the teleworking indicator on the logarithm of density, see Figure A2.

[5] As of September 2020, the largest Covid-related restrictions were completely lifted in France and most firms were fully functioning.

FIGURE I. Telework index by county



Notes: This figure maps the telework indicator presented in Section 2.2. Three counties are excluded due to missing data (in grey).

where Y_d is the actual measure of teleworking (from the manufacturing survey or from Google Mobility data) and X_d is our proxy for teleworking. We also control for local density. Results are presented in Table IV and show that the estimate of β has the expected sign (negatively correlated with workplace occupancy and positively correlated with the share of teleworkers in the manufacturing sector) and is most of the time significantly different from 0.

TABLE IV. Teleworking at the county-level - regression results

	GM 2020 (1)	GM 2021 (2)	Manuf 2019 (3)	Manuf 2020 (4)	GM 2020 (5)	GM 2021 (6)	Manuf 2019 (7)	Manuf 2020 (8)
Teleworking	-33.260***	-40.563***	0.041*	0.154*	-30.743***	-35.336***	0.042*	0.157*
	(5.480)	(11.469)	(0.023)	(0.080)	(5.079)	(7.694)	(0.021)	(0.093)
Density (log)	-1.105***	-1.550**	0.001	0.003	-1.464***	-2.266***	0.000	0.002
	(0.366)	(0.743)	(0.001)	(0.004)	(0.343)	(0.443)	(0.001)	(0.005)
R^2	0.757	0.513	0.138	0.235	0.845	0.725	0.150	0.202
N	91	91	88	88	91	91	88	88

Notes: This table presents regression results from an estimation of equation (1). Columns 1, 2, 5 and 6 use a measure of workplace occupancy from the Google Mobility (GM) data as a dependent variable while other columns use the share of teleworkers in manufacturing firms from Gerardin et al. (2021). Telework denotes the synthetic proxy for the potential for teleworking (see Section 2.2). Columns 5 to 9 use a weighted GLS with weights equal to population in 2019. Other columns use the OLS estimator. Standard errors are corrected for heteroskedasticity. *"Département"* 2, 4 and 9 are excluded from the sample as there are no manufacturing firms surveyed. ***, ** and * respectively indicate p-values below 1, 5 and 10% for the Student test of the nullity of coefficients.

3 Teleworking and real estate

To assess the impact of teleworking on the corporate real estate, we evaluate the differential impact of the Covid-19 crisis on corporate real-estate indicators depending on the propensity to telework. We first focus on rental market indicators, then on construction, and finally on price levels.

3.1 Rental market dynamics and teleworking

We first analyze how MSCI county-level rental market indicators correlate with teleworking exposures. Unconditionally, office vacancy rates increased by 3.4 pp in the most teleworkable areas, while they increased only by 0.7 pp in the other areas. To look at this question more formally, we estimate the following equation for county c and year t:

$$Vacancy_{c,t} = \alpha + \beta T_c \mathbb{1}_{2020} + \gamma_1 T_c + \gamma_2 \mathbb{1}_{2020} + \gamma_3 \Delta U_{c,t} + \gamma_4 Vacancy_{c,t-1} + \varepsilon_{c,t} \quad (2)$$

where $\mathbb{1}_{2020}$ is a dummy taking value 1 in 2020, T our teleworking indicator at the county level, $Vacancy$ is the vacancy rate, and ΔU the yearly variation in unemployment in percentage points. We estimate the regression for the two separate subsamples of retail and offices.

Results are presented in Table A2 in Appendix A. They show that after the Covid-19 outbreak, office vacancy rates increased significantly more in teleworkable areas, while retail vacancy rates are stable. We also perform this regression using rent growth rates as the dependent variable and show that they did not react. This could be related to the relative rigidity of rent levels. Overall, these results show that renters were already able to adjust their demand for space suggesting that telework is not just about expectations. Controlling for the change in unemployment alleviates the concern that what we capture through teleworking is the relative economic shock that counties endured due to their sectoral composition during the pandemic. Conversely, retail vacancy rates did not seem to react (although the difference between both coefficients is not significant). As retail vacancy rates are not expected to react directly to teleworking, these analyses suggest that teleworking is indeed the driving force behind these dynamics.

3.2 Construction and teleworking

In this subsection, we focus on how teleworking affects construction after the pandemic. The dynamics of construction capture short-term as well as more structural changes. The construction sector has been no exception to the economic downturn observed with the outbreak of the virus and the implementation of health protection measures. After reaching an all-time high of 1,000,000 square meters of office space built in January 2020, office construction collapsed to 125,000 square meters of space built in April 2020, its lowest level since records began. Since then, office construction has recovered without returning to pre-crisis levels.

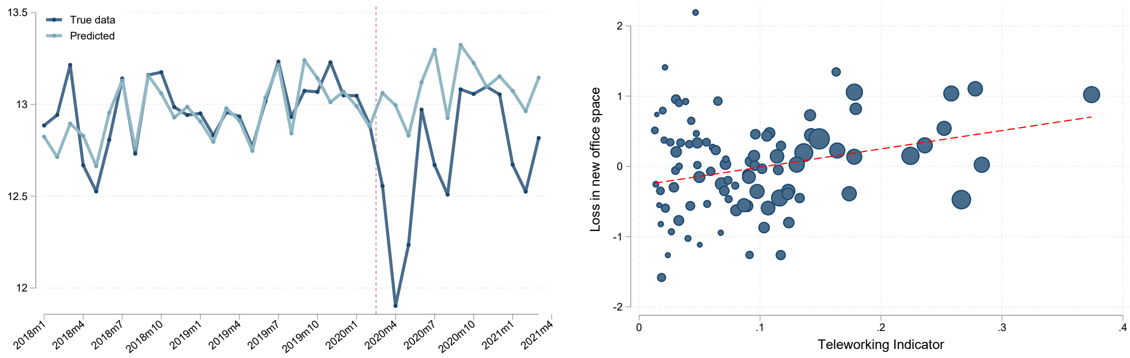
To measure the shortfall in office space built, we take advantage of the monthly frequency of Sitadel2 construction data, and build a simple statistical model for the development of new office real estate before the pandemic, and capture in particular its cyclical dynamics. Office space construction is modelled as follows:

$$\log(\textit{office space built}_t) = \alpha + \beta t + \nu_{m_t} + \varepsilon_t \tag{3}$$

where *office space built*$_t$ is office space built in period t, βt is a time trend, ν_{m_t} a month fixed effect and ε_t the error term. We estimate this model at the country level over Jan. 2014 - Jan. 2020, and use the estimated coefficients to construct a counterfactual for office space construction. Figure 2(a) shows the evolution of actual office space built since 2018 (light blue line), and its counterfactual (dark blue line). The dynamics of the data are accurately predicted by the model estimated up to the pandemic. The market is cyclical with the amount of space built almost doubling from one month to the next. Importantly, the gap between the light and dark blue lines starting in March 2020 suggests that the amount of commercial property built still falls short of its counterfactual, despite a strong rebound after the first lockdown (from March 17^{th} to May 10^{th} 2020).

FIGURE II. Correlation between office space construction and telework index

(a) Dynamics of office space construction (b) Loss in office building and telework index



Notes: This figure shows (a) the time serie of losses in office space building (seasonally adjusted and relative to trend as detailed in the text) between Feb. 2018 and Mar. 2021, and (b) the correlation between the loss of office space construction after the outbreak of the pandemic and the telework index at the department level.

To assess the relation between exposure to teleworking and commercial property construction dynamics, we now turn to a county-level panel and estimate the following model over Jan. 2014 - Jan. 2020:

$$\log(\textit{office space built}_{i,t}) = \alpha + \beta_i t + \nu_{m_t} + \gamma_i + X_{i,t} + \varepsilon_{i,t} \tag{4}$$

This model allows to control for county i specific and time-varying observable characteristics ($X_{i,t}$) that could be correlated with the development of new office spaces. In particular, we control for the local unemployment rate[6] and the logarithm of the density in 2018 interacted with a time trend. We also control for unobservable time invariant county characteristics using a county fixed effect γ_i. In addition, we remove the average value of the dependent variable for each t in order to control for any global effect.[7]

From this model, we predict the loss in construction. Formally, we measure the average gap between the predicted and actual values (both taken in log) of new square meters of offices from May 2020 to March 2021. Figure 2(b) presents this county-level loss as a function of the teleworking indicator. We see that while the whole country underwent an important slowdown in terms of new construction, the predicted losses

[6]Unemployment at the county-level is taken from the INSEE and is only available at the quarterly level, we create artificial monthly data using linear interpolation.

[7]One natural alternative would be to include time fixed effects to the model. However, in the next step we will predict and project the dependent variable using this model and for this reason we prefer to use demeaned variables.

are unevenly distributed over the territory and are positively correlated with the telework indicator defined in Section 2.2. We also present the cross-section regression coefficients in Table V (columns 1 and 2).

We then complete equation (4) to directly estimate the effect of being more exposed to teleworking after the pandemic. Formally, we add a variable $T_{i,t}$ which is the interaction of a dummy variable equal to 1 after May 2020 and the teleworking indicator. In addition, we directly include time fixed effects to the model. The coefficient associated with $T_{i,t}$ therefore captures the additional variation in new construction associated with an increase in the teleworking indicator after the pandemic. We expect it to be negative.

Results are presented in column 3 of Table V and show that, as expected, the estimate of the coefficient is significantly negative. Its magnitude (-1.7) indicates that a one standard deviation increase in the value of the teleworking indicator (0.072) corresponds to a decline in new office construction of about 12%. This decrease can be attributed to the current take-up of teleworking, as well as the anticipation of future teleworking.

TABLE V. Impact of teleworking on county-level office and retail loss

	Office			Retail		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Teleworking	2.089**	2.607***		0.993	2.045***	
	(0.916)	(0.905)		(1.139)	(0.736)	
$T_{i,t}$			-1.729*			-0.440
			(0.935)			(0.944)
R^2	0.050	0.136	0.577	0.478	0.007	0.065
N	91	91	7,917	91	91	7,917

Notes: Column 1, 2, 4 and 5 of this table presents regression results from an estimation in which the dependent variable is the predicted loss in new office spaces at the county ("*Département*") level in percentage point deviation from trend as modeled by equation (4). Regressor Teleworking is the synthetic indicator for the propensity to telework (see Section 2.2). Columns 1 and 4 use an OLS estimators and columns 2 and 5 use the GLS with weights equal to the level of population in 2019. Columns 3 and 6 estimate directly by OLS the following model $\log(\textit{office space built}_{i,t}) = \alpha + \beta_0 T_{i,t} + \beta_1 t + \nu_{m_t} + \gamma_i + X_{i,t} + \varepsilon_{i,t}$ where $T_{i,t}$ variable is the interaction of a dummy variable equal to 1 after May 2020 and the teleworking indicator. The model also includes time fixed effects. In all cases, standard errors are corrected for heteroskedasticity. ***, ** and * respectively indicate p-value below 1, 5 and 10% for the Student test of the nullity of coefficients.

In Appendix A, we show that results remain very similar if we refine our prediction of the number of new square meters using information on the construction of residential real estate. Formally, we add to the model the number of new square meters in the residential segment (in log) to control for the local dynamics of the construction sector, economic activity and demand for real estate in general. Results are presented in Table

A3.

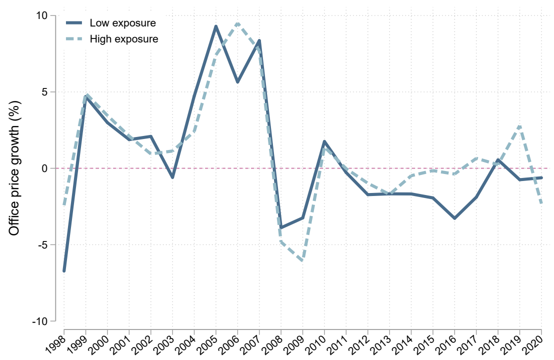
Next, we replicate the analysis for retail. Results are housed in columns 4 to 6 of Table V. They are consistent with findings for offices, but not significant except for the GLS estimation. We expect some level of correlation between the loss in new office spaces and the loss in new retail spaces due to local spillovers from the former to the latter. Indeed, the drop in office attendance should directly affect neighboring shops. More generally, real estate prices are strongly correlated within county which limits the possibility to disentangle effects across segments. However, the fact that the results are mainly not significant for retail suggest that what we are capturing in Table V is mostly specific to offices.

3.3 Valuation and teleworking

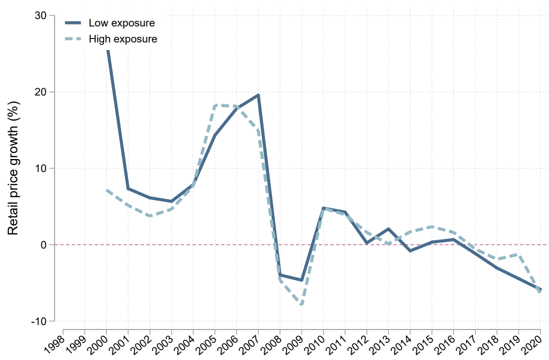
We now turn to our analysis of prices. First, we examine county-level price changes using data from MSCI. Figure III plots median office and retail price growths depending on counties' positions relative to the median teleworkability of counties with available office data. Both series fall in the most teleworkable areas. Econometrically, we re-estimate equation (2) with price growth as a dependant variable for office and retail. We show in Table A2 that price declines were steep for both segments.

FIGURE III. Price growth and teleworking

(a) Median office price growth by county



(b) Median retail price growth by county



Notes: Low (resp. high) teleworking areas are those with a teleworking indicator below median in the distribution of counties with available office data.

We run a simple rule-of-thumb exercise to assess the consistency of the joint evolution of prices and vacancy rates. In particular, we are interested in assessing whether prices reflect a permanent or temporary increase in vacancy rates. As made explicit in equation (5), we model asset prices P as 20-year Net Present Values (NPV) of a unit rent flow l growing at 2% annual growth rate, with a vacancy rate v (8.4% in 2019), discounted using the historical average of income returns (5.7% for offices). Assuming vacancy rates remain permanently at their 2019 level, this cash flow would be priced at 12.9€. A one standard deviation increase in teleworking (i.e., a 0.072 increase in the index) would translate in a 4.3pp increase in vacancy rates. If this increase is temporary, prices should decline by -0.3%. Conversely, if the rise is permanent, price should plummet as low as -4.7%. Since estimated prices decline by -3.8%, they are consistent with a near permanent increase in vacancy rates.

$$P = \sum_{t=1}^{20} \frac{l * (1-v) * (1+2\%)^t}{(1+r)^t} \tag{5}$$

To go a step further, we turn to our more granular building-level database drawn from REIF regulatory reportings. As explained in Section 2.1.3, it contains information on the valuation of buildings owned by real estate funds at a quarterly frequency.

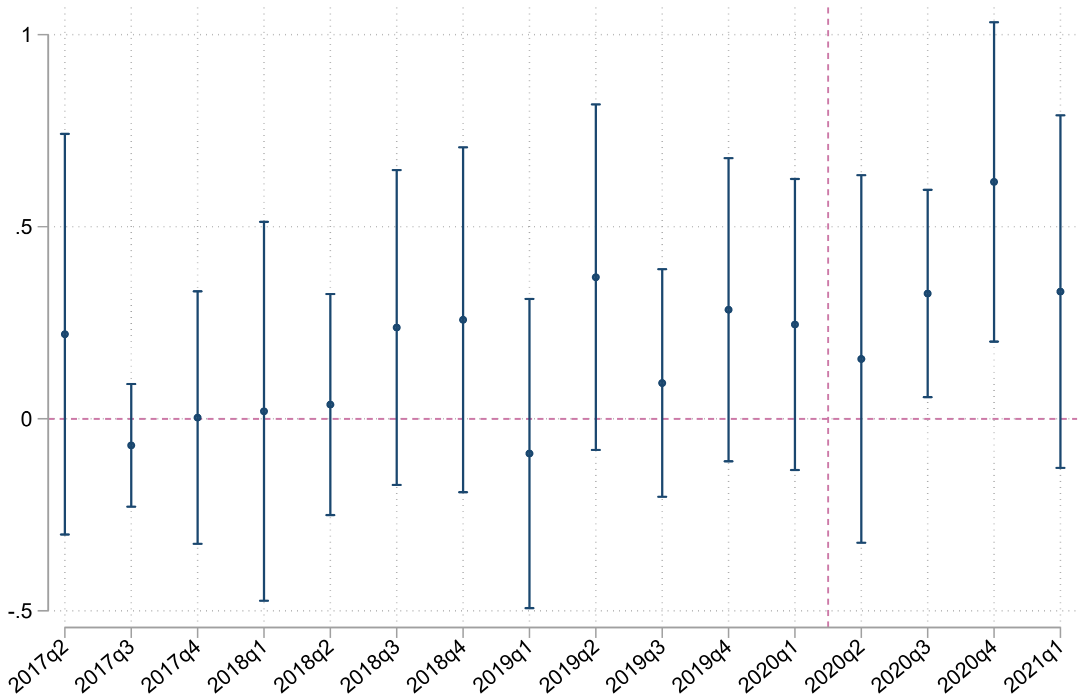
In line with the results presented in Section 3.2, we anticipate that funds will be more inclined to revise downwards the valuation of their real estate assets which are more impacted by a likely future increase in teleworking. These assets are office buildings that are located in counties more exposed to teleworking. We therefore estimate the following linear probability model:

$$D_{i,t} = \beta_t C_i T_{c(i)} + \delta X_{i,t} + \nu_{c(i),t} + \mu_i + \kappa_{j(i)} + \varepsilon_{i,t} \tag{6}$$

where $D_{i,t}$ is equal to 1 if the valuation of building i has been revised downward during quarter t compared to quarters $t-1$. $c(i)$ and $j(i)$ respectively denote the county in which building i is located and the fund to which it belongs. C_i is a binary variable equal to 1 if the building is used for offices, $T_{c(i)}$ is our measure of local exposure to teleworking and X is a vector of control variables that include the total assets of funds $j(i)$, and the past 4 quarters of the building price (all taken in log).

We are essentially interested in the evolution of β_τ over time. β_τ captures the additional probability of revising a value downward for an office compared to other types of building as T varies. The various set of fixed effects are included to capture the direct effects of any local characteristics, variations, and trends ($\nu_{i,t}$), and the specificity of the fund and the building. We estimate the model using generalized least squares and allow for correlation in modelling residuals within each fund. The value and 95% confident intervals for each β_τ are presented in Figure IV.

FIGURE IV. Marginal effect of teleworking on the probability to revise price downwards - Office



Notes: This figure plots the point estimate of β_τ from model (6) for different values of τ ranging from 2017q2 to 2021q1 as well as the confident interval at 95%. These are obtained using a GLS estimation of model (6) allowing for correlation of the residuals within each fund. Number of observations: 130,300.

These results suggest that funds were indeed more likely to update negatively the valuation of their office buildings following the pandemic (in particular in 2020q3 and 2020q4), all the more that these buildings are located in areas that are more exposed to a large generalization of teleworking. The magnitude of the effect (the sum of the coefficients from 2020q2 to 2021q1) suggests that a one standard deviation increase in the value of the teleworking indicator (0.072) increases the relative probability of downward revision of a price by about 7 percentage points. Such an increase will be equivalent to moving from the average county to the region of Lille or Lyon. This corresponds to a very large effect knowing that the unconditional observed probability of a downward revision of price was 5.8% prior to 2020.

In Table VI we formally test that the sum of coefficients corresponding to 2020q3, 2020q4 and 2021q1 is significantly positive, while the sum of pre-trend coefficients and the sum of the pre-trend coefficients restricted to just before the pandemics (2019q1 to 2019q4) are both non significantly different from 0.

One advantage of using data at the building-level is that this allows us to look more precisely at potential differential effects across real estate segments within a county.

TABLE VI. Building-level regression - sum of coefficients

	Office **(1)**	Retail **(2)**
Post pandemic coefficients	1.273***	-0.246
	(0.388)	(0.557)
Pre-trends (all)	1.605	-4.034
	(1.663)	(2.747)
Pre-trends (2019)	0.622	-0.954
	(0.443)	(0.612)

Notes: this Table presents the sum of coefficients and associated standard errors from an OLS estimation of equation (6). The first line presents the value of the sum of β_τ for τ ranging from 2020q2 to 2021q1 (the data are quarterly). The second line presents the sum of β_τ for τ ranging from 2017q1 to 2019q4 and the last line presents the sum of β_τ for τ ranging from 2019q1 to 2019q4. ***, ** and * respectively indicate p-value below 1, 5 and 10% for the Student test of the nullity of the sum of coefficients. Number of observations: 130,300.

Indeed, as underlined before, it is likely that at the county-level, retail and office real estate developments are highly correlated due to many potential confounding factors. Here, the high dimensionality of the database allows us to control for county-time fixed effects and to estimate the reaction of one specific segment compared to the other. Hence we simply re-estimate equation (6) but this time we replace the dummy C_i by an indicator variable equal to 1 if the building is used for retail activities. The sum of coefficients are presented in columns 2 and 3 of Table VI and show no significant impact of teleworking on retail real estate valuation. We also replicate Figure IV in Appendix A for retail (see Figure A4). Such a result suggests that REIF managers are not particularly anticipating a decline in the price of these types of assets, or at least not linked to the intensity of working from home.

4 Conclusion

The Covid-19 crisis is an unexpected teleworking shock. While teleworking was marginal before the pandemic, social distancing measures have led companies to experiment with new ways of producing. This experience is expected to have a lasting impact as companies have learnt to work remotely and made capital investments in teleworking tools.

Companies could take advantage of teleworking by downsizing their office space to reduce their operating costs. This would induce a structural downturn in the corporate real estate market. Using early post-crisis data, we test this hypothesis and assess how teleworking impacts the corporate real estate market using both spot and forward-looking indicators capturing anticipations.

To measure the local potential for teleworking, we construct an indicator combining the maximum teleworking capacity with potential frictions and incentives. To identify how the office market reacts to a potential increase in teleworking, we analyze how the Covid-19 crisis has affected the relation between corporate real estate indicators and local propensities to telework.

First, we find that the Covid-19 crisis translated in higher increases in vacancy rates in teleworkable areas. We thus conclude that corporations with high teleworking rates have already freed some office spaces. Then, we observe a deceleration of post-Covid construction in counties with a high teleworking propensity. This provides a first body of evidence that market participants anticipate a structural impact of teleworking on corporate real estate. This reaction of construction may also mitigate the downward trend in price, which we then analyze. In that last section, we find that the Covid-19 crisis led to stronger price declines in more teleworkable areas, based on both county-level and building-level data. Importantly, this tendency is not observed for retail prices. As prices incorporate anticipations, it provides additional evidence on the expectation by market participants of a market downturn associated with teleworking.

The consequences of this suggested structural change could have different impacts on the economy. In the short-run, the drop in corporate real-estate prices and associated uncertainty may constrain corporate financing capacity through the collateral channel. It may prevent some companies from accessing funding as national government-guaranteed lending programs come to an end. Reduced office space demand also creates imbalances on the supply-side, that the market will need to absorb. Increased vacancy rates in the commercial segment may eventually spill over to the residential real-estate market as both markets are historically correlated. Future developments now depend on whether market participants over-reacted, in a context of heightened uncertainty, or downplayed the future organization of labor.

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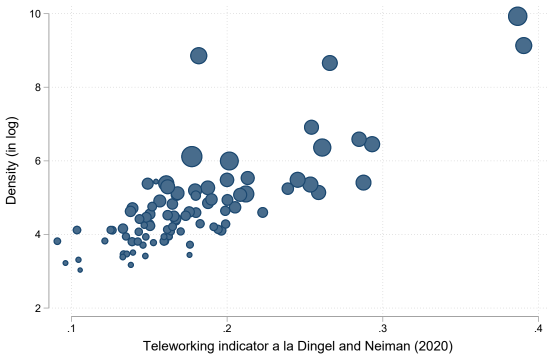
APPENDIX

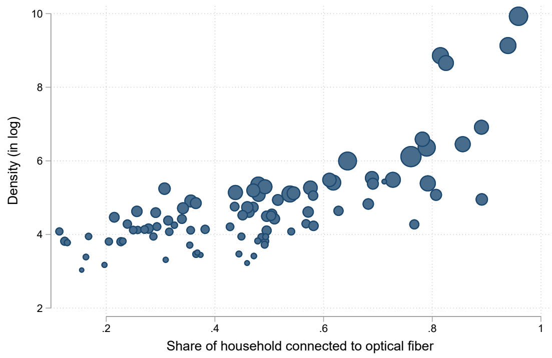
A Additional Tables and Figures

FIGURE A1. Correlation between the different measures of teleworking and population density

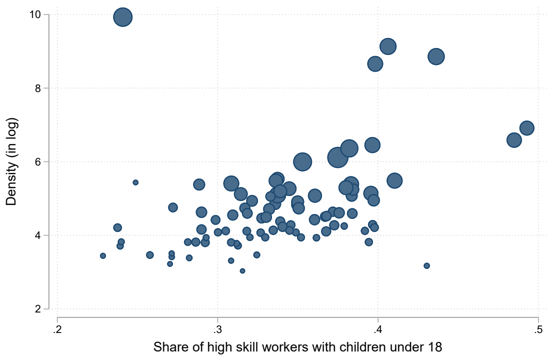
(a) Dingel and Neiman (2020) indicators



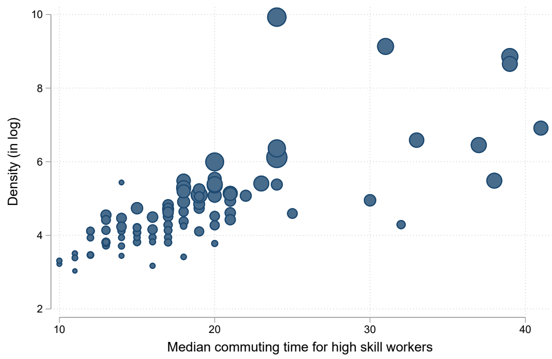
(b) Share of households connected to the optical fiber



(c) Share of high skill workers with children under 18

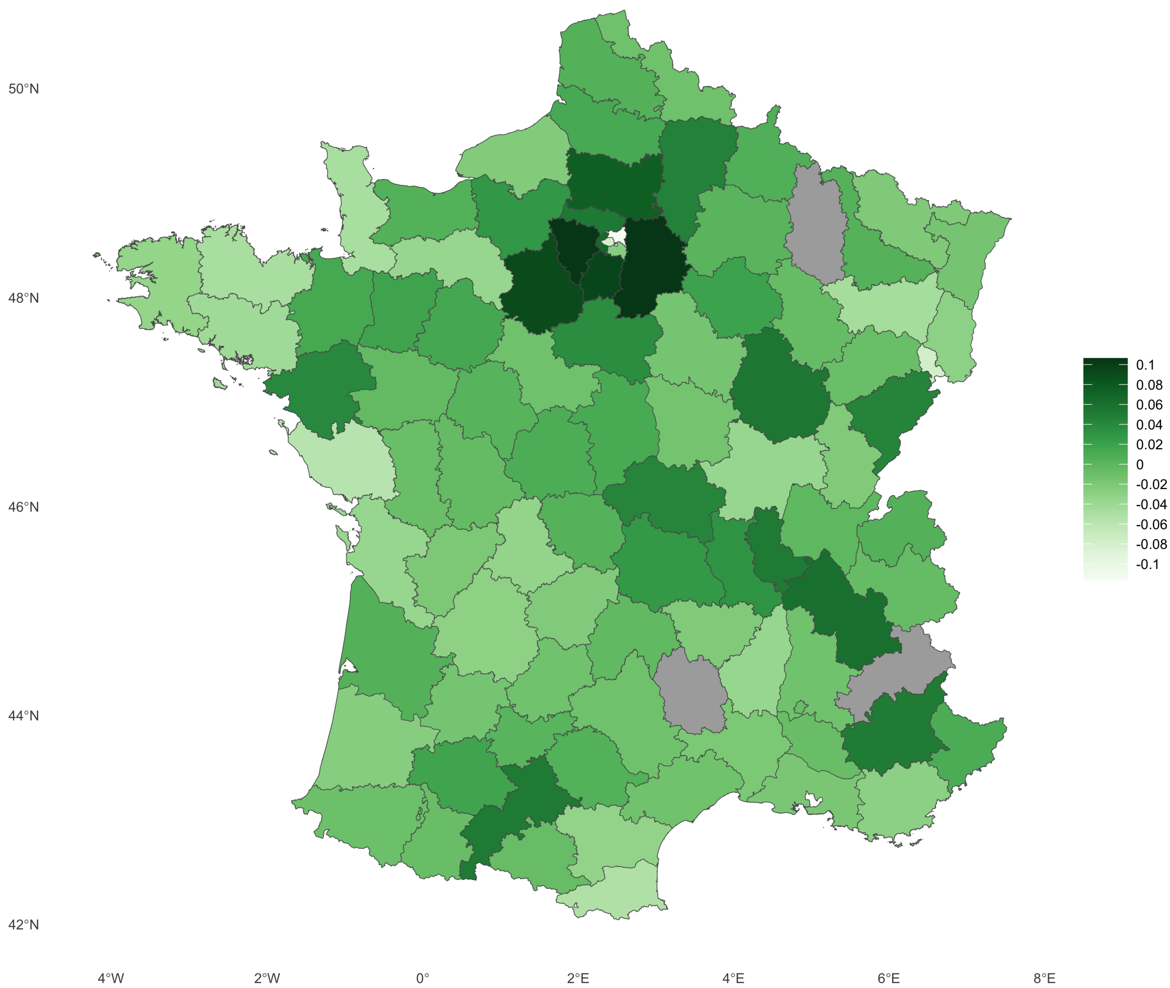


(d) Commuting time for high skill workers



Notes: These figures report the cross section between the logarithm of density at the "*département*" level (defined as the ratio of population in 2019 over area) and our different measures of teleworking presented in Section 2.2. Bins are proportional to population. Adjusted R squared are respectively equal to 0.597, 0.100, 0.052, 0.474.

FIGURE A2. Telework index by county controlling for population density



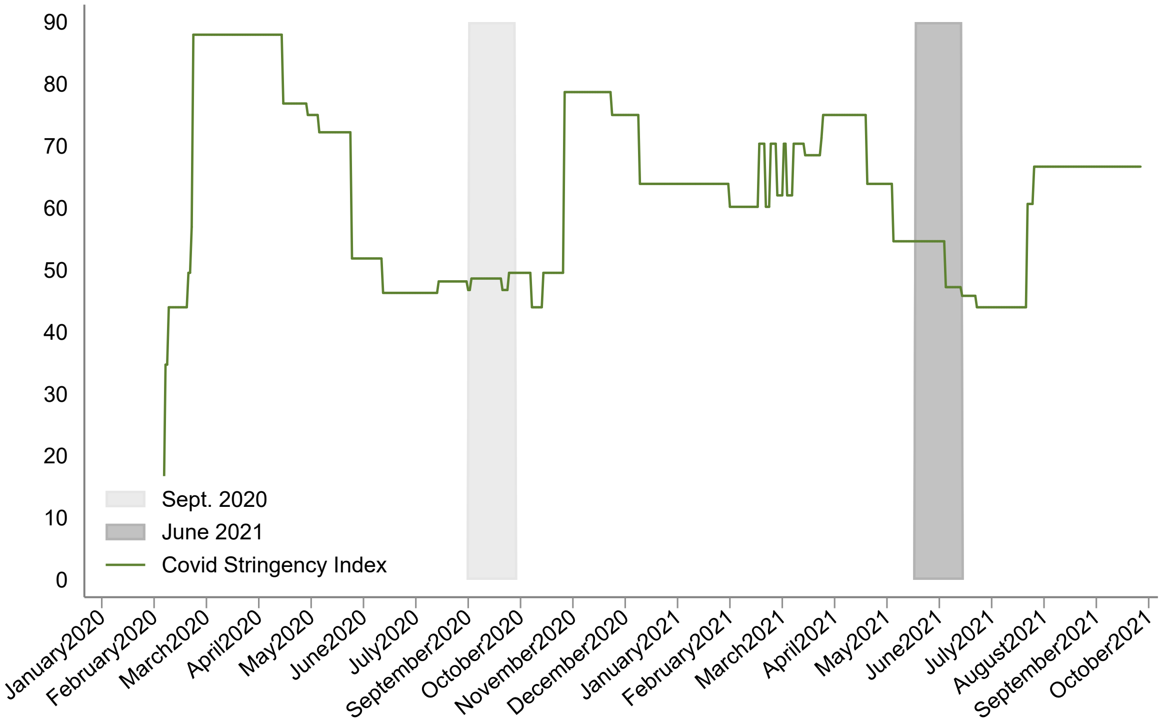
Notes: This figure maps the telework indicator presented in Section 2.2 once residualized on the log of density at the county-level. Three counties are excluded due to missing data.

TABLE A1. Detailed county-level measures

Département code	Density	Telework Indicator	Dingel and Neiman (2020)	Fiber	Children	Commuting Time
1	114	0.092	0.205	0.470	0.317	19
2	72	0.117	0.150	0.767	0.373	20
3	45	0.091	0.160	0.492	0.394	15
4	24	0.068	0.138	0.197	0.430	16
6	253	0.142	0.213	0.689	0.337	20
7	59	0.026	0.170	0.114	0.300	15
8	51	0.061	0.148	0.485	0.362	12
9	31	0.024	0.176	0.374	0.228	14
10	52	0.074	0.163	0.449	0.352	16
11	61	0.030	0.126	0.355	0.318	12
12	32	0.020	0.133	0.365	0.258	12
13	402	0.136	0.201	0.644	0.353	20
14	125	0.103	0.165	0.682	0.349	17
15	25	0.017	0.096	0.459	0.270	10
16	59	0.042	0.143	0.316	0.327	15
17	95	0.048	0.150	0.505	0.309	13
18	41	0.056	0.176	0.492	0.313	13
19	41	0.021	0.146	0.354	0.239	14
21	61	0.117	0.196	0.495	0.368	19
22	87	0.033	0.148	0.215	0.327	14
23	21	0.015	0.106	0.155	0.315	11
24	45	0.019	0.159	0.124	0.286	13
25	104	0.133	0.199	0.627	0.372	18
26	80	0.063	0.167	0.314	0.339	18
27	99	0.115	0.180	0.291	0.384	25
28	73	0.163	0.183	0.568	0.397	32
29	136	0.068	0.157	0.356	0.350	18
30	128	0.080	0.188	0.365	0.336	19
31	223	0.178	0.288	0.618	0.308	23
32	30	0.047	0.147	0.472	0.271	18
33	164	0.116	0.212	0.538	0.337	19
34	194	0.107	0.188	0.576	0.345	18
35	160	0.123	0.208	0.480	0.361	20
36	32	0.040	0.135	0.444	0.324	12
37	99	0.090	0.223	0.463	0.318	17
38	171	0.174	0.259	0.438	0.396	21
39	52	0.033	0.163	0.168	0.320	15
40	45	0.022	0.139	0.227	0.292	13
41	52	0.043	0.135	0.287	0.330	17
42	160	0.141	0.168	0.807	0.384	22
43	46	0.027	0.121	0.479	0.240	16
44	212	0.164	0.254	0.480	0.383	20
45	101	0.124	0.176	0.572	0.376	21
46	33	0.021	0.140	0.368	0.271	11
47	62	0.048	0.125	0.258	0.392	14
49	114	0.089	0.205	0.460	0.351	15
50	83	0.030	0.144	0.339	0.299	13
51	69	0.070	0.150	0.581	0.341	14
52	27	0.018	0.105	0.309	0.308	10
53	59	0.079	0.164	0.540	0.349	15
54	139	0.108	0.200	0.516	0.321	21
56	111	0.050	0.139	0.341	0.332	17
57	167	0.091	0.168	0.545	0.314	21
58	30	0.014	0.133	0.163	0.282	11
59	453	0.149	0.177	0.761	0.375	24
60	142	0.179	0.190	0.891	0.397	30
61	45	0.013	0.091	0.231	0.281	13
62	219	0.130	0.161	0.792	0.383	20
63	84	0.106	0.167	0.510	0.360	21
64	90	0.071	0.166	0.495	0.330	16
65	51	0.047	0.159	0.493	0.293	14
66	116	0.042	0.152	0.436	0.272	17
67	240	0.114	0.200	0.611	0.336	18
68	217	0.095	0.149	0.691	0.288	24
69	579	0.224	0.261	0.790	0.382	24
70	44	0.038	0.153	0.128	0.312	20
71	64	0.029	0.133	0.278	0.290	16
72	91	0.096	0.173	0.503	0.367	17
73	72	0.065	0.199	0.239	0.346	17
74	190	0.123	0.239	0.307	0.384	19
75	20,515	0.266	0.387	0.959	0.241	24
76	200	0.098	0.162	0.492	0.380	18
77	241	0.236	0.245	0.728	0.410	38
78	635	0.283	0.293	0.856	0.397	37
79	62	0.056	0.162	0.271	0.345	17
80	92	0.096	0.162	0.451	0.368	20
81	68	0.074	0.165	0.293	0.398	15
82	70	0.072	0.147	0.325	0.379	18
83	181	0.087	0.179	0.471	0.339	18
84	157	0.102	0.180	0.581	0.333	19
85	102	0.031	0.138	0.256	0.290	17
86	63	0.059	0.194	0.382	0.335	13
87	67	0.034	0.191	0.428	0.238	15
88	62	0.018	0.104	0.250	0.305	12
89	45	0.033	0.143	0.205	0.308	17
90	230	0.050	0.154	0.712	0.249	14
91	726	0.278	0.285	0.782	0.485	33
92	9,255	0.374	0.391	0.939	0.406	31
93	7,025	0.178	0.182	0.815	0.436	39
94	5,762	0.258	0.266	0.825	0.398	39
95	1,006	0.252	0.254	0.891	0.493	41

Notes: Detailed data for each *"département"* regarding the key variables used to measure teleworking. *"Département"* code correspond to official administrative codes and the corresponding names can be found in the national statistical office (INSEE) website. Density is the ratio of the population to the area in squared kilometers. Telework Indicator corresponds to the standardized synthetic indicator of teleworking that is obtained through principal component analysis (see Section 2.2. The other variables are defined in Section 2.2.

FIGURE A3. Covid-19 stringency index in France



Notes: This reports the daily level of the Oxford Covid-19 stringency index that measures the intensity of government restrictions to limit the development of the pandemic. The shaded areas corresponds to the periods used to construct the measure of effective teleworking in Section 2.2

TABLE A2. Correlation between real estate markets and teleworking propensity

	Office			Retail		
	Vacancy rate (1)	Rent growth (2)	Price growth (3)	Vacancy rate (4)	Rent growth (5)	Price growth (6)
Teleworking post 2020	59.890*	-0.918	-52.268***	13.117	-0.628	-72.039***
	(36.334)	(8.557)	(17.272)	(25.634)	(18.363)	(23.813)
Telework	-14.594	4.775	12.713*	-15.604*	17.616***	28.652***
	(16.325)	(5.158)	(6.661)	(8.274)	(5.816)	(5.610)
Year 2020 dummy	-4.472*	0.251	2.367	2.994**	-2.903***	-4.825***
	(2.508)	(0.664)	(1.508)	(1.303)	(1.112)	(1.433)
Δ Unemployment	0.942	-0.673	-2.703***	-0.416	0.526	-2.460***
	(0.600)	(0.418)	(0.388)	(0.282)	(0.339)	(0.329)
Lag Dep Var	0.221***	0.100**	0.351***	0.273***	0.113**	0.475***
	(0.051)	(0.048)	(0.031)	(0.059)	(0.057)	(0.032)
Observations	522	363	534	889	585	846
R^2	0.048	0.033	0.301	0.141	0.035	0.303

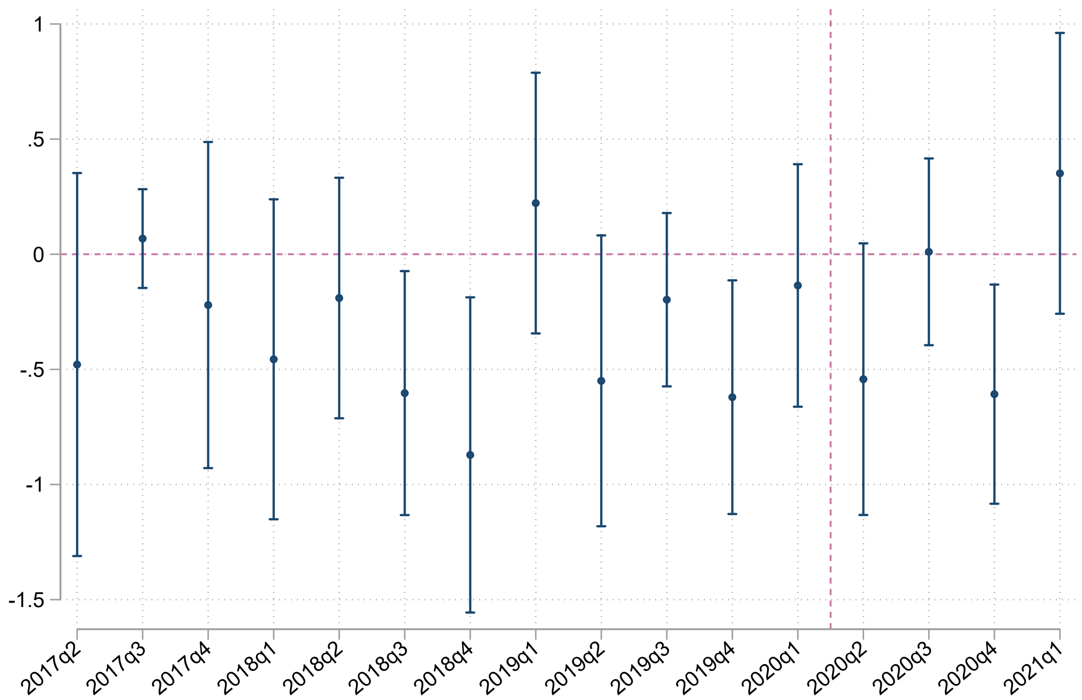
Notes: This table presents regression results from an estimation of equation (2). Columns (1) to (3) use data for the office segment and columns (4) to (6) for the retail segment. Telework is our indicator of teleworking (see Section 2.2). OLS regression with standard errors clustered at the county (*"Département"*) level. Not all counties are included due to missing information in MSCI (see Table I). Time period 1998-2020. *Lag Dep Var* designates the lag dependent variable. $***$, $**$ and $*$ respectively indicate p-value below 1, 5 and 10% for the Student test of the nullity of coefficients.

TABLE A3. County-level building loss and telework index

	Office			Retail		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Teleworking	1.908**	2.526***		0.812	1.965***	
	(0.886)	(0.873)		(1.112)	(0.709)	
$T_{i,t}$			-1.674*			-0.383
			(0.899)			(0.915)
R^2	0.044	0.132	0.586	0.005	0.064	0.489
N	91	91	7,917	91	91	7,917

Notes: This table replicates Table V but the predicted value of new office space has been calculated by including the number of square meters in the residential segment in the same month and county (in log) (columns 1, 2, 4 and 5) and added in the model in columns 3 and 6.

FIGURE A4. Marginal effect of teleworking on the probability to revise price downwards - Retail



Notes: This figure replicates Figure IV but replace office with retail. Formally, the variable C_i is replaced by another dummy variable which is equal to 1 if the building is used for retail activities in equation (6). Number of observations: 130,300.

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