COVID-19 and Dynamics of Residential Property Markets in France: An Exploration

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Abstract – In this article, we analyse the effects of the COVID-19 crisis on the French residential property markets. More precisely, we explore whether household demand for residential properties has been impacted by this crisis. Based on data on property transactions recorded between 2016 and 2021, we compare the evolution of prices before and after the crisis. The comparison is done between municipalities within urban areas on one hand, between urban areas on the other. Within urban areas, we show that the less dense municipalities that are farthest from the centre are also those where prices have risen the most. This reflects the desire among households for more spacious properties on the outskirts of urban centres. The results of the analysis of the evolution of prices between urban areas suggest, in line with urban economics theory, that a change in dynamics has occurred in favour of the least productive agglomerations.

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The health crisis caused by the emergence of COVID-19 in March 2020 in France has affected all activities. For households, the lockdowns and the development of teleworking, which have had an impact on both the professional and private spheres, have in particular led to a reconsideration of the choice of residential location and/or the characteristics of desired housing. On this latter point, the Qualitel 2020 Barometer[1] on the aspirations of French people in terms of space and interior design shows for example that households living in an apartment would like to have a house (58%), a garden (82%), a terrace or balcony (79%), larger rooms or a greater number of rooms. However, these characteristics are more often those of housing located outside urban centres, where property prices are relatively more affordable, but which may be further away from jobs. In this respect, the health may have modified or reinforced aspirations already present, as working remotely made the need of proximity between housing and work more flexible.

On the one hand, the continued confinement during the first lockdown from March to May 2020 highlighted (or reinforced) the need for space, both inside and outside, as well as a certain degree of dislike for large cities. Breuillé *et al*. (2022) thus show an increase in intentions to relocate to rural areas and purchase a house, of +5 points and +7.4 points, respectively, during the first lockdown compared to the pre-COVID period. Google geolocation data collected during the first lockdown also showed that the usual places frequented in large agglomerations were deserted, while some departments in rural France saw their shops gain visitors.[2]

On the other hand, since McFadden (1977), the economic literature has been in consensus about the major role of workplace accessibility in household location choice. Working remotely, which was introduced on a large scale during the first lockdown (involving 40% of companies), led to a reconsideration of the link between place of residence and place of work. It also seems to be a lasting change in working conditions: at the end of the first lockdown, nearly 26% of employers said they wanted to continue the practice (Duc & Souquet, 2020). More than a year after the start of the pandemic in the summer of 2021, the proportion of people regularly working remotely in the Paris region was 42%, which is twice the figure for 2019 according to a study by the Institut Paris Région (Brajon & Leroi, 2022). On average, the same trend is observed in OECD countries, although with strong differences across countries, as shown by a recent study based on job advertisement data (Adrjan *et al*., 2021); in particular, their results show that restrictions related to the management of the health crisis increased the prevalence of working remotely in job offers more than the relaxation of those restrictions has reduced it.

These different elements lead us to questions on the effects that the COVID-19 crisis may have on the location choice of household and, consequently, on property markets and territorial and urban dynamics. Household preferences were directly affected, with an adjustment of the trade-offs between different types of amenities and the increased flexibility of the link between area of residence and area of employment. However, the COVID-19 crisis also acted to accelerate location choices that were already evolving following deeper societal questions relating to the climate crisis or work-life balance, for example. The question is therefore whether these changes have "crystallised" due to the health crisis in terms of location choices and whether they are discernible in property markets in France.

There is already a relatively large body of work in the economic literature, particularly based on Chinese and American data. However, at the time of writing this article, we did not find work analysing the effects of the COVID-19 crisis on the French residential property market.[3] In this article, we therefore seek to explore the potential changes in the dynamics of the French residential property market after the emergence of COVID-19 in March 2020: has household residential demand been affected by the shock caused by COVID-19 and is it reflected by changes in property prices?

Relying on urban economics theories, we consider that the pandemic may have had two main effects: on the one hand, within agglomerations, an increase in the demand for space and a decrease in transport costs, which should lead to a change in the land rent gradient throughout urban areas (decrease in the gradients associated with distance and density in absolute values). On the other hand, an increase in the prices in urban areas where productivity is the lowest and in those with the most amenities.

We empirically test these hypotheses by studying the dynamics of residential property prices

1. https://www.qualitel.org/barometre-qualitel/resultats-2020/
2. https://www.google.com/covid19/mobility/.
3. Since then, we can cite Breuillé et al. *(2022) in this same issue, and France Stratégie (2022) on the evolution of residential property since the emergence of COVID-19, and Bergeaud* et al. *(2021) on the dynamics of corporate property.*

in France before and after the start of the health crisis. To do this, we use property valuation applications (*Demandes de Valeurs Foncières* – DVF) from 2016 to 2021. Identification is carried out using a difference-in-differences estimation, as in various works (Brueckner *et al*., 2021; Huang *et al*., 2021; Liu & Su, 2021), but we propose a strategy that allows potential differences in trends depending on the level of treatment to be taken into account, as in Dustmann *et al*. (2022). To the best of our knowledge, this is the first time that this method is applied to studying the effects of the pandemic on property prices.[4]

Our results indicate a change in price dynamics within large French agglomerations: the municipalities farthest from the centre and with a low population density experienced a price increase following the crisis. In the short term, reconfiguration effects appear to be less significant between urban areas than between municipalities within urban areas. However, in line with theoretical expectations, there appears to be a reduction in the income-related gradient, with a relative increase in the attractiveness of less productive urban areas compared to more productive ones.

The rest of the article is structured as follows: after a review of the empirical literature in Section 1, we present in Section 2 the elements of the theories of urban economics on the basis of which we formulate hypotheses to be tested, then we present the data and the empirical approach of the study. The results are set out in Section 3; we discuss the results and set out our conclusions in a final section.

1. Review of Empirical Literature

The effects of the COVID-19 crisis on household location behaviour have resulted in a variety of work, notably in China and the United States.

For China, the study by Cheung *et al.* (2021) on the city of Wuhan uses property transaction data from nine districts between January 2019 and July 2020 to identify the impact of the crisis on housing prices and household behaviour. The results, based on hedonic price models, reveal that housing prices fell by 5% to 7% after the outbreak of the pandemic and recovered after the lockdown. However, the authors show that the price gradient from the centre to the outskirts of urban areas has flattened. Recent work by Bricongne *et al*. (2021) reveals a similar trend in the United Kingdom. Based on data grouping together sale prices in online property advertisements and final prices recorded by notaries, they show a decrease of around 80% in property market activity during the COVID-19 crisis. In addition, property prices have increased in rural areas, and decreased near London. These results suggest a change in household behaviour, and a preference for low-density residential areas.

Huang *et al.* (2021) extend the previous analysis on China by studying property transactions in sixty cities between January 2019 and September 2020. The results of a difference-in-differences analysis show a negative and moderate effect on property prices but a strong negative effect on transaction volumes, which collapsed just after the emergence of COVID-19. Housing prices fell by about 2% on average, but the price of apartments near city centres has fallen more sharply; the authors conclude that the crisis has changed household preferences with regard to their location choices. Finally, Qian *et al.* (2021) also examine the impact of COVID-19 on property prices. Using difference-in-differences models, they find that property prices in regions where COVID-19 cases are confirmed would have dropped by 2.5%. This effect persisted for three months and its extent increased over time. However, this effect seems to be observed only in the regions the most affected by the pandemic.

For the United States, Gupta *et al.* (2021) study the variations in prices and rents following the pandemic in the thirty largest agglomerations. They estimate a model in which price is a function of distance to the city centre, of local and temporal fixed effects and of various control variables measured before the pandemic. They show that prices have continued to rise despite the COVID-19 crisis, but more strongly in neighbourhoods located away from the centre than in central neighbourhoods, leading to a significant flattening of the land rent gradient.

Ramani & Bloom (2021) also examine the effects of the COVID-19 crisis on property markets and migration patterns in major American cities. To that end, they estimate models in which the change in prices (or population) between February 2020 and February 2021 is explained by changes in population density during the previous period, distance to the centre and fixed effects. Two major facts emerge. First, they highlight a shift in the demand for property (from both households and companies) from the centre to the outskirts of major cities. This is the so-called "doughnut effect", which reflects a decline in city-centre activity and a shift to the peri-urban ring. This effect seems particularly

4. *And on differences-in-differences with continuous treatment.*

prominent in larger cities, while it is absent in smaller ones. Next, no movement of this type appears between the major cities considered. The existence of an 'intra' effect, but not an 'inter' effect suggests that the development of working remotely now makes it possible to move away from one's workplace, but that the persistence of hybrid forms of work (combining working on site and at home) limits the possibility of living too far away and, therefore, in another major city.

However, work by Brueckner *et al.* (2021) appears to lead to different results. Focusing on inter-agglomeration effects, and concentrating particularly on the effect of the COVID-19 crisis on working remotely, they decompose the variations in property prices according to the potential telework of urban areas in the United States. Based on estimates that combine telecommuting potential and a measure of city productivity, their analysis shows that cities with high productivity and high potential for telework have seen prices fall since the onset of the health crisis. However, no significant price change is observable for agglomerations with few amenities and high telecommuting potential.

Finally, Liu & Su (2021) also examine the impact of the pandemic on demand for housing on the US market by combining a temporal indicator (pre- or post-COVID) with different characteristics, such as population density or distance to the centre. Their main results confirm a change in behaviour following the pandemic: it would have led to a large shift in the demand for housing away from city centres and dense neighbourhoods to suburbs and neighbourhoods with a lower population density. The authors also note a significant shift in housing demand outside the major cities, although this is not as significant as the shift from city centres to the suburbs.

2. Methodology: Assumptions, Data and Variables and Empirical Strategy

In urban economics, two major categories of theoretical models make it possible to analyse the market at different levels. Firstly, the basic residential choice model, developed in particular by Alonso (1964), Mills (1967) and Muth (1969), based on the mechanisms behind the formation of property prices within an agglomeration. Secondly, the Rosen-Roback model (Rosen, 1979; Roback, 1982) based on the determining factors behind price differences between agglomerations. We draw from these models four hypotheses that we aim to test. We then present our data and variables, then our empirical approach.

2.1. Hypotheses

2.1.1. Within an Urban Agglomeration

According to the basic residential choice model, there is a trade-off between housing size and distance to the central business district (CBD). At the equilibrium, increased transport costs must be exactly offset by a decrease in the amount spent on property. Under these conditions, property prices decrease continuously with distance to the CBD, while the size of housing per individual increases with the distance. In addition, since housing size increases with distance to the centre, population density decreases across urban space.

Based on the conclusions of the Alonso-Muth-Mills model, it is easy to understand how the COVID-19 crisis can change the existing urban equilibrium. Indeed, the possibility to work from home can alter two major parameters of the Alonso model. On the one hand, it decreases the cost of transport to the CBD. Since it is no longer necessary to go to the workplace every day, the cost of transport is reduced at any point in the urban area. Locations close to the centre, which were sought after due to low transport costs, therefore become relatively less advantageous. In other words, the lower the transport cost, the lower the price difference between central and peripheral locations.

On the other hand, the increased need for residential space, in particular the need for a garden or an additional room in which to work, changes households' utility function. This phenomenon is increased due to changes in household preference in relation to housing size following successive lockdowns. All else being equal, a unit of space then provides a higher utility than before. As housing sizes are fixed in the short or medium term, households will choose to relocate where housing sizes correspond to their demand. This results in valuing locations where space is accessible. Thus, bid-rents will increase in sparsely populated locations. There should then be an increase in prices and population in the areas where space is most accessible, i.e. areas that were originally sparsely populated.

On this basis, we retain two initial hypotheses:

- *Hypothesis 1:* Property prices fall near the CBD and rise in more distant locations.
- *Hypothesis 2:* Demand increases in sparsely populated locations, leading to higher prices and populations in these locations.

2.1.2. Between Agglomerations

The Alonso model focuses on the mechanisms underlying the formation of property prices within an agglomeration. The work of Rosen (1979) and Roback (1982) is better able to account for potential price dynamics between agglomerations following the crisis. This work models the trade-offs made by households between the wage they can obtain, the level of amenities they can enjoy and the property price they have to pay in a given region. The wage is set exogenously by the level of productivity of the region and the level of amenities is also assumed exogenous. With a constant level of amenities, the regions with the highest wages must also have high property prices. Conversely, with a constant level of productivity (i.e. equal wages), the spatial equilibrium will be achieved by higher property prices in regions with more amenities.

The development of remote working, which is one of the consequences of the COVID-19 crisis, has the effect of making the relationship between the place of work and the place of residence more flexible, revealing new spatial trade-offs within the framework of the model set out above. Brueckner *et al*. (2021) explicitly incorporate the possibility of working remotely in this model, considering that an individual can work in any city without the need to reside there. They show that if cities differ only in their level of productivity, the implementation of remote working will allow a part of the population to move to the least productive city, where the price of property is lower, while continuing to work for a company in the most productive city and benefitting from higher wages. In the end, these migrations will lower property prices in the most productive city, with a loss of population, and will increase them in the less productive city.

Then, they examine what happens with constant productivity levels, but different amenity levels. The development of telework allows a part of the population to move to the most attractive city in terms of amenities, while keeping their job in the city with fewer amenities. In this case, there will be an increase in price differences between cities. Another mechanism can reinforce this effect: the lockdowns increased the value attached to certain amenities, for example natural spaces.

We thus retain two other hypotheses:

- *Hypothesis 3:* Prices fall in high-productivity agglomerations and rise in low-productivity agglomerations.

- *Hypothesis 4:* Prices rise in agglomerations with a high level of amenities and fall in agglomerations with a low level of amenities.

2.2. Data and Variables

Our data are based on real estate transactions listed in the property valuation applications (*Demandes de valeurs foncières* – DVF) from 2016 to July 2021 (the most recent data available when this study was conducted). These data, provided by the Directorate-General for Public Finance (*Direction Générale des Finances Publiques* – DGFIP), relate to the property sales published in the mortgage records, supplemented by the description of the property from the land register, over a maximum period of five years. For each registered sale, the nature of the property, its address and surface area, the date of transfer and the declared property value[5] are specified. We do not take into account industrial and commercial real estate.

The intra-urban area analysis only retains municipalities belonging to urban areas of more than 500,000 inhabitants (which gives 16 urban areas) and the inter-urban area analysis excludes urban areas grouping together multi-pole municipalities (i.e. linked to several urban areas) or isolated municipalities. We also exclude municipalities with extreme average price values.[6] Ultimately, the sample of municipalities contains 4,537 different municipalities spread over 16 urban areas and the sample of urban areas contains 736 different urban areas. The study focuses only on metropolitan France. Table 1 provides an overview of the construction of the samples.

The DVF are used to calculate the logarithm of the average price in municipalities (for intra-urban area analysis) and in urban areas (for inter-urban area analysis).

For explanatory variables, multiple sources are used:

- The distance to the centre of the urban area is calculated for each municipality using the projection systems of the French national geographic institute (*Institut géographique national* – IGN). The centre corresponds to the central business district in each of the urban areas chosen[7] and the distance is a Euclidean distance calculated from

5. *https://www.data.gouv.fr/fr/datasets/demandes-de-valeurs-foncieres-geolocalisees/.*
6. *Average prices of more than €10 million or less than €20,000.*
7. *It is the economic centre of each area and not the geographical centre. In the case of polycentric urban areas such as Aix-Marseille, a choice had to be made, and we chose Marseille, the largest of the two. However, areas with this type of configuration are rare in France.*

Table 1 – **Samples of municipalities and urban areas**

Initial sample		
Number of municipalities		**Number of urban areas (UAs)**
35,454		739
Exclusion of municipalities from UAs with fewer than 500,000 inhabitants		Exclusion of multi-pole municipalities from UAs
Number of municipalities	Number of urban areas	
4,539	16	736
Suppression of extreme values		
Number of municipalities	Number of urban areas	
4,537	16	

Notes: The number of municipalities and urban areas per sample corresponds to the number of different municipalities and urban areas present in the sample. The 16 urban areas of the intra-urban area analysis are: Avignon, Douai-Lens, Bordeaux, Grenoble, Lille, Lyon, Marseille-Aix-en-Provence, Montpellier, Nantes, Nice, Paris, Rennes, Rouen, Saint-Etienne, Toulon and Toulouse.

the geographical coordinates of a municipality *i* and the centre *j* of the area. This first indicator is used in relation to H1: "property prices fall near the central business district".

- The population density in the municipalities is calculated from the data from the INSEE population census (for the year 2017). This indicator allows us to test H2: "demand rises in sparsely populated locations". The median incomes of urban areas are determined using the localised social and tax file (*Fichier Localisé Social et Fiscal* – Filosofi) for the year 2017. Median incomes will be used as a proxy for the productivity in the urban area[8] and thus allow us to test H3, according to which "prices fall in high-productivity agglomerations".

- We also use indicators of natural amenities in the territories, in relation with H4 according to which "prices increase in agglomerations with a high level of amenities".[9] The amenities of the urban area are determined using the Corine Land Cover database, which provides a biophysical inventory of land use and its evolution, produced by visual interpretation of satellite images according to a 44-item classification.[10] On this basis, for the year 2018, we calculate the proportion of municipalities with natural areas and/or traversed by water courses (rivers and major tributaries) in the urban area. Specifically, we identify the municipalities that have one of these natural amenities and calculate the proportion they represent in the total number of municipalities in the urban area.

Table 2 presents descriptive statistics for the sample of municipalities and the sample of urban areas. They show that prices increase over time in both samples. Prices also appear higher on average in the sample of municipalities than in the sample of urban areas. This is due to the exclusion of the municipalities in urban areas with fewer than 500,000 inhabitants. The population density measured across the sample of municipalities is higher than that measured for France as a whole (105.5 inhabitants/km^2 in 2018). This is also due to the exclusion of municipalities from small urban areas, where the population density is much lower. Finally, the proportion of houses in the transactions is lower at urban area level than at municipality level because of the restriction to these more densely populated areas where apartments are more frequent.

2.3. Empirical Strategy

Our approach consists in estimating difference-in-differences models as presented by Angrist & Pischke (2008, p. 175). We estimate the prices of transactions that occurred from 2016 to 2021 to explore the effect of the emergence of the pandemic on the link between price and population density, between price and distance from the centre at municipality level within large urban areas, between prices and incomes, and between prices and amenities at urban area level.

As in the majority of recent studies on the subject (Brueckner *et al.*, 2021; Ramani & Bloom, 2021), prices are used at an aggregate level (i.e. the municipality or the urban area).[11] However, we control for the composition of sales in terms of property type (apartments or houses). The loss of precision compared to the use of hedonic regressions is low in our case, for two reasons. Firstly, the DVF contain little information on housing characteristics. However, the hedonic price method applied to housing is first

8. Data available via https://www.insee.fr/fr/statistiques/4291712
9. For reasons relating to data access, the test focuses on a restricted version of H4, considering only natural amenities. Other amenities, such as cultural amenities, are also important in the choice of location by households, even though it is conceivable that the crisis may have led to placing particular value on natural amenities.
10. Data available at the following address: https://www.statistiques.developpement-durable.gouv.fr/corine-land-cover-0
11. The number of municipalities per urban area (278 on average) and the average price differences between municipalities in the same urban area are important because of the restriction to municipalities in the largest agglomerations.

Table 2 – **Descriptive statistics**

	Mean	Standard error	Min.	Max.
Municipalities				
Property prices (€):				
2021	263,888	137,595	20,000	3,514,152
2020	252,464	117,911	20,000	2,410,636
2019	241,939	124,607	20,000	2,819,515
2018	233,688	106,570	20,000	1,854,240
2017	226,217	105,642	20,500	2,912,882
2016	218,230	105,302	21,000	2,968,701
Proportion of houses (%)	81.5	30.8	0.0	100.0
Population density (inhabitants per km^2)	634.5	1861.8	0.5	26,602.9
Distance to the centre of the urban area (km)	34.1	19.5	0.2	92.1
Urban areas				
Property prices (€):				
2021	161,575	115,271	32,000	2,114,600
2020	151,609	80,914	20,000	1,112,869
2019	143,872	79,855	54,929	1,474,643
2018	142,048	86,356	49,308	1,813,649
2017	138,396	70,086	49,408	1,245,500
2016	135,139	68,198	46,968	1,289,067
Proportion of houses (%)	69.6	24.4	0.0	100.0
Median income (€)	19,636	1892	12,390	31,860
Proportion of natural spaces (%)	26.1	21.6	0.0	91.3
Proportion of tributaries and rivers (%)	0.4	1.1	0.0	9.8

Sources: DVF 2016–2021; INSEE 2017 population census; Corine Land Cover 2018.

and foremost used to obtain implicit prices for these characteristics. The lack of information therefore makes this method less essential. Secondly, we are more interested in the valuation of the characteristics of the municipality (or urban area) in which the property is located. Reasoning at aggregate level therefore seems more appropriate.

The difference-in-differences method is based on the assumption of "parallel trends" according to which price developments, in the absence of COVID-19, would have been the same in the different categories of municipalities considered. To verify this, a standard test consists in comparing the trends observed over periods prior to the event in question. If these prior trends are similar, it can be assumed that they would have been in the absence of COVID-19. However, it is possible to take into account the existence of a linear trend difference in our estimation strategy, by including annual linear trends by municipality (see 2.3.1 below) or by removing from the data a linear trend from the coefficients estimated in an initial step (see 2.3.2 below).

In addition, two distinct but complementary levels of analysis are developed: one at intra-urban area level, between municipalities, the other at inter-urban area level, between urban areas.

2.3.1. Specifications for Intra-Urban Area and Inter-Urban Area Analysis

In order to explain price differentials at intra-urban area level, the estimated model is as follows:

$$\ln price_{cat} = \alpha + \beta Density_c + \delta Distance_c + \gamma Covid_t \times Density_c + \tau Covid_t \times Distance_c + \rho X_{ct} + \phi_{at} + \vartheta_{cm} + \theta_c Year_t + \varepsilon_{cat} \quad (1)$$

where $price_{cat}$ is the average price of housing in municipality c in urban area a as of date t, $Density_c$ is the population density in the municipality and $Distance_c$ is the distance between municipality c and the centre of the urban area, with these two variables being measured before COVID-19 and constant over time. $Covid_t$ is a dichotomous variable indicating the COVID-19 period (after March 2020). γ and τ respectively measure the variation of gradients associated with distance to the centre and population density after the emergence of COVID-19. We control for the proportion of houses in property transactions (X_{ct}). It is important to take this into account when explaining the variations in property prices, since the average price per square metre varies according to the type of property and the demand for houses is likely to have changed after the COVID-19 crisis, which may have led to changes in the composition of sales. ϕ_{at} are "date×urban area" fixed effects that reflect macroeconomic factors assumed to be unchanging between municipalities, as well as possible shocks affecting price dynamics in specific urban areas. ϑ_{cm} are "municipality×month" fixed effects: in addition to controlling for unobserved characteristics of the municipality that do not vary over time, they take into account possible differences in price seasonality between municipalities. In general, these fixed effects have the function of taking into account local characteristics that could explain a preference among households for certain territories, such as the presence of large infrastructures (universities, hospitals, TGV stations, etc.) and/or good Internet coverage, which vary little or not at all over time.

To take into account potential pre-existing differences in the evolution of prices, we introduce annual linear trends, $\theta_c Year_t$, into the model for each municipality. This allows controlling for differences in linear trends between the prices in municipalities observed before the emergence of COVID-19. Such a strategy thus allows to relax this assumption of "parallel trends" in the absence of the emergence of COVID-19 (Mora & Reggio, 2019; Egami & Yamauchi, 2021). In other words, it becomes possible to identify an exogenous effect of COVID-19, under the assumption that any pre-existing trend in prices between densely and sparsely populated municipalities (or between municipalities that are distant and close from the centre) is linear and would have continued at the same rate in the absence of the emergence of COVID-19.

At inter-urban area level, the model is estimated as follows:

$$\begin{aligned} \ln price_{at} = {} & \alpha + \beta Prod_a + \delta Amenities_a + \gamma Covid_t \\ & \times Prod_a + \tau Covid_t \times Amenities_a + \rho X_{at} \\ & + \phi_t + \vartheta_{am} + \theta_a Year_t + \varepsilon_{at} \end{aligned} \quad (2)$$

where $price_{at}$ is the average price of housing in urban area a as of date t. $Prod_a$ is the productivity (proxied by the median income) in urban area a and $Amenities_a$ are the natural amenities of urban area a. γ and τ measure the variation in gradients associated with productivity and amenities after the emergence of COVID-19. X_{at} here measures the proportion of houses in the transactions carried out in the urban area. ϕ_t are fixed temporal "month×year" effects and ϑ_{am} are fixed "urban area×month" effects that make it possible to control these differences between urban areas that do not vary over time as well as differences in price seasonality between urban areas. In the same way as before, annual linear trends by urban area, $\theta_a Year_t$, make it possible to control any potential differences in prices linear trends between urban areas.

The estimated coefficients related to level variables may be affected by the omission of certain variables. But, as indicated by Brueckner *et al.* (2020), since the coefficients of interest are related to interactions between variables and the post-COVID-19 period, the risk of bias related to their omission is relatively limited.[12] Nevertheless, for the intra-urban area analysis, although we use a wide range of fixed effects, identification is based on the assumption that no shock other than COVID-19 affects differently housing prices in municipalities depending on their population density or distance to the centre of the area. Our results remain subject to the assumption of the absence of other shocks alongside COVID-19 that would differently affect municipalities within areas on a non-seasonal basis. For example, it could be that the results of the municipal elections at the end of June 2020 led to variations between municipalities, with the establishment of moratoriums on construction in some cities. However, for this to create a bias in estimates, the establishment of these moratoriums would have to be systematically correlated with the distance from the centre or the population density of the municipalities, which seems unlikely. Likewise, for inter-urban areas analysis, the assumption is that no shock other than COVID-19 affects housing prices in urban areas differently depending on their income or amenity levels.

2.3.2. Dynamic Specifications

To estimate annual gradient variations at the intra-urban area level, we estimate:

$$\begin{aligned} \ln price_{ct} = {} & \alpha + \beta Density_c + \delta Distance_c \\ & + \sum_{\substack{l=-3 \\ l\neq 0}}^{2} \gamma^l Covid_{t+l} \times Density_c + \sum_{\substack{l=-3 \\ l\neq 0}}^{2} \tau^l Covid_{t+l} \\ & \times Distance_c + \rho X_{ct} + \phi_{at} + \vartheta_{cm} + \varepsilon_{ct} \end{aligned} \quad (3)$$

The dichotomous variables $Covid_{t+1}$ are defined in relation to the emergence of Covid. For example, $Covid_{t+2}$ equals 1 for the average price of a municipality observed two years after

12. *Our modelling does not allow taking into account potential spatial autocorrelation in the determination of property prices. This phenomenon appears limited in the case of inter-urban areas analysis, since the sample consists of the largest urban areas, each of which represents a specific property market and which are relatively distant from each other. It is more likely in intra-urban area analysis because the setting of prices in one municipality can effectively impacts prices in neighbouring municipalities. Nevertheless, we group together the standard errors for the municipality (or urban area), which allows taking into account a potential serial correlation of the error term.*

the emergence of COVID-19, i.e. in 2021, and otherwise it equals 0. As COVID-19 appeared in France in 2020, the reference period is the year 2019.[13] The coefficients γ^l and τ^l flexibly reflect the evolution of the distance from centre and population density gradients around the year 2019 (i.e. from 2016 to 2021).

This specification also makes it possible to test the assumption of parallel trends of prices between municipalities of different population densities and at different distances from the centre of the area before COVID-19. Indeed, the coefficients γ^l and τ^l for the periods before the pandemic inform us about the potential presence of prior trends in the evolution of the gradients associated with population density and distance from centre.

To take into account the possibility that prices will evolve differently in densely and sparsely populated municipalities (respectively municipalities distant and not far from the centre of the urban area) before the emergence of COVID-19, we use our estimates of γ^l (respectively τ^l for the preceding years (2016 to 2019) to adjust a linear temporal trend. We then remove this linear trend from our data, in the same manner as Monras (2018).[14] Specifically, this method consists of estimating a linear trend for the coefficients before COVID and removing this trend from the price variable data (or performing a projection for the post-COVID period and calculating the effect based on the difference between the estimated post- COVID coefficients and this projection). Next, we re-estimate equation (3) using the new trend-free price variable.

For the inter-urban area analysis, we estimate:

$$\ln price_{at} = \alpha + \beta Prod_a + \delta Amenities_a + \sum_{\substack{l=-3 \\ l\neq 0}}^{2} \gamma^l Covid_{t+l} \times Prod_a + \sum_{\substack{l=-3 \\ l\neq 0}}^{2} \tau^l Covid_t \times Amenities_a + \rho X_{at} + \phi_t + \vartheta_{am} + \varepsilon_{at} \quad (4)$$

where $price_{at}$ is the average price of housing in urban area a as of date t. As before, the dichotomous variables $Covid_{t+l}$ take the value 1 when an urban area is $t+l$ years after the date when the COVID appeared. $Prod_a$ is our measurement of productivity and $Amenities_a$ are the natural amenities in urban area a. γ and τ measure the variation in the gradients associated with productivity and amenities after the emergence of COVID. The coefficients γ^l and τ^l flexibly reflect the evolution of the gradients for productivity and the presence of natural amenities.

3. Results

3.1. First Descriptive Approach to the Evolution of Prices

Figure 1 presents the quarterly evolution of prices in municipalities within urban areas according to distance to the centre of the urban area and the population density of the municipality. This representation allows an initial exploration of H1 and H2, according to which property prices fall near the central business district and in densely populated municipalities and increase in others. We calculate an average, weighted by population in 2017, of price indices at municipality level and we compare the price evolution between municipalities according to distance to the centre (with a threshold of 25 km corresponding to the median distance) on the one hand, and according to population density (with a threshold of 279 inhabitants/km^2 corresponding to the median population density), on the other.

The evolution of prices is quite close in both groups of municipalities, whether before or after the appearance of COVID (Figure I-A). In contrast, a change is evident in the evolution of prices according to population density (Figure I-B): they rise more sharply in the most densely populated municipalities over the period 2017-2020, then more quickly in the least densely populated municipalities from March 2020 onwards.

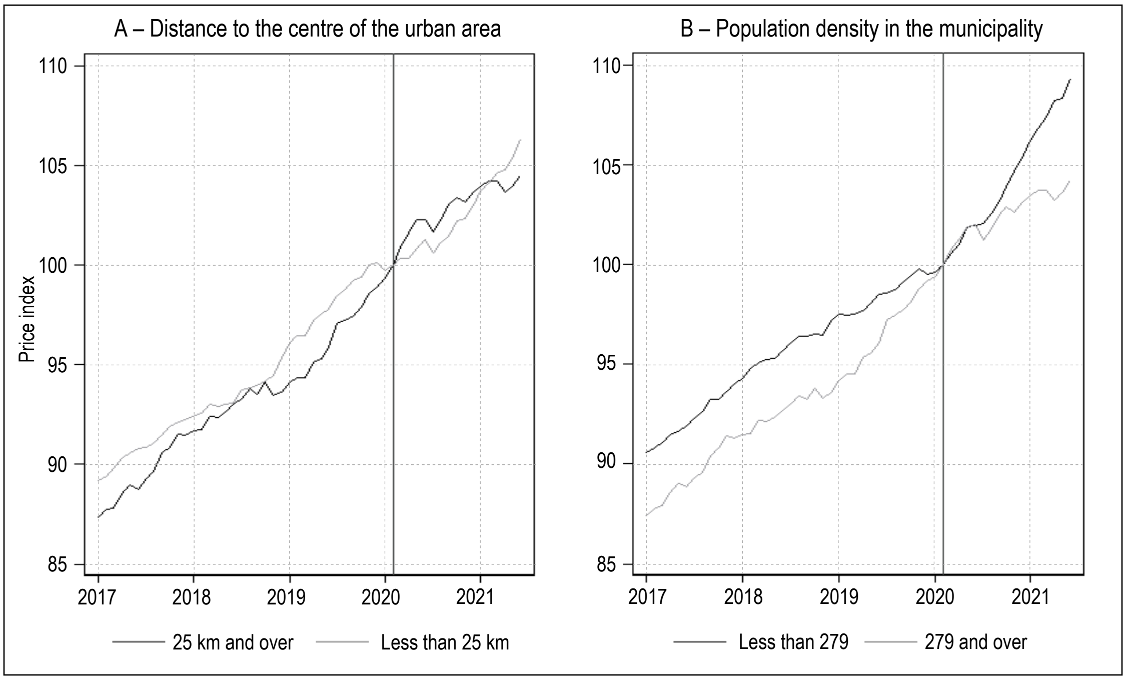
Figure II shows the variation in property prices according to the median income of the urban area, which is used as a proxy for productivity. In this way, we explore H3, according to which “prices fall in high-productivity agglomerations”. Two groups of urban areas are distinguished according to median income (on either side of the national annual median income in 2017). Between 2017 and 2020, prices rose the most in urban areas with the highest median income, reflecting their overall attractiveness and the dynamism of the property market. From March 2020 onwards, price rises slowed down in those areas and accelerated in urban areas where the median income is less than €19,500.

Finally, we compare the variation of prices between urban areas according to level of

13. The observations corresponding to the first three months of 2020 are removed, as the prices cannot have been affected by the COVID crisis at this time.

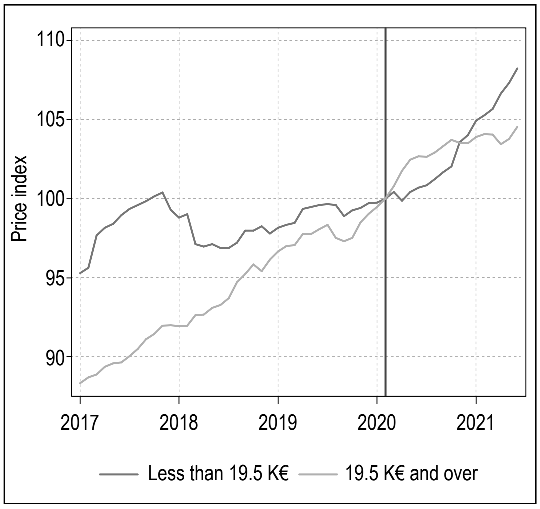
14. This method is similar to that used by Dustmann et al. (2022) or Ahlfeldt et al. (2018) who then plot the differences between the estimates of γ^l (respectively τ^l and the linear temporal trend predicted for the years after the implementation of a policy.

Figure I – **Price variation in municipalities of large urban areas according to the distance to the centre of the urban area and population density**



Notes: The price index is the population-weighted average calculated for all municipalities in each group. Each aggregated index is normalised so that March 2020 = 100. The moving average of prices in each group over the last 12 months is then calculated.
Sources: DVF 2016-2021; INSEE, 2017 population census; French national geographic institute (IGN).

Figure II – **Evolution of prices of urban areas according to median income**



Sources: DVF 2016-2021; INSEE, 2017 population census.

natural amenities (proportion of natural spaces and presence of large tributaries or rivers), in relation to H4 according to which "prices increase in agglomerations with a high level of natural amenities". The price trend remained of the same order of magnitude both before and since the beginning of the crisis in urban areas where the proportion of natural spaces is above the median, while it has fallen slightly for other urban areas (Figure III-A). In contrast, the price increase is slightly higher in urban areas with a watercourse between 2017 and 2020 and then, from March 2020 onwards, prices seem to stabilise in urban areas with such an amenity, while they continue to increase sharply in the other areas (Figure III-B).

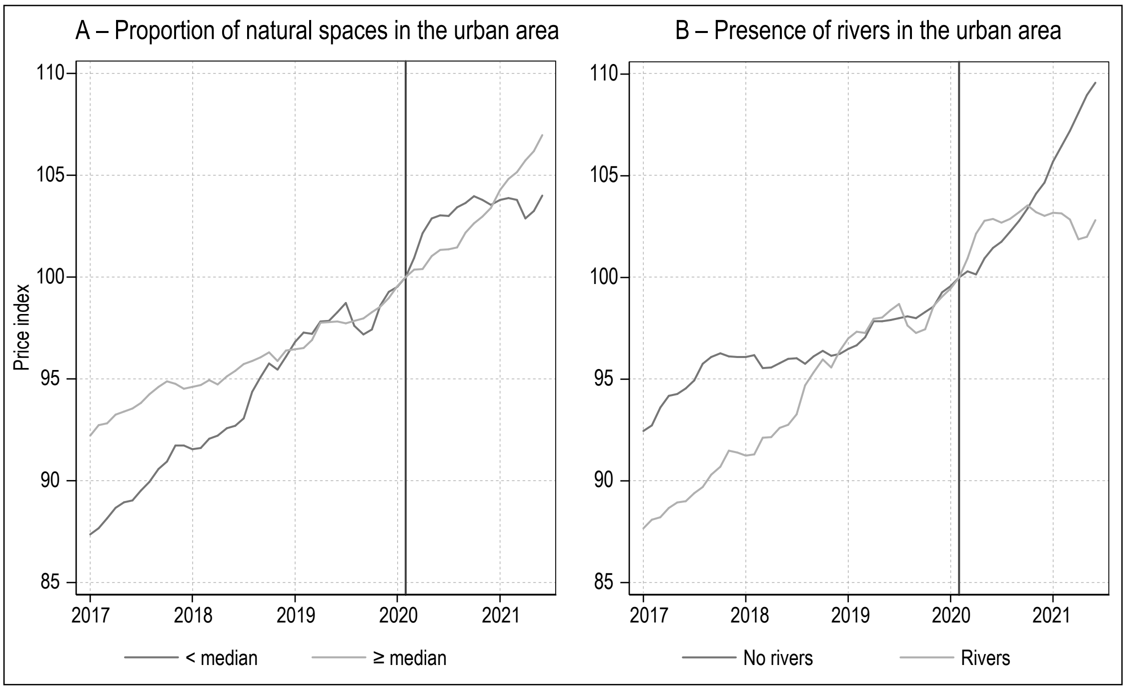
3.2. Estimation Results

3.2.1. Intra-Urban Area Analyses

To analyse the changes in the evolution of prices that occurred after the emergence of COVID-19 between the municipalities of large agglomerations, we estimate equation (1). Fixed municipality effects are introduced to control for possible differences in unobserved characteristics between municipalities, then "date×urban area" and "month×municipality" fixed effects are added to control, respectively, for potential shocks altering price dynamics in certain urban areas, and seasonal variations in prices specific to each municipality. We finally introduce annual linear trends for each municipality, to control for differences in prior linear trends in the evolution of prices. The results are shown in Table 3.

First of all, Table 3, column 1 shows that property prices are negatively associated with the distance to the centre of the urban area, which is a classic result in urban economics. They are also positively associated with population density, which is also as expected. The inclusion of municipality fixed effects has little effect on outcomes. In

Figure III – **Evolution of prices in urban areas according to natural amenities**



Sources: DVF 2016-2021; Corine Land Cover 2018.

Table 3 – **Regressions at municipality level**

Variables	(1)	(2)	(3)	(4)	(5)
Population density (inhabitants/km²)	0.0016***				
	(0.0003)				
Distance to the centre of the UA (km)	−1.1544***				
	(0.0326)				
COVID × Population density	−0.0003***	−0.0004***	−0.0002**	−0.0002*	−0.0005***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
COVID × Distance to the UA centre	0.0044	0.0008	0.0283*	0.0328**	0.0522**
	(0.0128)	(0.0120)	(0.0156)	(0.0163)	(0.0238)
Fixed urban area effects	Yes	No	No	No	No
Fixed Month × Year effects	Yes	Yes	Yes	Yes	Yes
Fixed municipality effects	No	Yes	Yes	Yes	Yes
Date × Urban area	No	No	Yes	Yes	Yes
Month × Municipality	No	No	No	Yes	Yes
Municipality linear trend	No	No	No	No	Yes
Observations	193,173	193,162	193,162	187,031	187,031
R^2	0.2255	0.5083	0.5121	0.6352	0.6522

Notes: *** p<0.01; ** p<0.05; * p<0.1. Standard errors grouped with the municipality in brackets. The estimated coefficients are multiplied by 100 to make them easier to read. The proportion of houses in the municipality is controlled.
Reading note: Each additional 1 kilometre of distance to the centre of the urban area is associated with a 1.15% drop in prices in the municipality. After March 2020, the drop in prices is 1.11% (−1.15+0.04).
Sources: DVF 2016-2021; INSEE, 2017 population census.

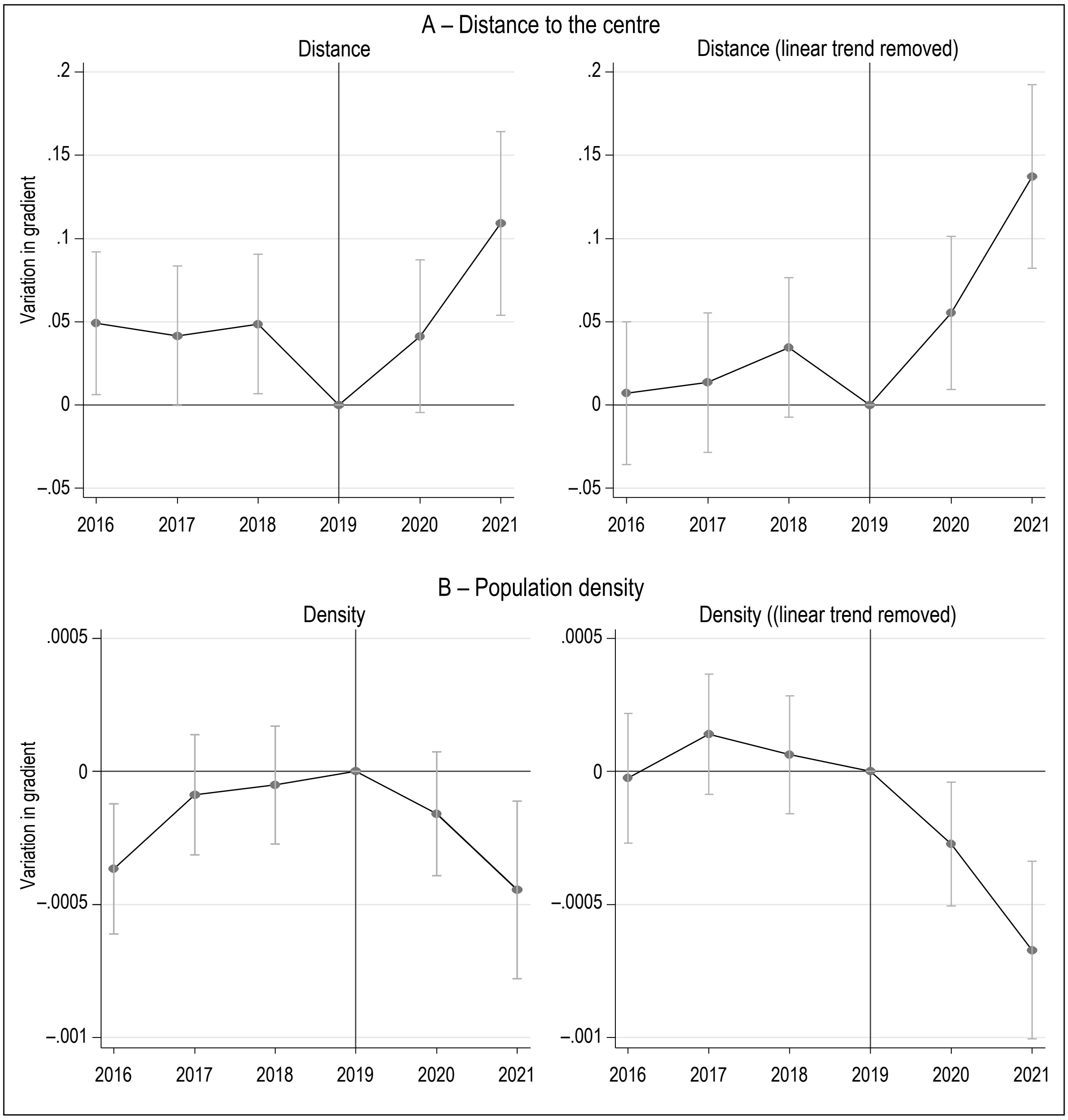
contrast, the range of the estimated coefficients is affected more by the addition of the fixed effects “date×urban area” (column 3) and “month×municipality” (col. 4) and by the linear temporal trends by municipality (col. 5). Taking the latter into account tends to increase the significance and range of the estimated coefficients. This is an expected result since price trends before COVID-19 were sometimes different depending on population density and distance to the centre of the urban area (cf. Figure I). The results ultimately show a relative increase in prices in municipalities which have a lower population density and are farther from the centre.

As the analysis of Figure 1 suggested, the difference in prices between densely populated municipalities and more sparsely populated municipalities narrowed after March 2020. The estimation shows that the increase in population density by one additional inhabitant/km^2 was associated with a price increase of 0.0016% in a municipality between 2016 and March 2020 (Table 3, col. 1). Applying the post-COVID change (col. 5), the same increase in population density was associated with a price increase of only 0.0011% (0.0016−0.0005). This suggests that the attractiveness of purely urban amenities, present in densely populated areas, has lessened in favour of greater demand for space.

There is also a change in relation to the distance from the municipality to the centre of the urban area. The price gradient associated with distance changed from −1.15% for each additional kilometre farther away from the centre to a gradient of −1.10% (−1.15+ 0.05) after March 2020. The distance to the centre of the area, which represents a point of interest for households, therefore remains a factor of lower prices, but less of a factor since the start of the pandemic than it was previously. While proximity to the centre is still sought after in the demand for property, it now seems less valued.

The results obtained with the flexible specifications (equation 3) are presented in Figure IV, first with the same controls as in column 4 of Table 3, then in a version where their (linear) price trends before COVID are removed, i.e. the flexible version of the results presented in column 5 of Table 3. The coefficients correspond to the estimated gradient variations compared to the reference period of 2019.

Figure IV – **Variation in price gradients associated with distance to the centre and population density in the municipality**



Notes: The vertical bars represent the 95% confidence intervals. The first three months of 2020 have been removed.
Sources: DVF 2016-2021; INSEE, 2017 population census; IGN.

As the previous results suggest, even if the coefficients estimated before the emergence of COVID-19 are not always significant, we observe a downward linear trend in the variation of the gradient related to distance (Figure IV-A): before 2020, the distance-related price gradient was lower in absolute value in 2016 than in 2019 and appears to have increased in a fairly linear manner between these two periods; there seems to have been a trend towards concentration around city centres. The year 2020 marks a clear break and a reversal of the trend evidenced by a decrease in the gradient in absolute value. The presence of a trend prior to COVID-19 would therefore tend to cause an underestimation of the effects of the pandemic on the distance-related price gradient. When the previous trend is removed (Figure IV-B), the effects of the pandemic appear even more clearly.

The analysis is substantially identical with respect to the evolution of the population density-related gradient. Here too, there is a clear break in 2020: the trend towards rising prices in densely populated municipalities compared to less densely populated municipalities before the emergence of COVID-19 is followed by a clear relative decrease in prices in densely populated municipalities.

3.2.2. Inter-Urban Areas Analyses

Table 4 presents the results of the estimations for the inter-urban areas specification (equation 2), introducing first the "urban areas" fixed effects, then the "urban areas×month" fixed effects and, finally, the linear trends by urban area.

In line with the predictions of the Rosen-Roback model, we see the positive association between income (and therefore productivity) and property prices. When all controls are included (column 5), we see, after the appearance of the COVID crisis, a relative decrease in prices in urban areas where incomes are high, compared to urban areas where they are lower. While urban areas that show strong economic dynamism (measured by household income) remain very attractive and are therefore subject to strong demand for property, these phenomena are less pronounced after the appearance of COVID. This suggests a possible inflection in preferences, with urban areas with more modest dynamics having new appeal. It is likely that initially lower property prices will generate greater demand, which will ultimately contribute to higher prices in these markets.

In contrast, our results do not show price variations following the emergence of COVID-19 that would be explained by natural amenity variables. The "proportion of tributaries and rivers" variable is never significant and the significant effect of the "COVID×proportion of natural spaces" variable disappears when linear price trends are included. The presence of these natural amenities does not appear to be a particularly decisive feature in the choice of location of households after the crisis and H4 does not seem to be empirically validated in relation to the French property markets.

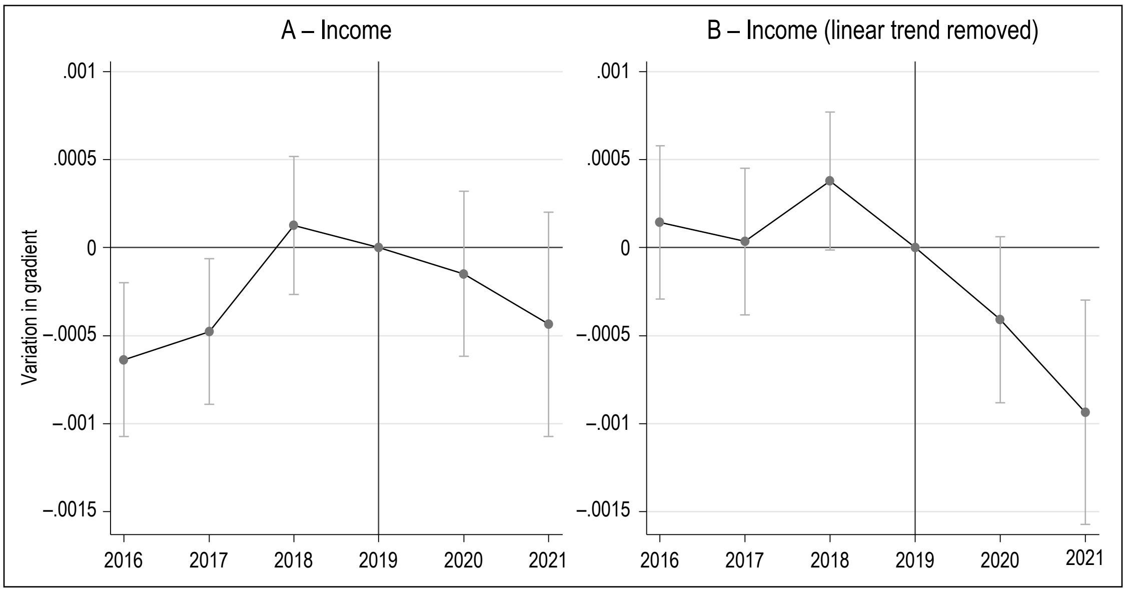
The results obtained from the flexible specifications (equation 4) are shown in Figure V (incomes) and Figure VI (natural amenities). As for the intra-urban area analysis, the model is estimated first without and then with control of (linear) price trends before COVID, which corresponds, respectively, to the controls of columns 3 and 4 of Table 4.

Table 4 – **Regressions at urban area level**

Variables	(1)		(2)		(3)		(4)	
Median income (€)	0.0110***	(0.0008)						
Proportion of tributaries and rivers (%)	1.1918	(0.9562)						
Proportion of natural spaces (%)	0.0053	(0.0538)						
COVID × Median income	0.0002	(0.0002)	−0.0000	(0.0002)	−0.0000	(0.0002)	−0.0006**	(0.0003)
COVID × Proportion of rivers and tributaries	0.2528	(0.4148)	0.0699	(0.3080)	0.0787	(0.3065)	0.5717	(0.4539)
COVID × Proportion of natural spaces	−0.0248	(0.0244)	−0.0704***	(0.0186)	−0.0662***	(0.0183)	−0.0019	(0.0227)
Fixed Month × Year effects	Yes		Yes		Yes		Yes	
Fixed urban area effects	No		Yes		Yes		Yes	
Fixed Urban area × Month effects	No		No		Yes		Yes	
Urban area linear trend	No		No		No		Yes	
Observations	46,976		46,976		46,973		46,973	
R^2	0.2477		0.6671		0.7264		0.7352	

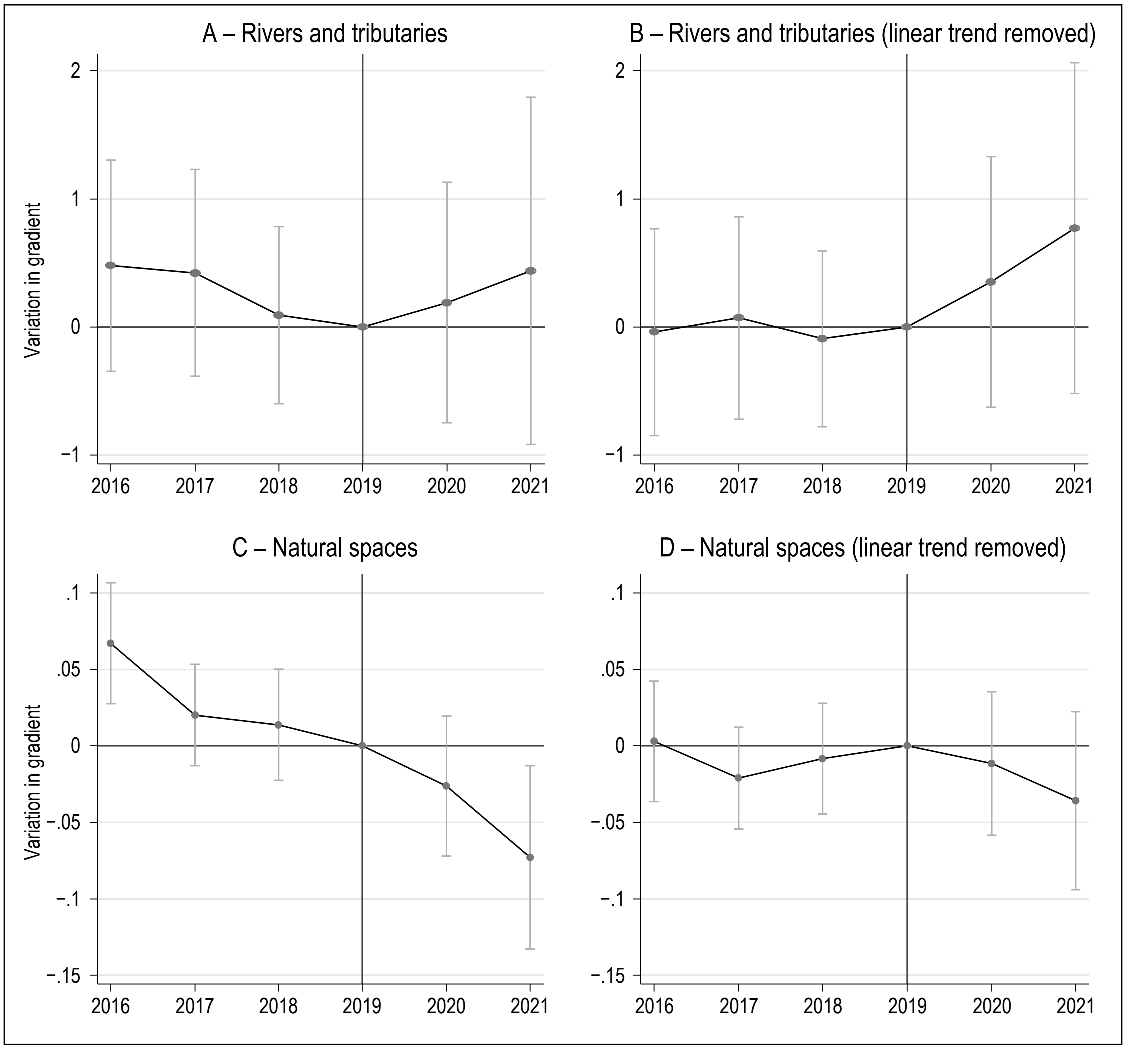
Notes: *** p<0.01; ** p<0.05; * p<0.1. Standard errors grouped with the urban area in brackets. The estimated coefficients are multiplied by 100 to make them easier to read. The proportion of houses in the urban area is controlled.
Reading Note: An increase in median income of €1,000 in the urban area is associated with a price increase of 11%.
Sources: DVF 2016-2021; INSEE, 2017 population census; Corine Land Cover.

Figure V – **Variation in price gradients associated with income**



Notes: The vertical bars represent the 95% confidence intervals. The first 3 months of 2020 have been removed.
Sources: DVF 2016-2021; INSEE, 2017 population census.

Figure VI – **Variation in price gradients associated with the proportion of rivers and tributaries and of natural spaces in the urban area**



Notes: The vertical bars represent the 95% confidence intervals. The first 3 months of 2020 have been removed.
Sources: DVF 2016-2021; Corine Land Cover 2018.

We first see that the gradient positively associating prices and incomes tended to increase in a quite linear way until 2018, stabilised between 2018 and 2019 and decreased sharply after that date (Figure V). Once the previous linear trend has been removed, the gradient decrease from 2020 onwards is even sharper. This confirms the previous results in relation to H3.

In contrast, we do not see any break in the gradients associated with the natural amenities of the urban area (Figure VI): the downward trend of the gradient associated with the proportion of natural spaces continues after 2020 and the gradient associated with the proportion of rivers appears relatively constant throughout the period. As suggested by the results of previous estimations, the evolution of prices according to the presence of these natural amenities within the urban area does not change substantially after the appearance of COVID.

3.3. Robustness

In the analyses conducted so far, we have examined the potential effects of the COVID crisis after March 2020, i.e. the beginning of the first lockdown. However, the effect of COVID on property prices is unlikely to have materialised in the first two months of the period, due to both the lockdown and the delays in completing property transactions. Nevertheless, we estimate an average effect over the period up to July 2021, which does not necessarily imply that the effect started as early as April. Moreover, prices are unlikely to be influenced by the inclusion or non-inclusion of transactions that occurred during lockdown, as there were few such transactions: the average number of transactions per municipality decreased by 53% in April 2020 compared to April 2019. Nonetheless, to check the robustness of the results to the exclusion of transactions unlikely to have been affected by the pandemic, we re-estimate our equations by delaying the start of the COVID period to June 2020, which corresponds to the month following the end of the first lockdown. The results, which are presented in the appendix, show that this change of date does not change the results.

We also carry out "placebo" tests. These tests consist in evaluating the effect of fictitious pandemics that would have occurred in 2017, 2018 and 2019 and considering only transactions that occurred before 2020. The idea is that these fictitious pandemics should not have a significant effect on price dynamics. We estimate the same specifications as those presented in column 5 of Table 3 for municipalities, and column 4 of Table 4 for urban areas, varying the start date of the pandemic between 2017 and 2019. The results (see Appendix) show – reassuringly – no significant change at the 5% threshold in price dynamics after these fictitious pandemics.

* *
*

In this article, we have sought to explore how the pandemic has affected household location choices and residential property markets in France. The results show that, at the intra-urban area level, prices increased relatively more in the least densely populated areas as well as in the areas located farthest from urban centres after the emergence of COVID-19, suggesting that households are seeking more space and place less value on the positive externalities that can be produced by a high population density. At the inter-urban areas level, the level of productivity, reflected by the level of income, also partly explains the differences in price variations. In contrast, we do not find any significant effect related to the level of amenities.

Our results therefore support the expectations of hypotheses 1 and 2, according to which property prices decrease in the centre and increase in the periphery of urban areas, where population densities are lower. They join the results of Gupta *et al*. (2021) and Ramani & Bloom (2021) based on American data. The former show that the crisis has indeed led to lower property prices and rents in city centres and higher prices in areas away from the centre (flattening this relationship between distance to the centre and prices in most US metropolitan areas). The latter show, in major American cities, a shift (the "donut effect") in household demand for property from densely populated city centres towards more sparsely populated suburban locations.

Our estimates also support hypothesis 3, according to which prices rise in agglomerations with low productivity. This result is in line with those obtained by Brueckner *et al*. (2021) which show, on the basis of US data, downward pressure on property prices in high-productivity cities following the health crisis and the development of working remotely. In contrast, hypothesis 4, according to which prices would tend to increase in agglomerations with a certain level of natural amenities, is not verified in our estimates. On this point, our results therefore differ from those obtained by Brueckner *et al*. (2021) showing that property prices have increased in cities with high levels of amenities and decreased in cities with low levels of amenities. However, for natural amenities, the authors use a richer set of indicators (differences in temperature, precipitation, proximity to the oceans, etc.), some of these not being available at the level of analysis carried out here. We therefore cannot rule out that the amenities that we take into consideration are not necessarily those for which the value placed on them has changed the most.

Our exploration also has other limitations that we must emphasise. In particular, we considered that the pandemic was able to affect the demand for property mainly through two factors: the increased use of telework and changes in preferences related to successive lockdowns. This allowed us to identify a limited number of hypotheses that could then be tested. However, this does not exclude other effects that the pandemic may have had on behaviour related to demand for property: for example, fear of contagion may have increased the psychological costs of transport. In this case, households would opt for locations close to the centre or would give preference to the use of a private vehicle, with an additional cost. This could then mitigate changes in the price gradient across the urban space. It is also not possible for us to distinguish between the respective effects of the two potential factors, or to say that they are precisely the ones that explain the observed evolutions of prices. Deeper societal changes, particularly in relation to work-life balance, may contribute to some of the changes just as much as changes directly caused by the crisis. If this is the case, the health crisis may have acted as an accelerator, leading households to concretise mobility projects they already considered before COVID.

Keeping these limitations in mind, it would nevertheless seem that, at intra-urban area level, we are witnessing a strengthening of the phenomenon of peri-urbanisation that has already been under way for several decades. The effect observed on the prices of the residential property markets of distant and sparsely populated municipalities suggests that it is primarily individuals who can work remotely, who are often executives and have strong economic and cultural capital, that have flocked to peri-urban municipalities. Therefore, in addition to an effect on property prices, these potential changes in the social composition of the inhabitants can ultimately have consequences on the overall economic dynamics of the municipalities. This can lead to gentrification processes, with increased inequality and greater exclusion of the most fragile social categories. Nevertheless, if relatively wealthy populations arrive in municipalities where less affluent populations can remain despite rising price dynamics, for example through social housing, this could foster social diversity.

At inter-urban areas level, the fact that property prices in cities with the lowest productivity are catching up suggests a broader economic and social rebalancing: territories that could have been losing economic impetus could be revitalised by the arrival of a new population. Nevertheless, at this stage, our analysis does not allow us to observe the effects of a social recomposition of municipalities or urban areas at granular level. In addition, it is difficult to determine whether the changes observed over the study period will be confirmed in the longer term or whether they are only temporary: our data stopped in July 2021, at a time when the pandemic was not over and government recommendations on working remotely were still in place. It is therefore necessary to question whether the changes observed will last beyond the pandemic and whether they will affect the dynamics of socio-spatial inequalities. ☐

BIBLIOGRAPHY

Ahlfeldt, G., Roth, D. & Seidel, T. (2018). The Regional Effects of Germany's National Minimum Wage. *Economics Letters*, 172, 127–130. https://doi.org/10.1016/j.econlet.2018.08.032

Angrist, J. & Pischke, J. (2008). *Mostly Harmless Econometrics*. Princeton University Press.

Alonso, W. (1964). *Location and Land Use. Toward a General Theory of Land Rent*. Cambridge: Harvard University Press.

Bergeaud, A., Eyméoud, J.-B., Garcia, T. & Henricot, D. (2022). Working From Home and Corporate Real Estate. *LIEPP Working Paper*. https://hal-sciencespo.archives-ouvertes.fr/hal-03548889

Brajon, D. & Leroi, P. (2022). Le télétravail s'installe durablement. L'Institut Paris Région, *Note rapide* N° 930. https://www.institutparisregion.fr/fileadmin/NewEtudes/000pack2/Etude_2728/NR_930_web.pdf

Breuillé, M., Le Gallo, J., & Verlhiac, A. (2022). Residential Migration and the COVID-19 Crisis: Towards an Urban Exodus in France? *Economie & Statistique / Economics and Statistics*, 536-37, 57–73 (ce numéro).

Bricongne, J.-C., Meunier, B. & Pouget, S. (2021). Web Scraping Housing Prices in Real-time: the Covid-19 Crisis in the UK. Banque de France*, Working Paper* N° 827. http://dx.doi.org/10.2139/ssrn.3916196

Brueckner, J., Kahn, M. & Lin, G. (2021). A New Spatial Hedonic Equilibrium in the Emerging Work-from-Home Economy. NBER *Working Paper* N° 28526. https://doi.org/10.3386/w28526

Cheung, K., Yiu, E. & Xiong, C. (2021). Housing Market in the Time of Pandemic: A Price Gradient Analysis from the COVID-19 Epicentre in China. *Journal of Risk and Financial Management*, 14(3), 1–17. https://doi.org/10.3390/jrfm14030108

Duc, C. & Souquet, C. (2020). L'impact de la crise sanitaire sur l'organisation et l'activité des sociétés. *Insee Première* N° 1830, décembre. https://www.insee.fr/fr/statistiques/4994488

Dustmann, C., Lindner, A., Schönberg, U., Umkehrer, M. & vom Berge, P. (2022). Reallocation Effects of the Minimum Wage. *Quarterly Journal of Economics*, 137(1), 267–328. https://doi.org/10.1093/qje/qjab028

Egami, N. & Yamauchi, S. (2021). Using Multiple Pre-treatment Periods to Improve Difference-in-Differences and Staggered Adoption Designs. *Working Paper*. https://doi.org/10.48550/arXiv.2102.09948

France Stratégie (2022). Les villes moyennes, un pilier durable de l'aménagement du territoire ? *La note d'analyse,* janvier 2022. https://www.strategie.gouv.fr/sites/strategie.gouv.fr/files/atoms/files/fs-2022-na107-villes-moyennes-janvier.pdf

Gupta, A., Mittal, V., Peters, J. & Van Nieuwerburgh, S. (2022). Flattening the Curve: Pandemic Induced Revaluation of Urban Real Estate. *Journal of Financial Economics*, 146(2), 594–636. https://doi.org/10.1016/j.jfineco.2021.10.008

Huang, N., Pang, J. & Yang, Y. (2021). COVID-19 and the Urban Housing Market in China. *Working Paper SSRN*. http://dx.doi.org/10.2139/ssrn.3642444

Liu, S. & Su, Y. (2021). The Impact of the COVID-19 Pandemic on the Demand for Density: Evidence from the U.S. Housing Market. *Economics Letters*, 207, 110010. https://doi.org/10.1016/j.econlet.2021.110010

McFadden, D. (1977). Modeling the Choice of Residential Location. *Transportation Research Record*. https://onlinepubs.trb.org/Onlinepubs/trr/1978/673/673-012.pdf

Mills, E. S. (1967). An Aggregative Model of Resource Allocation in a Metropolitan Area. *American Economic Review*, 57, 97–210. https://www.jstor.org/stable/1821621

Monras, J. (2019). Minimum Wages and Spatial Equilibrium: Theory and Evidence. *Journal of Labor Economics*, 37(3), 853–904. https://doi.org/10.1086/702650

Mora, R. & Reggio, I. (2019). Alternative Diff-in-Diffs Estimators with Several Pretreatment Periods. *Econometric Reviews*, 38(5), 465–486. https://doi.org/10.1080/07474938.2017.1348683

Muth, R. F. (1969). *Cities and Housing. The Spatial Pattern of Urban Residential Land Use*. Chicago and London: The University of Chicago Press.

Qian, X., Qiu, S., Zhang, G. (2021). The impact of COVID-19 on housing price: Evidence from China. *Finance Research Letter*, 43, 101944. https://doi.org/10.1016/j.frl.2021.101944

Ramani, A. & Bloom, N. (2021). The Donut Effect of Covid-19 on Cities. NBER *Working Paper* N° 28876. https://doi.org/10.3386/w28876

Roback, J. (1982). Wages, Rents, and the Quality of Life. *Journal of Political Economy*, 90(6), 1257–1278. https://www.jstor.org/stable/1830947

Rosen, K. T. (1979). A Regional Model of Multifamily Housing Starts. *Real Estate Economics*, 7, 63–76. https://doi.org/10.1111/1540-6229.00195

ROBUSTNESS ANALYSES

Table A1 – **Regression at municipality level (start June 2020)**

Variables	(1)	(2)	(4)	(5)	(6)
Population density	0.0016***				
	(0.0003)				
Distance to the UA centre	−1.1553***				
	(0.0326)				
COVID × Population density	−0.0004***	−0.0004***	−0.0002**	−0.0002**	−0.0005***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
COVID × Distance to the UA centre	0.0093	0.0062	0.0337**	0.0434***	0.0699***
	(0.0133)	(0.0125)	(0.0164)	(0.0168)	(0.0236)
Fixed Month × Year effects	Yes	Yes	Yes	Yes	Yes
Fixed municipality effects	No	Yes	Yes	Yes	Yes
Date × Urban area	No	No	Yes	Yes	Yes
Month × Municipality	No	No	No	Yes	Yes
Municipality linear trend	No	No	No	No	Yes
Observations	193,173	193,162	193,162	187,031	187,031
R^2	0.2255	0.5083	0.5121	0.6352	0.6522

Notes: *** p<0.01; ** p<0.05; * p<0.1. Standard errors grouped with the municipality in brackets. The estimated coefficients are multiplied by 100 to make them easier to read. The proportion of houses in the municipality is controlled.
Sources: DVF 2016-2021; INSEE, 2017 population census.

Table A2 – **Regression at urban area level (start June 2020)**

Variables	(1)		(2)		(3)		(4)	
Median income (€)	0.0111***	(0.0008)						
Proportion of tributaries and rivers (%)	1.2033	(0.9582)						
Proportion of natural spaces (%)	0.0041	(0.0538)						
COVID × Median income	−0.0001	(0.0003)	−0.0002	(0.0002)	−0.0002	(0.0002)	−0.0009***	(0.0003)
COVID × Proportion of tributaries and rivers	0.2292	(0.4689)	0.1459	(0.3552)	0.2183	(0.3590)	0.7554	(0.4792)
COVID × Proportion of natural spaces	−0.0216	(0.0263)	−0.0768***	(0.0200)	−0.0757***	(0.0198)	−0.0192	(0.0236)
Fixed Month × Year effects	Yes		Yes		Yes		Yes	
Fixed urban area effects	No		Yes		Yes		Yes	
Fixed Urban area × Month effects	No		No		Yes		Yes	
Urban area linear trend	No		No		No		Yes	
Observations	46,976		46,976		46,973		46,973	
R^2	0.2477		0.6671		0.7264		0.7353	

Notes: *** p<0.01; ** p<0.05; * p<0.1. Standard errors grouped with the urban area in brackets. The estimated coefficients are multiplied by 100 to make them easier to read. The proportion of houses in the urban area is controlled.
Sources: DVF 2016-2021; INSEE, 2017 population census; Corine Land Cover.

Table A3 – **Placebo tests**

	Municipalities		
	2019	2018	2017
Period × Population density	−0.0001 (0.0001)	−0.0002 (0.0002)	0.0002 (0.0001)
Period × Distance to the centre	−0.0364 (0.0283)	0.0268 (0.0343)	0.0184 (0.0282)
Observations	136,607	136,607	136,607
R^2	0.6862	0.6862	0.6862
	Urban areas		
	2019	2018	2017
Period × Median income	−0.0004 (0.0003)	0.0006* (0.0003)	0.0000 (0.0003)
Period × Proportion of rivers and tributaries (%)	0.0602 (0.4041)	−0.2532 (0.5066)	0.1060 (0.4426)
Period × Proportion of natural spaces (%)	0.0185 (0.0256)	0.0250 (0.0288)	−0.0353 (0.0238)
Observations	34,937	34,937	34,937
R^2	0.7649	0.7649	0.7649

Notes: *** p<0.01; ** p<0.05; * p<0.1. Standard errors grouped with the municipality for municipality level estimates and with the urban area for urban area level estimates, in brackets. The estimated coefficients are multiplied by 100 to make them easier to interpret. The control variables correspond to those in column (4) of Table 3 (or 4) for estimates at municipality (urban area) level. Transactions after 31 December 2019 are removed. The "period" variable corresponds to a fictitious processing date starting at the beginning of the year, indicated at the top of each column.
Sources: DVF 2016-2021; INSEE, 2017 population census; Corine Land Cover.