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Changes in the geography housing demand after the onset of COVID-19: First results from large metropolitan areas in 13 OECD countries

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CHANGES IN THE GEOGRAPHY HOUSING DEMAND AFTER THE ONSET OF COVID-19: FIRST RESULTS FROM LARGE METROPOLITAN AREAS IN 13 OECD COUNTRIES

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This working paper has been prepared through joint work by
- the Centre for Entrepreneurship, SMEs, Regions and Cities (CFE),
- the Economics Department (ECO) and
- the Statistics and Data Directorate (SDD).
It contributes to the OECD Horizontal Project on Housing Policies for Sustainable and Inclusive Growth: Phase II.

Authorised for publication by Luiz de Mello, Director, Policy Studies Branch, Economics Department.

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ABSTRACT / RESUME

Changes in the Geography Housing Demand after the onset of COVID-19:
First Results from Large Metropolitan Areas in 13 OECD Countries

The paper introduces a novel, granular house-price dataset sourced from a network of public and private data providers. It offers the first results of investigations into changes in the urban geography of housing markets following the COVID-19 pandemic. The rapid rise of working from home practices is likely to incentivise many people to seek more space and accept living further away from city centres as commuting requirements are reduced. The paper's results indicate that housing demand might have indeed shifted away from the centres to the peripheries of many large urban areas. These early results also show that such a shift has been neither universal nor uniform. It is typically stronger in cities where pre-COVID-19 house price disparities were larger and where moving to the periphery provides significantly better access to green space while still allowing easy access to high-speed internet and/or where COVID-19 restrictions were more stringent. The paper concludes by discussing implications for policy, including the benefits of flexible settings that allow supply to adjust smoothly to new demand patterns and outlining avenues for future work planned to improve and capitalise on the new dataset.

Keywords: housing, COVID-19, working from home, teleworking, digitisation, geospatial economics

JEL classification codes: R31, O18

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Evolutions de la géographie de la demande de logement après l’apparition de la COVID-19 :
premiers résultats pour les grandes villes de 13 pays de l’OCDE

Cet article s’appuie sur un nouvel ensemble de données granulaires sur les prix des logements provenant d'un réseau de fournisseurs de données publics et privés. Il présente les premiers résultats d’études qui visent à identifier les changements survenus dans la géographie urbaine des marchés du logement depuis la pandémie COVID 19. L'essor rapide des pratiques de travail à domicile est susceptible d'inciter de nombreuses personnes à rechercher plus d'espace et à accepter de vivre plus loin des centres-villes, parce que les trajets domicile-travail deviennent moins fréquents. Les premiers résultats indiquent que la demande de logements semble s'être déplacée des centres vers les périphéries de nombreuses grandes zones urbaines. Ce mouvement n'est ni universel ni uniforme : il est généralement plus fort dans les villes où les disparités pré-existantes de prix des logements entre centre et périphérie étaient plus importantes et où le déplacement vers la périphérie offre un meilleur accès aux espaces verts tout en permettant un accès facile à l'Internet haut débit et/ou où les restrictions du COVID-19 étaient plus strictes. L'article conclut en discutant des implications pour l’action publique, y compris les avantages de politiques d’urbanisme qui permettent à l'offre de s'adapter avec réactivité et flexibilité aux modèles de demande. La conclusion indique en outre un certain nombre de pistes de travail prévues pour améliorer le nouvel ensemble de données ainsi que pour approfondir et étendre les résultats.

Mots clés : logement, COVID-19, télétravail, travail à distance, numérisation, transformation numérique, économie spatiale

Classification JEL : R31, O18

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Changes in the Geography Housing Demand after the onset of COVID-19: First Results from Large Metropolitan Areas in 13 OECD Countries

By Rudiger Ahrend, Manuel Bétin, Maria Paula Caldas, Boris Cournède, Marcos Díaz Ramírez, Pierre-Alain Pionnier, Daniel Sanchez Serra, Paolo Veneri and Volker Ziemann[1]

Introduction and main findings

1. The COVID-19 crisis has profoundly modified people's views of their own homes. Lockdowns, school closures, mandates and encouragements to work from home, as well as social distancing, meant that most people spent much more time in their homes for work, education and leisure. This experience is likely to have changed housing preferences: many want more space, notably to accommodate more teleworking, even if this implies living further away. Simultaneously, the value of proximity to jobs and consumer services has diminished amid the rise of teleworking and online services.

2. The OECD, through a team spanning across its OECD Centre for Entrepreneurship, SMEs, Regions and Cities, Economics Department and Statistics and Data Directorate, has launched an activity to document the extent to which the geography of housing demand has changed since the onset of COVID-19 and investigate the role of potential drivers. This activity relies on a specially assembled dataset of housing transactions and prices at a granular geographical level, which, as of January 2022, covers 13 OECD countries. The authors would like to extend their gratitude to all private and public data providers who have contributed to collecting and designing this novel and innovative database.

[1] Rudiger Ahrend, Maria Paula Caldas, Marcos Díaz Ramírez and Paolo Veneri are members of the OECD Centre for Entrepreneurship, SMEs, Regions and Cities. Boris Cournède and Volker Ziemann are members of and Manuel Bétin consultant for the OECD Economics Department. Pierre-Alain Pionnier and Daniel Sanchez Serra are members of the OECD Statistics and Data Directorate. The authors are indebted to Federica de Pace, Young-Hyun Shin (OECD Economics Department), Andres Fuentes Hutfilter (Centre for Entrepreneurship, SMEs, Regions and Cities) and Johannes Schuffels (European Commission, formerly OECD Statistics and Data Directorate) for the contributions they have provided to the preparation of the database before they left the project team for new responsibilites. An earlier version of this paper was dicussed by the Working Party No. 1 on Macroeconomic and Structural Policy Analysis of the OECD Economy Policy Committee on 10 March 2022. The authors are grateful to the Chair of the Working Party, Mr. Arent Skjaeveland (Norwegian Ministry of FInance), and Delegates for their comments. They would also like to thank Luiz de Mello (OECD Economics Department) and Alain de Serres (OECD Environment Directorate) for their comments on earlier drafts and guidance and insights throughout the project and Celia Rutkoski (OECD Economics Department).

3. In 2020, at the onset of the COVID-19 pandemic, many OECD governments required people to work from home. Since then, many workers have returned to their workplaces (including partially, e.g. three days per week), and more will probably do so once the pandemic finally retreats, but not all. It is safe to say that the COVID-19 shock has accelerated the transition to working-from-home practices enabled by the digital revolution (Criscuolo et al., 2021[1]). As a result, more workers can afford to live farther from their workplace amid a reduced number of commuting days, fundamentally altering a key criterion in the choice of residence. By lingering or fuelling fears of infectious diseases, the pandemic might also instil a greater appetite for living in lower-density areas, where contagion is lower. Lockdowns and other restrictions on consumer services also reduce the desirability of living in big cities (Glaeser, 2021[2]).

4. Across OECD countries, the COVID-19 shock has effectively involved a massive quasi-natural experiment whereby the maximum possible share of remote work has been implemented for several months. The share of employees working occasionally or regularly from home jumped from 16% before the COVID-19 crisis to 37%, or even nearly 50%, according to other surveys, in March-April 2020 (OECD, 2021[3]; Ker, Montagnier and Spiezia, 2021[4]). This unprecedented experience implies that the possibilities of change in working habits enabled by digitalisation, which, in normal times, would have been tried and tested gradually over years if not decades, were explored all at once in 2020. Mandates for telework also removed the stigma associated with working from home (Barrero, Bloom and Davis, 2021[5]; Criscuolo et al., 2021[1]).

5. This experience will likely have lasting consequences even as the COVID-19 crisis recedes, primarily because it has revealed previously unknown or uncertain benefits of working-from-home practices for both employers and employees (Criscuolo et al., 2021[1]). It may have also challenged previous ideas of the costs to employers of their staff teleworking. Even if the COVID-19 crisis recedes completely, managerial attitudes are likely to have changed in favour of greater flexibility, which would encourage more people to work from home. Evidence from 20 OECD countries shows that online job postings in September 2021 advertised teleworking three times as frequently as they did in January 2020 (Adrjan et al., 2021[6]). A survey of 22 500 US citizens uncovered that 22% of workdays are likely to be carried out from home after COVID-19, compared with 5% before (Barrero, Bloom and Davis, 2021[5]).

6. Teleworking opens options to relocate, notably within large cities, which tend to concentrate the largest shares of jobs amenable to remote working (OECD, 2020[7]) and the highest quality of internet (OECD, 2021[8]). This might imply that, unlike after previous epidemics or disasters, high-density urban centres would not have the same level of attractiveness after COVID-19 (Glaeser, 2021[2]). In extreme cases, former office workers could become so-called "digital nomads" who can work from where they please, though preferably in the same jurisdiction or time zone as their employer. A survey claims that the number of "digital nomads" has risen from 3.5% of the US working-age population in 2019 to 7.5% in 2021 (MBO Partners, 2021[9]).

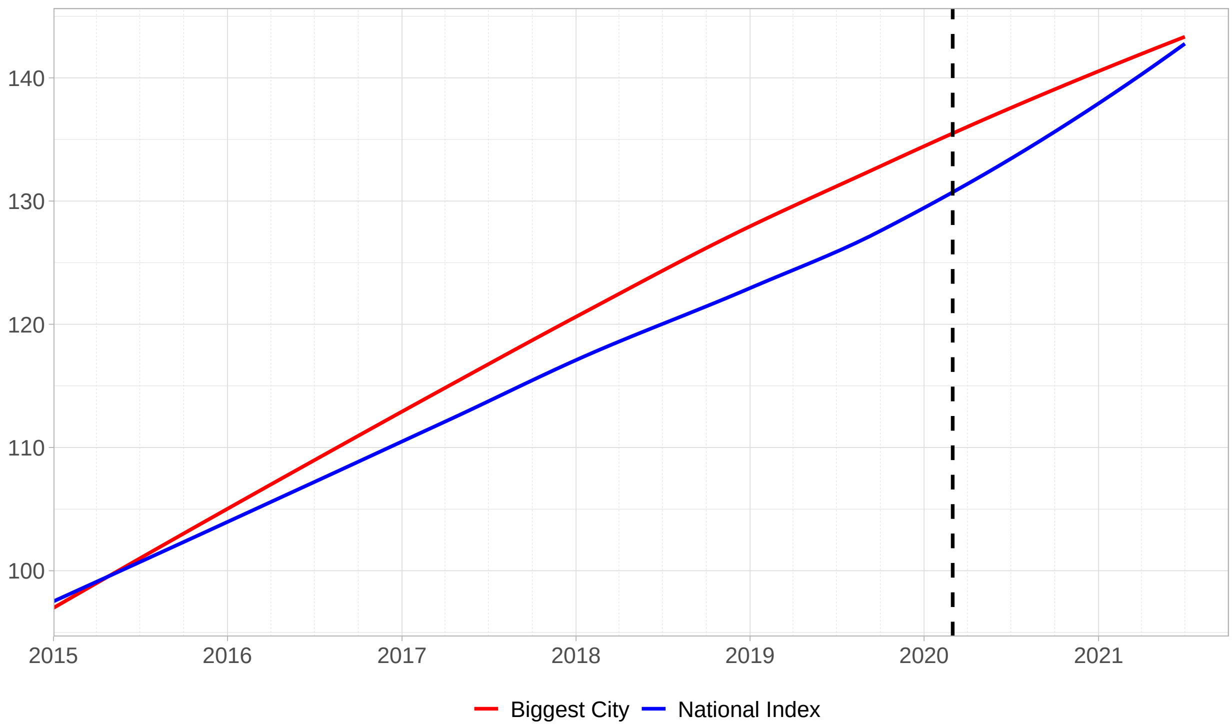
7. A more common setting is the possibility to work remotely most of the time or regularly. By reducing commuting, such arrangements make it possible to live further away from the workplace, enabling relocation towards areas that offer lower prices (or more space for the same price), higher-quality environmental amenities, or both. However, one caveat of such relocation considerations is that the distance to cultural and leisure activities also increases.

8. Further key benefits of moving away from high-density urban areas often include better access to green space and better air quality. Indeed, high levels of local air pollution recorded in high-density areas prompt large numbers of premature deaths (OECD, 2016[10]). The COVID-19 crisis may also have fuelled the desire to relocate towards lower-density areas where people feel more at ease to keep themselves away from infectious diseases at a time when the amenities of life in big cities were diminished.

9. In contrast to pre-pandemic trends, many OECD countries have, since the onset of COVID-19, seen their most-populated cities experience lower house price growth than the national average (Figure 1). For instance, the moderate increases observed in Budapest, London, Mexico City, Paris or New York City contrast with strongly rising national house prices in Hungary, the United Kingdom, Mexico, France and the United States.

Figure 1. House prices accelerate outside major cities

House price index (2015=100)



Note: City-level indices according to OECD National and Regional House Price Indices. Averages across nine countries that figure in this study and yield valid city- or small-region-level house price data are shown: AUT, DNK, FIN, FRA, GBR, HUN, IRL, NOR, USA. Absent the city level index, corresponding small region indices have been used for GBR (Inner London) and DNK (Byen København). For ESP, only large region indices are available, which impedes are precise mapping to their biggest cities. EST, DEU, PRT do not publish official regional house price indices.
Source: OECD National and Regional House Price Indices (http://dotstat.oecd.org/Index.aspx?DataSetCode=RHPI).

10. The provision of regional and city-based house price indices has helped gauge regional differences and detect divergences. The OECD stands at the forefront of this progress with the production of the OECD Database on National and Regional House Price Indices. Yet, anecdotal evidence hints at heterogeneous effects within urban areas due to the disruptions perpetuated by the pandemic. More granular house price data is necessary to assess better and understand recent developments. Unfortunately, harmonised cross-country datasets for that purpose are unavailable and most studies, if not all, focus on individual countries or cities. This paper provides the first results from the activity undertaken to fill this gap. The first section describes the dataset and exhibits stylised facts. The second section provides econometric analyses to identify systematic patterns according to which the geography of housing demand has evolved following the COVID-19 shock. The third and final section discusses policy implications and directions for future work.

11. The main findings of the first explorations of the data are:

- The novel database of disaggregated house price data across a broad and increasing range of countries paves the way for structural assessments of national and local housing markets. The comprehensive country coverage enables new analytical work to enrich the policy discussion.
- Spatial changes in transaction intensity and prices since the onset of COVID-19 indicate that many large metropolitan areas (of more than 1.5 million inhabitants) have experienced a shift in housing demand from the city centres towards their peripheries.
- This effect has, however, been far from universal or uniform. The house price curve that links prices to the distance to the city centre has flattened more in large metropolitan areas where:
  - Wide gaps separated house prices in city centres and commuting zones pre-COVID-19;
  - Peripheral areas provide substantially better access to green spaces than the urban core;
  - Good high-speed internet coverage extends to the periphery;
  - The metropolitan area's population and population density are larger.
  - COVID-19 containment measures were more stringent.

12. These preliminary results seem to corroborate the "doughnut effect" for many, though not all, large metropolitan areas. Working-from-home practices appear to modify the balance in housing preferences and contribute to a shift in housing demand away from higher-density, typically central, toward more peripheral areas. This shift offers the potential to relieve price pressures in central areas, reduce within-city spatial disparities and redirect demand to places where it can be better accommodated.

13. These developments underscore the case for flexible housing supply policies at the level of metropolitan areas. If greater demand for peripheral areas cannot be accommodated, including through densification, the risks are twofold: steep price increases in these areas and/or urban sprawl. The occurrence of such a shift also requires policies that enable widespread access to high-speed internet, including in peripheral areas.

14. Further work, to be published in subsequent papers, is underway to extend and strengthen the evidence base. Collection efforts to cover additional countries continue. Satellite imagery will be analysed to gauge land-use changes with a view to better disentangling demand from supply effects. Additional explanatory variables such as mortality rates at the local level, the share of jobs amenable to teleworking or city-to-city migration flows might yield new insights. Furthermore, the statistical properties of the data will be further evaluated by comparing trends in the granular house prices with more established regional or national house price indices. Finally, data updates will shed light on whether the estimated shifts persist or will be partly or wholly reversed as COVID-19 recedes.

A novel cross-country dataset for disaggregated house prices

15. The establishment of regional and city-level house price indices has enabled policymakers and other stakeholders to identify the built-up of house price divergences and address the resulting challenges for housing affordability and equality of opportunity. However, the possible reshaping of housing demand within urban areas requires more disaggregated data.

16. Most empirical studies assessing spatial shifts of housing demand in the COVID-19-era have focused on the United States. Analysis of data from the online real estate platform Zillow has revealed that the house price difference between zip codes close to and far from the central business districts of the largest US metropolitan areas has narrowed following the onset of COVID-19 (Brueckner, Kahn and Lin, 2021[11]). A similar study, also relying on Zillow data, confirmed this conclusion for prices and identified a similar flattening effect on the rent differences (Gupta et al., 2021[12]). A third inquiry mobilising Zillow data

corroborated these results, finding stronger effects in areas with large shares of telework-compatible jobs and amenities such as restaurants (Liu and Su, 2021[13]). Another US study documented that the short-lived sharp fall in listings in the second quarter of 2020 had a temporary effect on prices (Bhutta, Raajkumar and van Straelen, 2021[14]). Analysis of individual-level property transactions found direct evidence of some population redistribution from densely populated areas to nearby locations in the New York area following the COVID-19 outbreak (Li, Liu and Tang, 2021[15]).

17. At the time of writing, a single econometric study had been identified that investigates within-urban-area shifts in house prices after the onset of COVID-19 outside the United States. Transaction data from Wuhan, China, show a narrowing of spatial house price differences in the immediate aftermath of COVID-19 but say little about post-COVID-19 effects as the time period covered stops in July 2020 (Cheung, Yiu and Xiong, 2021[16]).

Data sources and limitations

18. The data is based on housing transactions. One exception is the United States, where the numbers are model-based Zillow estimates, but the Zillow model primarily draws on sales data. Relying on transacted prices (and the number of transactions) rather than rents or survey responses ensures that the data reflects long-term commitments of housing choices rather than transitory ones. Innovative collaborations and data collection efforts have been mobilised to gather the necessary data to study this question over as many OECD countries as possible (Box 1). The investigation requires data at a sufficiently disaggregated level to distinguish between central, close-periphery, suburban, semi-rural and rural areas. This requirement typically means having house price data at the zip code level (or equivalent when the aggregation unit was too large). For three countries, France, Ireland and the United Kingdom, transaction-by-transaction data is available, allowing re-aggregating at the zip code in dense urban areas or community level in more sparsely populated rural areas.

19. This study uses the dwelling's floor area as a proxy for quality. Indeed, in the absence of sufficiently detailed information on the sold properties, the data does not allow computing hedonic house price indices including additional quality attributes in the same way as official house price indices do. The floor area is available for all countries except the United Kingdom, Ireland and the United States. However, the data allow stratification by type of dwelling in the United Kingdom and the number of bedrooms in the United States. Beyond its usefulness to build a proxy quality-adjusted house prices, size information also yields valuable information regarding changing preferences in the wake of the pandemic. Indeed, living in a bigger dwelling can be a key reason for moving away from central urban areas.

Box 1. A New Network of Independent Data Providers

A network of independent data providers has shared quantitative information on housing transactions with the OECD. National statistical organisations comprise the largest group in the network (Austria, Denmark, Finland, Hungary, Norway). Specific property authorities provide the data for three countries (Property Service Regulatory Authority in Ireland, HM Land Registry in the United Kingdom, Estonian Land Board in Estonia, General Council of Notaries in Spain). A number of private partners are also sharing information *pro bono* (Zillow in the United States, Confidential Imobiliario in Portugal and Vdp Research in Germany). The dataset for France, which covers all transactions, comes from an open-data programme managed by the Ministry of Finance.

The source data covers the COVID-19 period and at least two years before the pandemic at a within-urban-area level of granularity (Table 1). This level of detail allows analysing geographical changes since the onset of COVID-19.

Deep gratitude goes to the providers for their work to produce the data and share them.

Table 1. Data providers and coverage

	Source	Geographical units	Period covered
AUT	Statistik Austria	955 municipalities	2015Q1 - 2021Q2
DEU	vdpResearch	4 191 postal codes + 154 districts	2018Q1 - 2021Q2
DNK	Statistics Denmark	529 postal codes	1992Q1 - 2021Q2
ESP	Centro de information estadistica del notariado & INE	4 283 municipalities + 31 districts	2011Q2 - 2021Q2
EST	Estonian Land Board transactions database	45 towns + 13 districts	2003Q1 - 2021Q4
FIN	Statistics Finland	225 municipalities	2010Q1 - 2021Q1
FRA	Demande de valeurs foncieres (data.gouv.fr)	10 065 communes + 180 districts	2014Q1 - 2021Q2
GBR	UK Government Price Paid data	8 131 postcode sectors	1995Q1 - 2021Q3
HUN	Hungarian Central Statistics Office	2 704 communes + 23 districts	2008Q1 - 2021Q2
IRL	Property Services Regulatory Authority	119 local electoral areas + 331 communes	2015Q1 - 2021Q2
NOR	Statistics Norway	56 municipalities	2006Q1 - 2021Q3
PRT	Confidencial Imobiliário	496 parishes	2009Q1 - 2021Q2
USA	Zillow Research Institute	29 823 zip codes	1996Q1 - 2021Q1

Note: Geographical units reflect the final aggregation and may differ from the granularity of the original data set to allow for a sufficient number of transactions per geographical unit.

20. Building a database of disaggregated house price data entails challenges. While the following issues make cross-country comparisons of prices difficult, they should not affect the comparability of spatial house price differences or their evolution over time:

- Official house price statistics, which would include cleaning, stratifications and quality adjustment, are generally not available at the required level of disaggregation.The data used in this study differ both conceptually and methodologically from standard house price indices (Pionnier and Schuffels, 2021[17]).
- There is substantial heterogeneity in the type of data sources across countries. The data originate from stamp duty requirements, property tax collection, land registries or financial information, depending on the country. This heterogeneity results in differences in coverage across countries: for instance, the dataset excludes transactions that do not involve mortgages in Germany; contains only transactions published online for Portugal and uses statistical smoothing in the United States.

It also results in different sets of variables (price, floor area, type of building, total value) and the absence in some cases of the floor area of each unit or the inclusion or not of value-added tax or notarial fees in the final price.

- Owing to privacy concerns, transactions, even if aggregated at the level of small administrative units, are usually not communicated when the number of transactions is lower than a minimum threshold. This reduces the sample, especially in rural areas. For countries where all the raw information is available (France, Ireland and the United Kingdom), this study applies a similar treatment: at least five transactions in the quarter are required for an observation to enter the dataset. This correction aims at limiting artificial volatility created by changes in the composition of the observed transactions.

21. The noise embedded in the source data can vary depending on the collection method and cleaning applied by the data provider. In the United States, for instance, the Zillow Home Value Index is a smoothed, seasonally-adjusted measure of the typical home value and market changes across a given region and housing type. It reflects the typical value for homes in the 35th-65th percentile range. The heterogeneity in the production of source data contributes to differences in patterns such as the relative smoothness of price changes in the United States by comparison with Portugal or Ireland, where the data exhibit greater volatility.

Geographical units and coverage by country

22. Table 2 illustrates the granularity of the obtained house price dataset based on geographical units with valid house price data for the first half of 2021. In the case of Spain, notary data was only available up to 2020 at the time of writing, and only district data for Barcelona and Madrid could enter the analysis, which explains the limited coverage. In terms of population and area, the size of geographical units is quite different in some instances (e.g. Norway compared with Ireland). Box 2 provides more detail on the country-specificities of the collected data.

Table 2. Main characteristics of the geographical units in the database

	Population coverage	Area coverage	Population per unit			Surface in km2			Population density		
	% of total	% of total	P5	P50	P95	P5	P50	P95	P5	P50	P95
AUT	66	30	1433	4628	31360	5.4	30.4	143.7	24	163	1845
DEU	85	84	2548	12536	46081	2.4	26.6	203.2	63	389	5188
DNK	68	36	2585	15760	59492	5.4	48.2	285.2	40	286	4778
ESP	10	<1	71200	146076	289585	4.4	10.2	49.1	3633	13175	20649
EST	63	2	794	5714	58532	2.0	10.0	36.0	137	782	3566
FIN	82	41	3829	11849	88080	44.6	487.0	2501.8	3	29	726
FRA	89	80	244	1468	27087	3.4	13.3	68.6	17	97	1808
GBR	86	62	1266	6882	13753	0.4	4.2	87.0	47	1839	9401
HUN	92	74	330	1780	20222	8.4	29.9	122.5	18	57	389
IRL	96	100	535	2889	43689	0.1	0.7	935.0	30	3118	8933
NOR	63	12	20183	33711	159329	71.2	440.5	2229.1	16	133	582
PRT	45	8	2976	16442	48470	2.6	14.4	95.1	76	1118	8007
USA	97	65	191	3547	42359	2.6	97.6	689.3	2	35	2104

Note: P5, P50, P95 refer to 5th, 50th (median) and 95th percentiles of the variable's distribution across geographical units. Population density is in people per square km.

Box 2. Metadata by country

- **Austria**: Quarterly housing transactions, limited to purchases by households, were aggregated at the municipal level. Transactions between relatives, partial transactions, and acquisitions for demolition are removed when possible. Missing or implausible data, as well as tail ends of prices and areas, are removed.
- **Denmark**: Average prices per square meter for three property categories: i) detached and townhouses, ii) condominiums, and iii) holiday homes. Properties with exceptionally high or low realised trading prices and postal codes with less than five transactions are discarded to limit measurement errors. The final average prices are computed as unweighted averages across property categories for each Location.
- **Estonia**: Data aggregated at the municipal level.
- **Finland**: Geometric averages of square metre prices based on asset transfer tax statements from the Finnish Tax Administration's asset transfer tax data are reported. The preliminary data on quarterly statistics includes around two-thirds of all housing transactions, though coverage varies by area.
- **France**: All property transactions in France, excluding Alsace, Moselle, and Mayotte, were recorded in notarial acts and cadastral registers. Median square meter prices are aggregated to the commune or district (arrondissement) level depending on the number of observations: if 80% of the communes in a district report on average less than five observations, all communes of that district are aggregated.
- **Germany**: The data reflects quarterly transaction data gathered from around 600 credit institutions. Data is aggregated at the postal code level in metropolitan areas of cities with more than 500 000 inhabitants. Outside these areas, house price transactions are aggregated at the municipal.
- **Hungary**: Quarterly house price data based on stamp duty receipts provided by the National Tax and Customs Administration (NAV). Average and median per square meter prices are calculated after excluding 5% of cases identified as outliers and 1% of cases where prices are missing. Available original floor areas supplemented with estimated values where the actual information is missing (40% of all cases are estimated).
- **Ireland**: House price data as declared to the Revenue Commissioners for stamp duty purposes. Properties not sold at full market price are excluded. Geocoded addresses were retrieved from a third-party aggregator (propertypriceregisterireland.com).
- **Norway**: Number of transactions and average per square meter prices at the commune level. Commune nomenclature from 2021 is used (major mergers in 2021 and before were backcasted).
- **Portugal**: The transaction price does not include taxes. In the case of transactions resulting from the action of a real estate agent, the price corresponds to the amount on which the mediation commission is calculated.
- **Spain**: Municipal and, for Barcelona and Madrid only, more granular district data is used from General Council of Notaries. Outside Barcelona and Madrid, more granular data is provided by INE. The 2021 update from INE came too late for this report but will be incorporated in later subsequent work.
- **United Kingdom**: The data includes information on all residential property sales in England and Wales that are sold for value and are lodged with HM Land Registry. The dataset excludes all commercial transactions as well as sales without market value.
- **United States**: the study uses the Zillow Home Value Index, a smoothed, seasonally adjusted estimated sale prices (Zestimates) for the typical value for homes in the 35th to 65th percentile price range computed based on proprietary statistical and machine learning models. This model-based rather than transaction-based nature of the index reduces the spatial and intertemporal noise observed in other countries' data that are based on actual transactions.

23. The bulk of the statistical analysis throughout the study refers to urban areas and the impact of COVID-19 on urban house price *gradients*, defined as the slope of the curve depicting house prices as a function of the distance to the city centre. An *increase* in the house price gradient means that the curve of house prices according to distance *flattens* (because the slope is negative, adding a positive number to it makes the curve less steep).

24. For the sake of harmonisation, urban areas relate to OECD's classification of Functional Urban Areas (FUAs) (Dijkstra, Poelman and Veneri, 2019[18]). FUAs consist of an urban core, a contiguous set of local units with a high population density accommodating at least 50 000 people, and a commuting zone defined as the contiguous set of local units surrounding the urban core and in which at least 15% of the employed residents work in the urban core (city). The distribution of geographical units by FUA size varies a lot across countries (Table 3). The OECD PostGIS database is used to perform the mapping from small geographical units (i.e. SAUs, zip codes or municipalities) to more comparable statistical units (including FUAs) and to estimate geospatial variables such as area, population density and distance to the city centre, among others.

Table 3. Distribution of geographical units by FUA size

Country	50K-100k FUA (%)	100k-250k FUA (%)	250k-1.5M FUA (%)	>1.5M FUA (%)	Outside FUA (%)
AUT	0	0	26.5	26.2	47.3
DEU	0.2	5.1	37.0	35.7	22.0
DNK	0	0	23.2	21.5	55.3
ESP	0	0	0	100	0
EST	4.0	0	16.3	0	79.7
FIN	0	14.1	23.4	0	62.5
FRA	0.2	5.6	32.5	16.6	45.1
GBR	1	8.1	36.2	31.6	23.2
HUN	0.9	19.5	9.5	11.3	58.9
IRL	8.4	13.4	16.3	45.0	16.8
NOR	1.7	1.7	35.6	0.0	61.0
PRT	1.0	4.7	22.5	38.9	32.9
USA	0	3.2	18.7	23.3	54.9

Source: OECD calculations.

Testing the monocentric model

25. Despite its simplicity, the monocentric model developed by Alonso (1964[19]), Mills (1967[20]) and Muth (1969[21]) correctly predicts fundamental forces underlying urban form and spatial distribution of dwelling characteristics. According to the model, jobs and other amenities are concentrated in the city centre (central business district, CBD). Urban residents incur commuting costs that increase with the distance to the CBD. As compensation for longer commutes, residents ask for lower land prices as the distance to the CBD increases. As a result of lower land prices, residents substitute other consumer goods in favour of land resulting in larger dwelling sizes. As a corollary, the model also stipulates that population density and building heights decline as distance increases (Brueckner, Mills and Kremer, 2001[22]).

26. In line with the OECD definition of functional urban areas, the geographical units' distances to high-density clusters (HDC) within FUAs are computed based on each area's population-weighted centroid. FUAs can contain one or several HDCs. Accordingly, two different measures of distances are available: the distance to the largest HDC and the distance to the closest HDC. The former will be the default measure for distances, while the latter allows for relaxing the standard assumption of monocentricity when assessing house price gradients, a useful option for future work. Table 4 suggests

that the dwelling size gradient is positive in large metropolitan areas up to 30km from the FUA centre. In contrast, the dwelling size–distance curve seems flat in metropolitan areas of 250 000-1.5 million people. Importantly, unconditional averages mix between and within-FUA effects. The within-FUA analysis suggests that size gradients also exist in smaller FUAs, albeit only up to a distance of 10km.

Table 4. Dwelling size gradient by FUA size

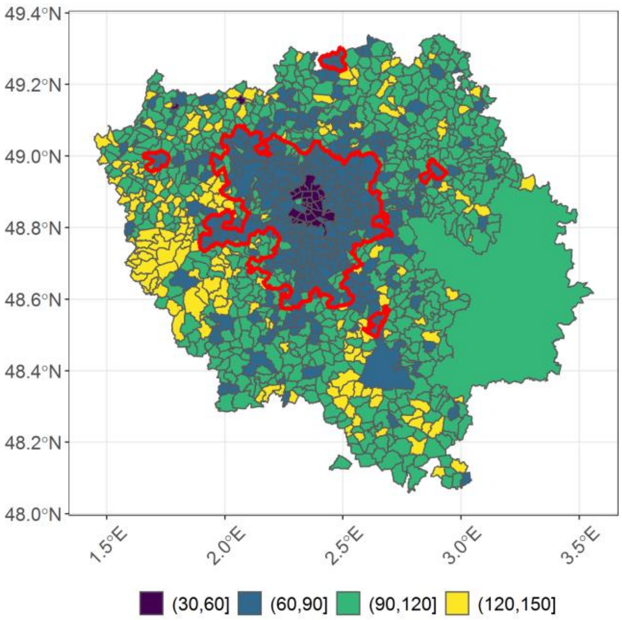
Distance brackets	[0,5)	[5,10)	[10,20)	[20,30)	[30,40)
Unconditional average					
50K-250K people	98	110	108	98	93
250K-1.5M people	95	107	112	115	119
1.5M people or more	84	92	107	110	113
Differences with respect to FUA average (within)					
50K-250K people	-16	4	3	-1	-2
250K-1.5M people	-24	-5	2	5	5
1.5M people or more	-28	-19	-3	3	7

Note: Based on registered housing transactions in 2019. Only geographical units with at least 10 transactions over this period have been included.
Source: OECD calculations.

27. Even within FUAs, the granular data available for this study reveal a high level of spatial entropy (see one example on Figure 2). Spatial entropy can be loosely defined as measuring the heterogeneity of adjacent or nearby observations (Altieri, Cocchi and Roli, 2018[23]). It describes the randomness (disorder) of the spatial distribution of indicators (average dwelling size by zip code in Paris on Figure 2). High entropy inevitably creates statistical noise for the econometric analysis.

Figure 2. Dwellings are typically larger further from the centre: The example of Paris

Average dwelling size by small geographic area, square-meter brackets



Note: The figure displays the average dwelling size brackets in m2 for the period 2018-2021. The large uniformly coloured area in the East of Paris reflects the aggregation at the TL3 level due to the lack of sufficient transactions (less than 5 transactions) for more than 80% of the communes in that TL3 zone. Red line illustrates the border between the core metropolitan area and its commuting zone.
Source: OECD calculations.

28. The data also confirms the monocentric model's prediction that house prices tend to decline with increasing distance to the city (Table 5). The relationship appears to differ by size bracket (Table 5). Up to 10km, house prices decline exponentially in large metropolitan areas while the house price-distance curves appear flat in smaller FUAs. Beyond a distance of 10km, house prices decline at a slower pace in large metropolitan areas, while the decline typically accelerates in small and medium-sized FUAs. Figure 3 suggests some non-linearities in the house price to distance relationship, notably for smaller urban areas where prices tend to be lower in the city centre. This finding justifies focussing on large metropolitan areas when investigating the presence of a "doughnut effect".

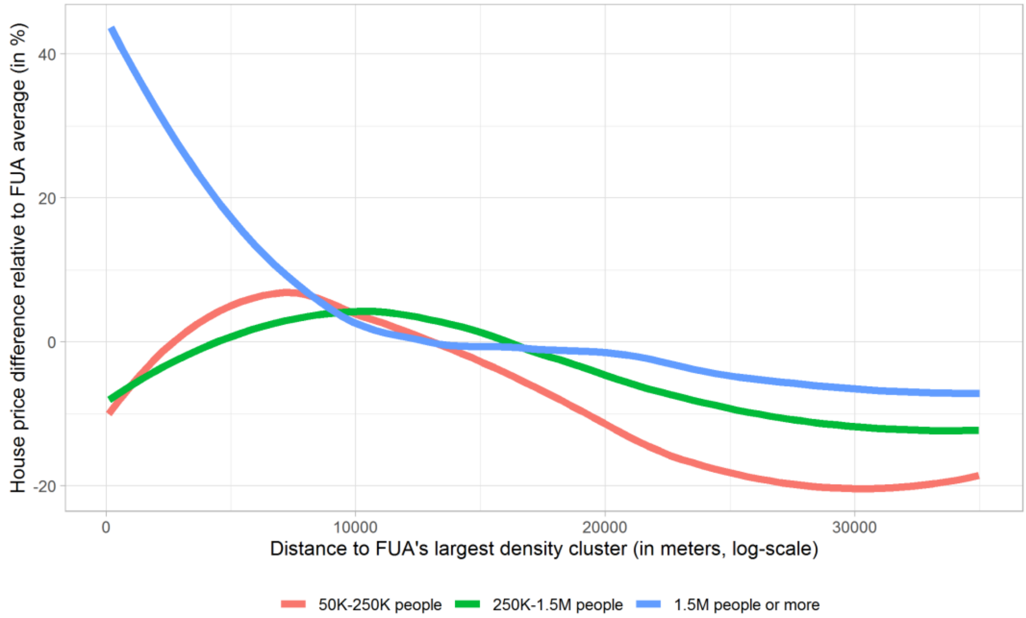
Table 5. House price gradients are more negative in large urban areas

Result of regressing house prices over the log-distance to the city centre

	Small and medium-sized urban areas 50K-250K people	Metropolitan areas 250K-1.5M people	Large metropolitan areas 1.5M people or more
log-distance	-6.101***	-4.863***	-20.640***
	(1.003)	(0.454)	(0.556)
Num.Obs.	2462	13373	13098
R2	0.050	0.034	0.152
Std.Errors	Heteroskedasticity-robust	Heteroskedasticity-robust	Heteroskedasticity-robust
FUA fixed effects	yes	yes	yes

* p < 0.05, ** p < 0.01, *** p < 0.001.
Source: OECD calculations.

Figure 3. House prices decline when moving away from city centres in large metropolitan areas



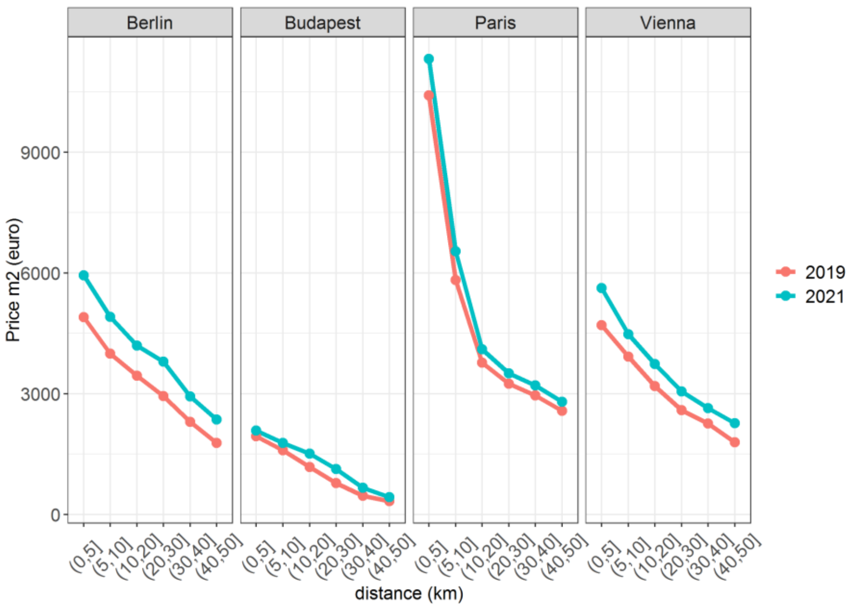
Note: The curves show within-FUA prices relative to population-weighted average FUA prices, smoothed by a nonlinear LOESS filter.
Source: OECD calculations.

29. Figure 4 shows the house price gradient for a selected number of large metropolitan areas in Europe and the United States. Panel A suggests a negative house price gradient for four European capital cities, Berlin, Budapest, Paris and Vienna. In Paris, the house price curve is particularly steep, with an average price per square meter of EUR 10 500 in a 5km radius around the city centre and less than EUR 4 500 per square meter in a 10 to 20km radius. The gradient for Berlin and Vienna are similar. Top prices reach an average of close to EUR 5 000 per square meter in the city centre (within 5km) and around EUR 1 500 per square meter in a radius of 40 to 50km.

30. Figure 4 Panel B shows house price gradients for average house prices for countries with no information on per square meter prices. In Dublin, the slope of the curve is similar to the one found in other European capital cities such as Berlin or Vienna. In contrast, London displays a steeper house price curve, similar to the one observed in Paris. Flats are sold on average for around USD 2 million within a 5km radius around the city centre but only USD 500 000 within 20 to 30km and stabilised further away. In New York, flats are sold for an average price of USD 911 000 within 5km, USD 1 million within 5 to 10km and USD 650 000 within 10 to 20km. This inverse U-shape gradient is also observed in San Francisco and many other metropolitan areas in the United States where top house prices are observed in the closer suburbs within 5 to 20km for the city centres rather than downtown as is observed in most European countries.

Figure 4. House prices as a function of distance to the city centre: Selected urban areas

A: Average prices per square meter (euros)



B: Average house prices

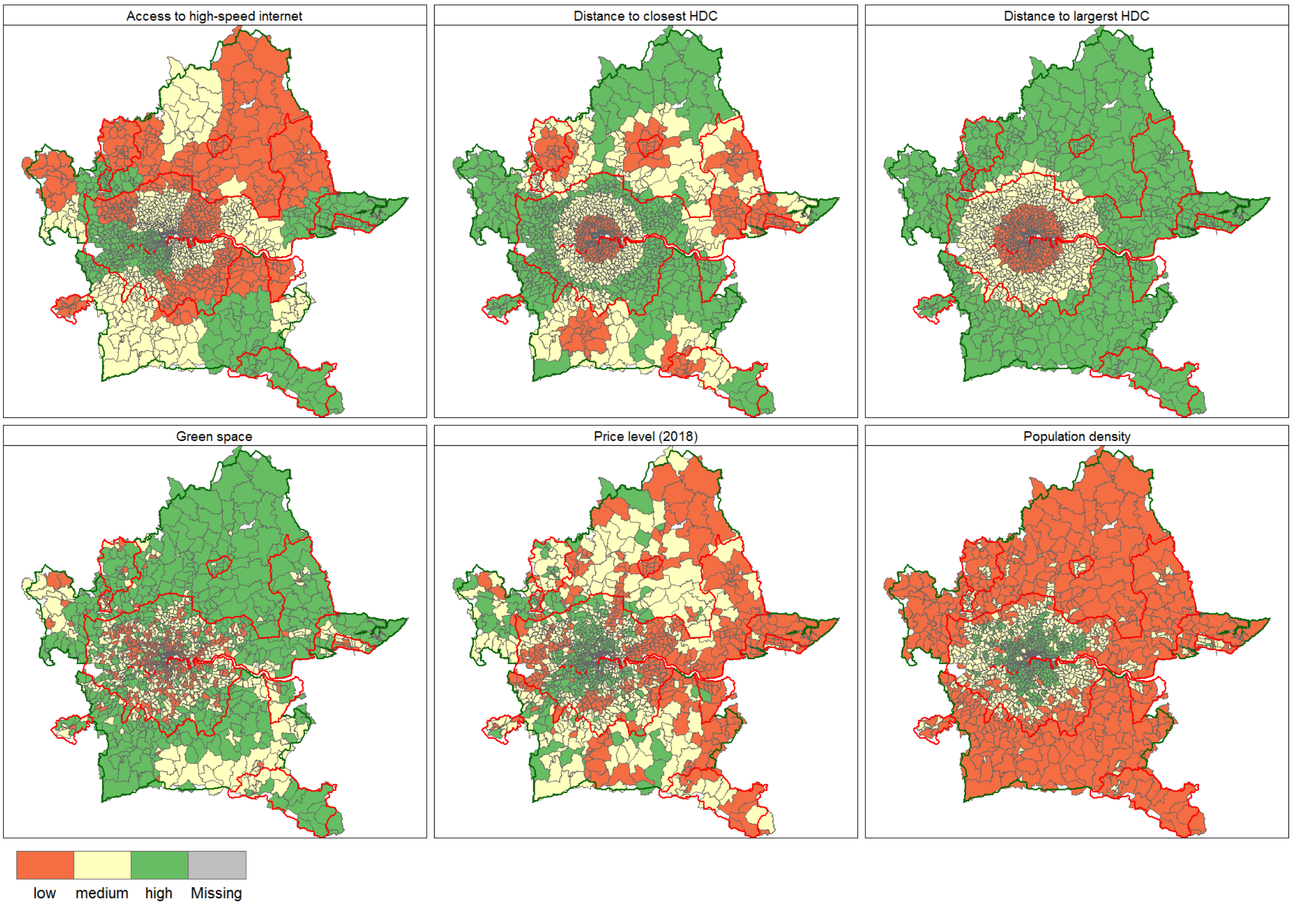
Note: Panel A displays the relationship between the average price per square meter and the distance to the largest urban center. Panel B displays the average house price and the distance to the closest urban center for the selected metropolitan areas. Averages are computed over the period 2018Q1-2021Q2.
Source: OECD calculations.

31. Several covariates have been collected to investigate drivers and co-determinants of urban house price developments. The share of green space has been computed using OpenStreetMap following the tag classification from (Novack, Wang and Zipf, 2018[24]).[2] Internet download speeds are obtained from Ookla's geolocalised data (OECD, 2020[25]). Figure 5 illustrates this data for London, depicting how distance influences the availability of different amenities (transport, internet connection and green space).

[2] The OpenStreetMap tags classified as green space are i) amenity: grave yard; ii) landuse: allotments, cemetery, farmland, forest, grass, allotments, cemetery, farmland, forest, grass, greenfield, meadow, orchard, recreation ground,village green,vineyard; iii) leisure: garden, golf course, nature reserve, park, pitch; iv) natural: wood, scrub, health, grassland, wetland,water; and v) tourism: camp site.

Figure 5. The geography of housing in London

Zipcodes partitioned by tercile for the selected indicator



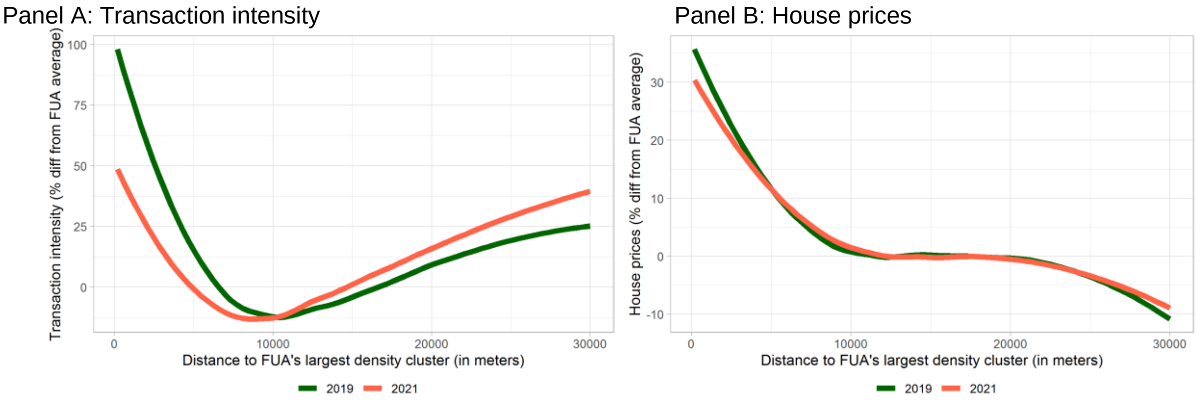
Note: Distance expressed with respect to population-weighted centroid of HDCs ("high-density cluster").
Source: OECD calculations.

Indications of shifts in the geography of housing demand since COVID-19

32. Against this background and using the new database, this section looks at signs of changes in the geography of house price changes and transaction intensity. In particular, it investigates how the gradients of price and transaction intensity have evolved following the start of the COVID-19 crisis, first on the whole and second controlling for more factors through econometric regressions. As the data run through to mid-2021, the results mix potentially transitory effects with permanent ones. Yet, the house price analysis arguably reflects some lasting preference changes, especially as current house prices embed today's anticipations of future housing market conditions. Indeed, house prices are generally considered forward-looking, while rents reflect current demand-supply interaction (Gupta et al., 2021[12]). The persistency of the established results will nonetheless have to be confirmed as more data becomes available (covering the second half of 2021 and beyond).

33. The reshuffling of demand depending on the distance to the centre is most likely to occur in large metropolitan areas, where affordable housing in the proximity of well-paying jobs is scarce, forcing many workers to trade off commuting time against the size of their homes. Figure 6 illustrates that transaction intensity has increased beyond the 10km radius in large metropolitan areas (Panel A). Simultaneously, the house price curve has become, on average, less steep, mostly because of a reduction of the inner-city price premia relative to the FUA average.

Figure 6. COVID has reduced inner-city price premia in large metropolitan areas



Note: Only geographical units in large metropolitan areas (>1.5m people) are considered. Nonlinear loess smoother for each year is displayed.
Source: OECD calculations.

34. Timely spatial data about construction permits would also provide direct indications about demand shifts, except for areas where supply is highly rigid. However, such data is unavailable across a sufficient number of countries to allow analysis. In Canada, the spatial distribution of building permits in 2021 indicates a shift away from large metropolitan areas towards smaller urban areas (Statistics Canada, 2021[26]).

Econometric assessment of a shift in housing demand

35. In the long-run equilibrium, house prices reflect the interplay of housing demand and supply. In the short run, however, given the sluggish supply response to changes in demand, house price movements are more likely to reflect changes in housing demand. Yet, the price elasticity of housing demand also depends on the supply elasticity through the expectation that supply will also adjust and bring new homes later. Hence, house prices alone are an imperfect measure of housing demand. The number of housing transactions is complementary to the price information. Transaction intensity (*TI*), defined as the number of sales per 100 000 people, can shed further light on spatial shifts in housing demand over time as it is not affected by the price elasticity of demand. There are, nonetheless, caveats to this indicator, too. First, it is also endogenous to the availability of housing units and thus to supply elasticity. Second, a transaction can reflect selling and buying pressure (e.g. "fire sales").

36. A shift in housing demand from the city centres to the peripheries would be reflected by an increasing number of people selling their dwellings in the city centre and buying a bigger dwelling in the outskirts of the same agglomeration. Theoretically, such an urban shift would lead to peaks in transaction intensity at both places. While this would arguably lead to an increase in the transaction intensity in more remote areas, the impact on the level of transaction intensity in the city centre is less clear. Overall, assuming that traditional pull factors have weakened, the narrative would be consistent with an increase in the transaction intensity gradient (somewhat lower intensity in the core, and higher intensity in the periphery) corroborated by average developments depicted in Figure 6 (Panel A). The impact on the house price gradient should be similar on average but also depends on the scarcity of supply in both the city centre and the periphery. Importantly, the following investigations do not control for interregional migration, new construction, office-to-residential building conversions, or initial vacancy rates, all of which affect supply patterns and, thereby, house price movements and transaction intensity.

37. According to the two established housing demand measures (house prices and housing transaction intensity), two specifications are tested to identify potential spatial housing demand shifts amid the COVID-19 pandemic:

$$\Delta TI_{ij} = \alpha_1 + \delta_1 \ln D_i + \mu_{1,j} + e_{1,i} \quad (1)$$

$$\Delta p_{ij} = \alpha_2 + \delta_2 \ln D_i + \mu_{2,j} + e_{2,i} \quad (2)$$

where p_{ij} denotes the house price metric[3] in Location *i* of FUA *j*, TI_{ij} the corresponding transaction intensity, defined as the number of sales per 100 000 people, D_i the distance between the geographical unit *i* and the FUA's largest high-density cluster, μ_j dummies for FUA *j* (based on OECD functional urban areas). The inclusion of FUA fixed effects means that the equation only looks at changes in each zipcode relative to FUA-wide changes. The Δ operator denotes the percentage change from the first half of 2019 to the first half of 2021.[4] The δ_1 and δ_2 coefficients therefore estimate 2019H1-2021H1 changes in the gradients of transaction intensity and house prices.

38. Estimating a model with changes rather than levels as dependent variables has the advantage of isolating the effect of unobserved variables on levels, which cannot be controlled for by individual fixed effects since the key dependent variable, distance, is time-invariant. As a result, even the inclusion of time-fixed effects cannot control for level-determining characteristics that are correlated to distance (e.g. economic, cultural and environmental amenities). The chosen specification in differences avoids this potential source of bias.

39. The results in Table 6 corroborate the visual impression from Figure 6 that the house price and transaction intensity gradients have increased from the first half of 2019 to the same period of 2021. While both coefficients are statistically significant, economically, the estimated coefficients signal a quantitatively limited effect on the respective gradients. A 10 percentage point increase in the distance to the FUA centre is associated with one additional transaction per quarter per 100 000 residents and a 0.06 percentage point increase in the house price.

Table 6. Estimated COVID-19 changes in transaction intensity and price gradients

Large metropolitan areas (population greater than 1.5 million people)

	Transaction intensity equation (1)	House price equation (2)
Distance (log)	3.018***	0.623***
	(0.620)	(0.166)
Num.Obs.	5700	12349
R2 adj	0.166	0.156
FUA FE	X	X

Note: Three stars denote 99.9% statistical significance (* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$). Distance is taken from largest high-density cluster within the FUA. No transaction data are available for the United States.
Source: OECD calculations.

40. Figure 7 shows city-by-city estimates post vs pre-COVID-19 changes in transaction intensity and house prices. The results suggest differentiated impacts across and within countries. The most notable changes are estimated to have occurred in Budapest, Dublin, Lisbon and Lyon, where house price and transaction intensity gradients have increased significantly (implying that the curves linking transaction

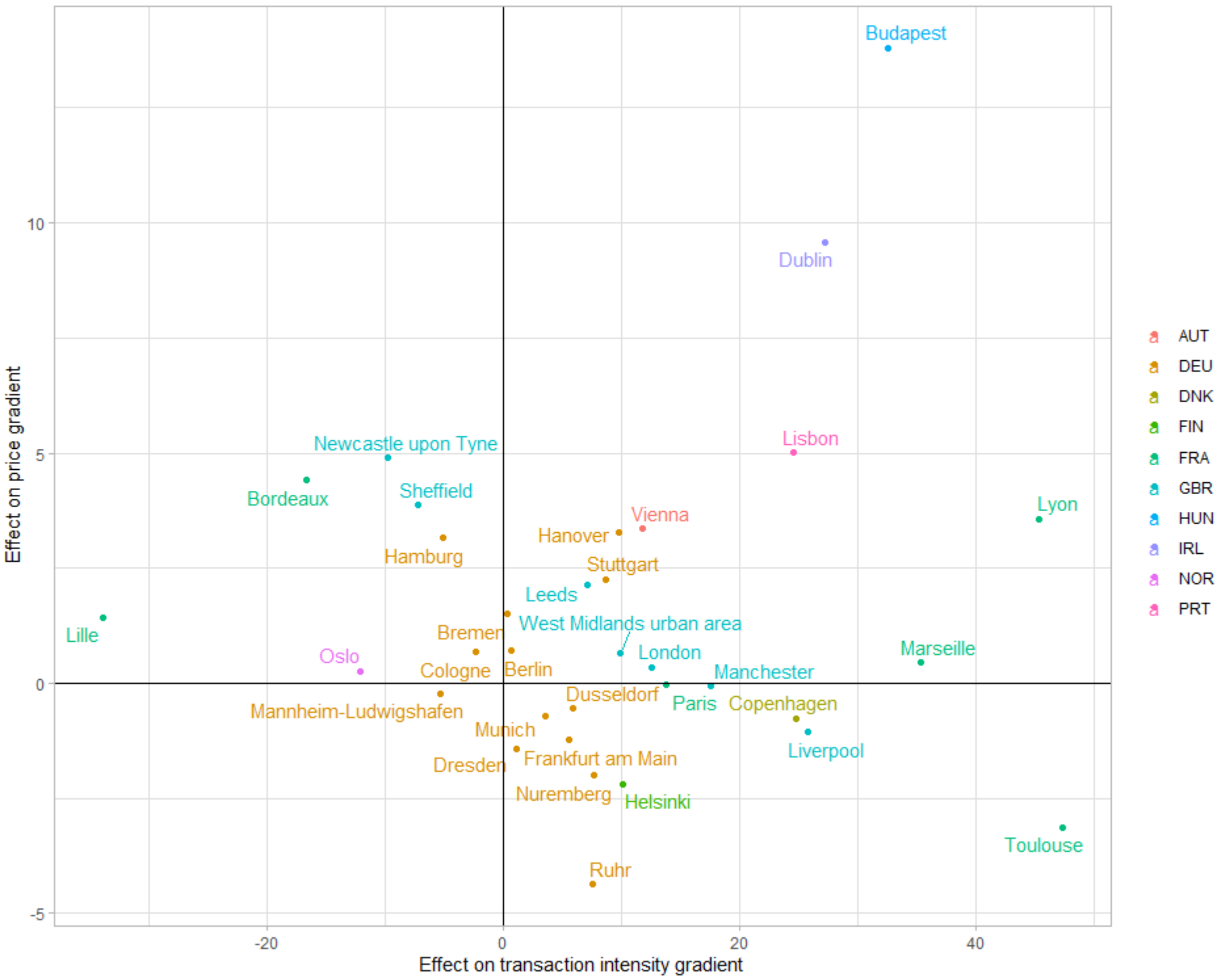
[3] Per square meter price in countries where square footage is available and per dwelling type in the other ones.

[4] $\Delta y = 100 * [(y_{2021Q1} + y_{2021Q2})/(y_{2019Q1} + y_{2019Q2}) - 1]$.

intensity and prices to distance to the centre have flattened). Paris and Liverpool exhibit an increased concentration of housing transactions at their peripheries without, however, a statistically significant impact on price gradients.

Figure 7. Transaction intensity and house price gradients have evolved far from uniformly across cities

Metropolitan areas of more than one million inhabitants



Note: The chart shows estimates δ_1 on the x-axis and δ_2 on the y axis from equations (1) and (2) run separately for each FUA of more than one million inhabitants. By comparison with the rest of the paper, which focuses on large urban areas defined as having more than 1.5 million inhabitants, the threshold of one million was chosen to show more cities. Coverage is limited to the countries listed on the right-hand-side legend.
Source: OECD calculations.

Determinants of housing demand shifts

41. A range of factors can influence how housing preferences have shifted in the wake of the pandemic. Assuming that most people stick to their current job, living quality benefits and benefits from lower housing costs must outweigh the disutility from longer though more infrequent commutes. Against this backdrop, this section investigates potential drivers of shifts in housing transactions and intensity gradients. Accordingly, equation (2) is augmented with interactions between distance to the urban centre on the one hand and i) initial house price differences between the core and the commuting zone, ii) the difference in access to green space, iii) the availability of high-speed internet, iv) the stringency of COVID-

19 containment measures, as well as city characteristics such as size and density on the other hand. The specification is as follows (Equation 3):

$$\Delta TI_{i,j} = \alpha_1 + \delta_{1,0}\ln D_i + \boldsymbol{\delta_{1,x}}(\ln D_i * X) + \mu_{1,j} + e_{1,i} \quad (3)$$

$$\Delta p_{i,j} = \alpha_2 + \delta_{2,0}\ln D_i + \boldsymbol{\delta_{2,x}}(\ln D_i * X) + \mu_{2,j} + e_{2,i} \quad (4)$$

where $\mathbf{X}$ denotes one of the described characteristics assumed to be related to potential shifts in housing demand. The standalone contribution of these covariates (i.e. β X) is absorbed due to the inclusion of FUA-fixed effects. The Δ operator denotes the percentage change from the first half of 2019 to the first half of 2021.[5] The results are summarised in Table 7.

Table 7. Estimated links between large-FUA characteristics and COVID-19 changes in transaction intensity and house price gradients

Covariate	Transaction intensity		House prices	
	$\hat{\delta}_{1,0}$	$\hat{\delta}_{1,x}$	$\hat{\delta}_{2,0}$	$\hat{\delta}_{2,x}$
Initial house price (Core/Commuting) ratio	3.107***	-2.452*	0.602***	**3.011*** **
	(0.627)	(1.417)	(0.173)	(0.512)
Green space (Core/Commuting zone) ratio	3.034***	0.353	0.656***	**-0.970*** **
	(0.622)	(1.375)	(0.175)	(0.103)
High-speed internet access (Core/Core+Commuting) ratio	3.040***	0.596	0.627***	**-1.277** **
	(0.616)	(1.275)	(0.166)	(0.516)
FUA population size	2.954***	-1.491*	0.656***	**0.495** **
	(0.618)	(0.871)	(0.169)	(0.217)
FUA population density	3.062***	-0.009*	0.660***	**0.007*** **
	(0.617)	(0.005)	(0.173)	(0.002)
Oxford containment and health index	2.954***	0.210	0.656***	**0.181** **
	(0.618)	(0.145)	(0.169)	(0.075)

Note: Three, two and one stars denote 99.9%, 99% and 95%statistical significance (* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$). Equations (3) and (4) are estimated for each covariate X. Log-distances are centred for each FUA so that the sign of the estimated interaction effect can be interpreted. The sample is made of observations located in functional urban areas of more than 1.5 million inhabitants.
Source: OECD calculations.

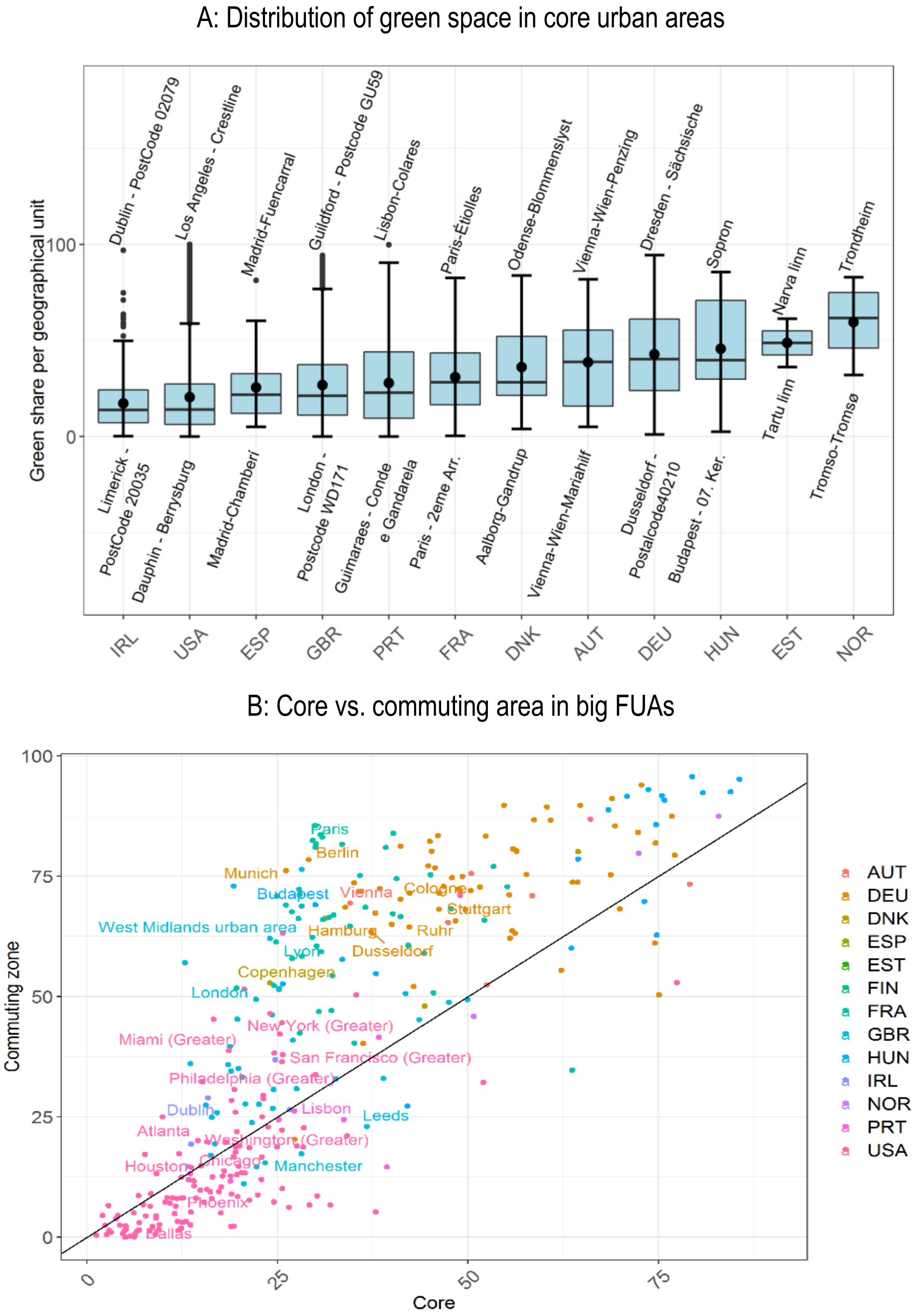
42. Incentives to relocate into the periphery can be anticipated to be stronger where movers can benefit from a larger price gap between the centre and the periphery. Indeed, house price gradients have gone up more in large urban areas that exhibited wider pre-COVID-19 house price differentials between the core and commuting areas (positive coefficient in the last column of the first row of Table 7). The negative effect on the transaction intensity gradient is difficult to interpret but could reflect a particularly strong increase in transactions in the centre as a result of the reallocation.

Access to green space

43. People have stronger incentives to move away from the city centre if the suburbs are considerably greener, all else being equal. Available GIS data can be used to compare green space in urban areas across countries (Figure 8, Panel A) and within FUAs, comparing core areas to commuting zones (Figure 8, Panel B). Indeed, the scarcer the availability of green space in the core area relative to the commuting zone, the more housing demand shifts away from the city centre (third row, last column of Table 7).

[5] $\Delta y = 100 * [(y_{2021Q1} + y_{2021Q2})/(y_{2019Q1} + y_{2019Q2}) - 1]$.

Figure 8. The share of green space in urban areas differs considerably across and within countries



Note: Green areas are defined by the following tags: i) amenity (grave_yard), ii) landuse (allotments, cemetery, farmland, forest, grass, allotments, cemetery, farmland, forest, grass, greenfield, meadow, orchard, recreation_ground,village_green, vineyard), iii) leisure (garden, golf_course, nature_reserve, park, pitch), iv) natural (wood, scrub, heath, grassland, wetland, water) and v) tourism (camp_site). Only geographical units with available house price data are considered. Panel B labels FUAs with a population above 1.5 million (USA: >5 million).
Source: OpenStreetMap and OECD calculations.

Availability of high-speed internet

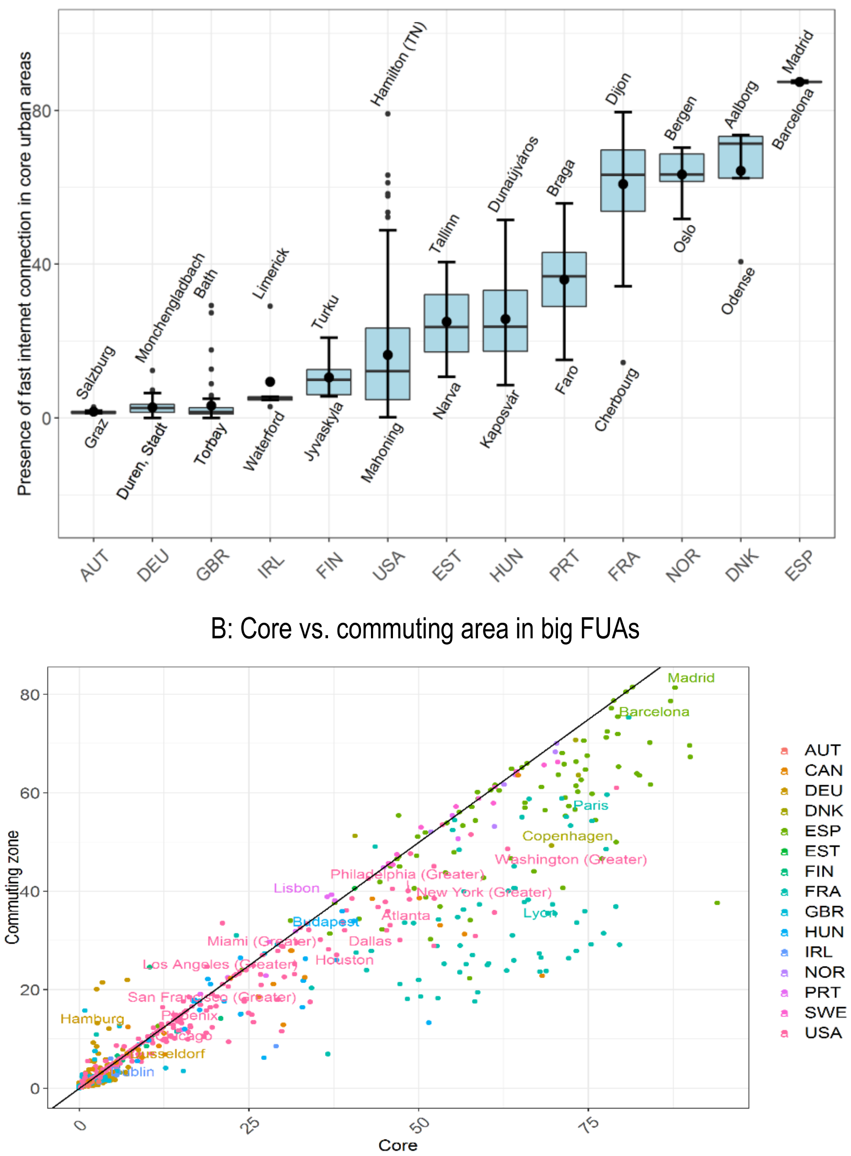
44. Increased use of working from home practices requires sufficient availability of high-speed internet. Measurements from Ookla and other speed test providers offer indications of real-world Internet speeds

experienced by users (OECD, 2021[8]; OECD, forthcoming[27]). The data suggest that the provision of high-speed internet is generally very good in urban cores but less so in some commuting areas, notably in smaller FUAs (Figure 9). The insufficiently widespread availability of fast internet, therefore impeding working-from-home in more remote areas, might be one of the reasons why a shift in housing demand is not observed in a number of cities (Figure 7).

Figure 9. Presence of fast internet in urban areas differs considerably across and within countries

Percentage of the area where download speed averages 50Mbps or more

A: Distribution of fast internet in core urban areas



Note: The indicator on the availability of fast internet is based on average download speed across web Mercator tiles at zoom level 16 (approximately 610.8 by 610.8 metres at the equator). Panel B labels FUAs with a population above 1.5 million (USA: >5 million).
Source: OECD calculations based on Speedtest by Ookla Global Fixed and Mobile Network Performance Maps. Based on analysis by Ookla of Speedtest Intelligence data for 2021Q2.

45. The results indicate that, as expected, house price gradients have increased more in urban areas where access to high-speed internet is more evenly spread between the core and commuting areas (fifth

row, last column of Table 7). This means that a lower coverage of high-speed internet in the commuting zone reduces the magnitude of the shift in housing towards the suburbs, also as anticipated.

46. This empirical investigation could be enhanced by assessing the share of jobs that can be done from home for each FUA. Dingel and Neiman (2020[28]) show that this number varies considerably in the United States and across countries. For the United States, Bloom and Ramani (2021[29]) find evidence that the share of residents that can work from home is positively associated with home price changes following the onset of COVID.

47. As expected, the drive towards the periphery has been stronger in more populated cities (seventh row, last column of Table 7). Similarly, greater density is also accompanied by a sharper post-COVID-19 flattening of house price gradients (ninth row, last column of Table 7).

Stringency of COVID-19 containment measures

48. Tighter lockdowns and generally more restrictive COVID-19 containment measures are likely to reduce by more the attractiveness of amenities in the centre (such as restaurants, theatres, dance floors, etc.) than in the periphery (parks, forests, etc.). To the extent that inhabitants may consider these measures likely to come back to some degree if COVID-19 becomes endemic, they may durably alter their location preferences. Estimating this effect is empirically difficult, as no internationally comparable measure of restrictiveness has been identified at the city level. Despite the limited number of countries, using the national-level Oxford containment and health index suggests that, indeed, house price differences between city centres and their peripheries have narrowed by more in urban areas located in countries that have applied more stringent measures (penultimate row, last column of Table 7).

Policy implications and future work

Policy implications

49. The shift from centres towards peripheries to which the new dataset is pointing in many large cities offers an opportunity for housing markets. A flattening of the house price curve (i.e. increase in the house price gradient) could help offset some of the spatial inequalities that have been building up over past decades. Before the pandemic, many cities had indeed faced increasingly unaffordable housing in central urban areas, which had acted as a brake to agglomeration effects and productivity gains (Glaeser and Gyourko, 2018[30]).

50. Policies have an important role to play to realise the potential created by shifts in demand toward the periphery for more inclusive and sustainable housing. However, if housing supply is not allowed to expand in areas receiving new demand, the result could be steep price increases in these areas, offsetting the affordability benefits. Inadequate supply response could also increase urban sprawl, exacerbating the challenge of transport and greenhouse gas emission reduction. Accordingly, land-use policies should allow some densification of the peripheral areas that face greater demand while also adjusting the provision of infrastructure and public services.

51. The OECD Housing Policy Toolkit outlines avenues for public policy to enhance the responsiveness of housing supply (OECD, 2021[31]). In particular, residential construction is generally more responsive to price signals when land-use governance systems avoid overlap in responsibilities and place decision authority at the metropolitan level. Indeed, by comparison with more highly decentralised decision-making processes that can give strength to "not-in-my-backyard" pressures, decisions made at the metropolitan level are more able to incorporate functional-area-wide externalities and urban policy objectives.

52. Furthermore, balanced policies that protect tenants while leaving sufficient flexibility in the setting of rents between contracts have shown to be supportive of housing supply, as they create a more favourable environment for the provision of rental housing. In addition, there is also a role to play for social housing policy in ensuring affordable supply that matches the emerging new geography of housing demand.

53. The effective use of working-from-home practices requires a widespread coverage of high-speed broadband internet, notably covering peripheral and more remote areas. The OECD Recommendation on Broadbank Connectivity emphasises the importance of investing in broadband deployment and eliminating digital divides, notably by fostering innovation and competition in deploying broadband internet infrastructure (OECD, 2021[32]). A regular assessment of the state of connectivity at a granular geographical level through collecting, analysing, and publishing data on the availability, performance, and adoption of connectivity services and infrastructure deployment would help to guide public decisions in the direction of better equipping underserved areas.

Future work

54. Looking ahead, the policy discussion would benefit from information about developments in supply. For this purpose, work is underway to analyse satellite imagery so as to quantify changes in land use (residential, green areas, open spaces) (Banquet et al., forthcoming[33]). This would shed light on the extent to which a new pattern of construction may be emerging in urban areas.

55. Furthermore, ongoing work aims to strengthen and extend the evidence in the following directions:

- Adding countries would widen the evidence base, help to strengthen or nuance the findings in this report, and provide a basis for more econometric analysis using country-level variables. Already underway are Belgium, Korea, Mexico, Sweden and Canada.
- Revisiting the statistical treatment of highly disaggregated data to find the best compromise between measurement risk (higher for more granular data) and model risk (one needs a critical level of granularity to answer the present research question).
- Other relevant explanatory variables could be explored:
    - A measure of excess mortality at local level (Diaz Ramires, Veneri and Lembcke, 2021[34]) could help to capture the intensity of the local COVID shock.
    - Cross-city differences in industry composition and type of jobs (that is, occupational composition effects) could contribute to explaining why house price gradients have evolved differently across urban areas (Dingel and Neiman (2020[28]) and Bloom and Ramani (2021[29]). A measure capturing the percentage of jobs amenable to remote working (OECD, 2020[35]) could be tested.
- The extent of population inflow/outflow could also provide additional control for the effect of inter-regional migration on house prices. Indeed, if a shift in housing demand from a FUA's centre towards its periphery can be accompanied by a move from people living in the periphery towards another FUA, the second change may mask the effect of the first one in prices.
- The understanding of the statistical quality of the price database would be enhanced by comparing it with hedonic regional and local house price indices wherever possible.
- The extent to which the changes are persistent is planned to be assessed as new data come in extending the coverage beyond mid-2021.

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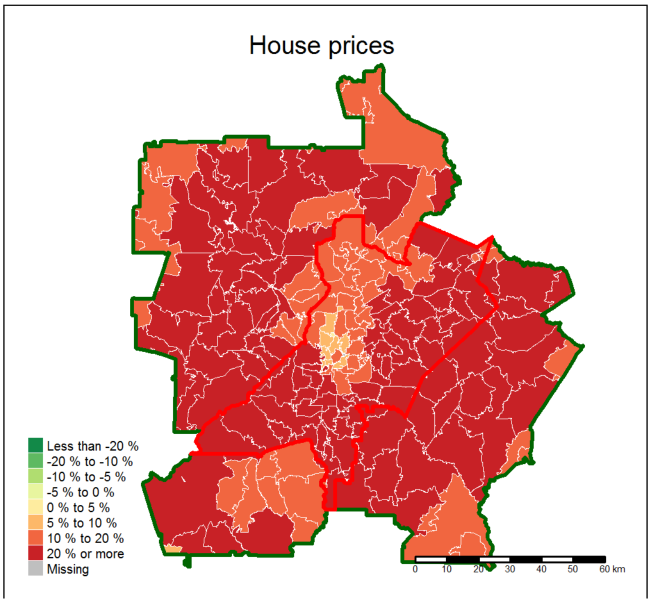
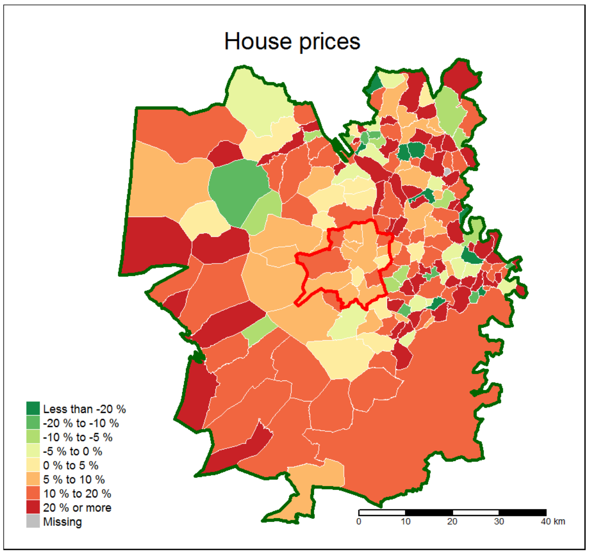
Annex A. Appendix: changes in house prices and transaction intensity gradients for selected metropolitan areas

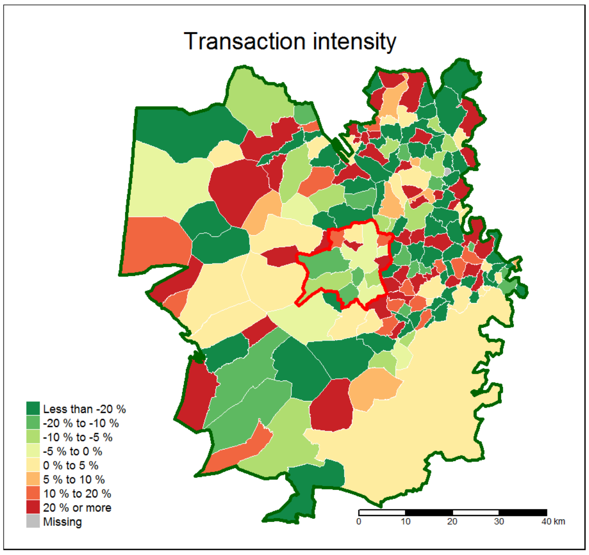
The following maps illustrate changes in house prices and transaction intensity from the first half of 2019 to the first half of 2021. Transaction intensity is defined as the number of transactions per 100 000 population. The red line represents the border of the core urban area, while the green line is the commuting zone's border.

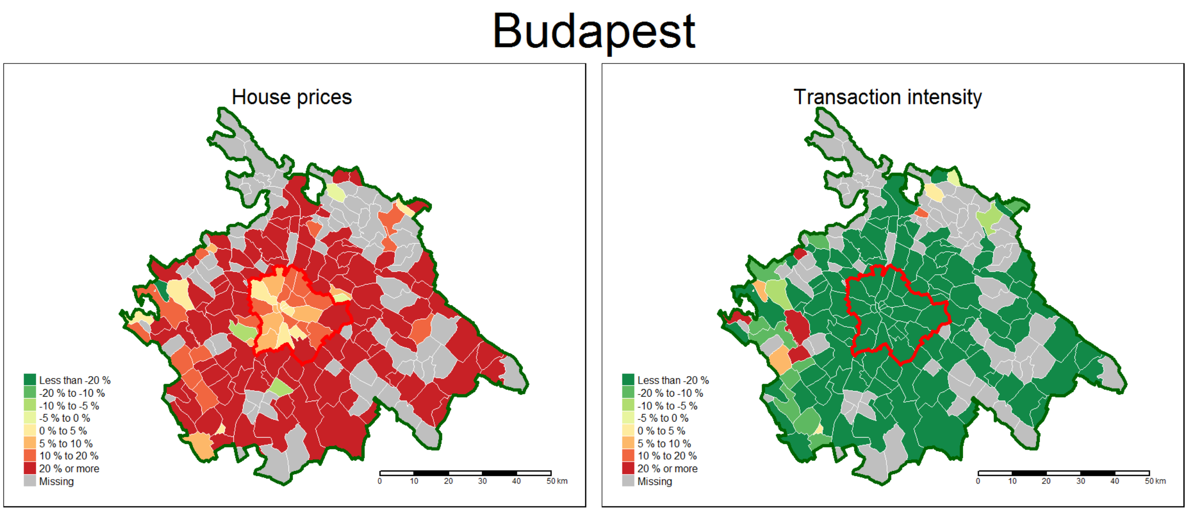
Atlanta



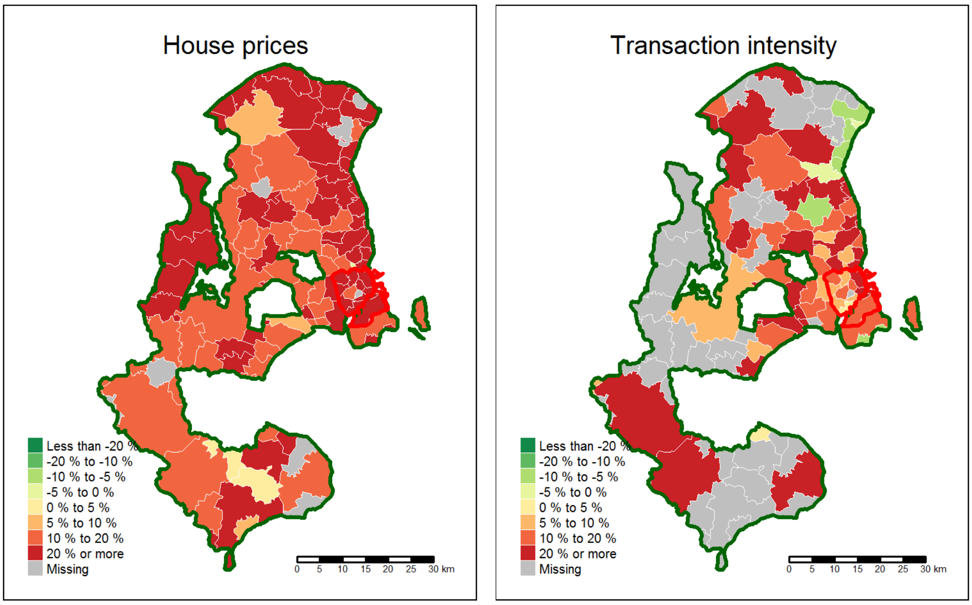
Bordeaux



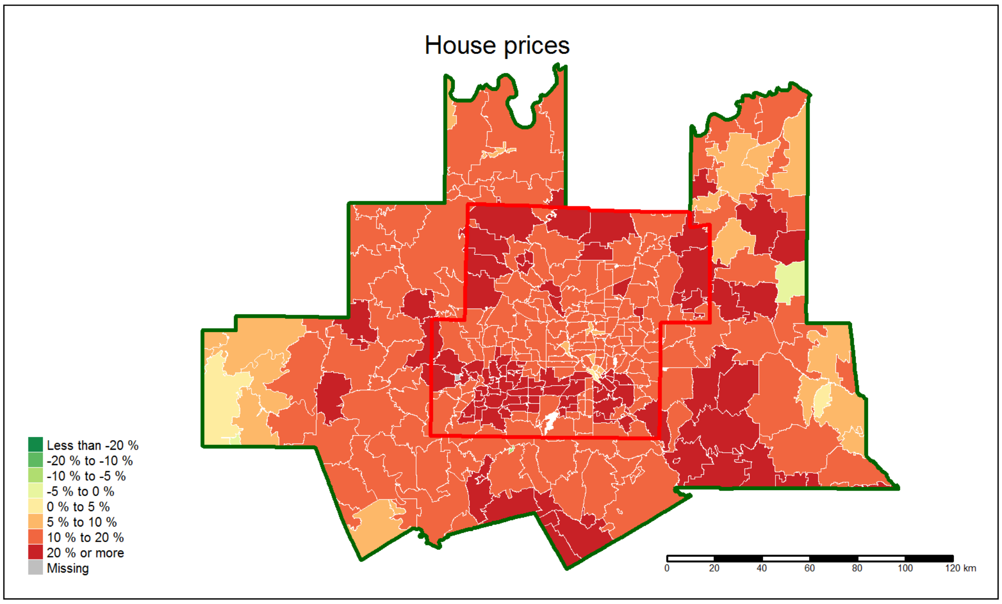



Budapest
House prices
Less than -20 %
-20 % to -10 %
-10 % to -5 %
-5 % to 0 %
0 % to 5 %
5 % to 10 %
10 % to 20 %
20 % or more
Missing
0
10
20
30
40
50 km
Transaction intensity
Less than -20 %
-20 % to -10 %
-10 % to -5 %
-5 % to 0 %
0 % to 5 %
5 % to 10 %
10 % to 20 %
20 % or more
Missing
0
10
20
30
40
50 km

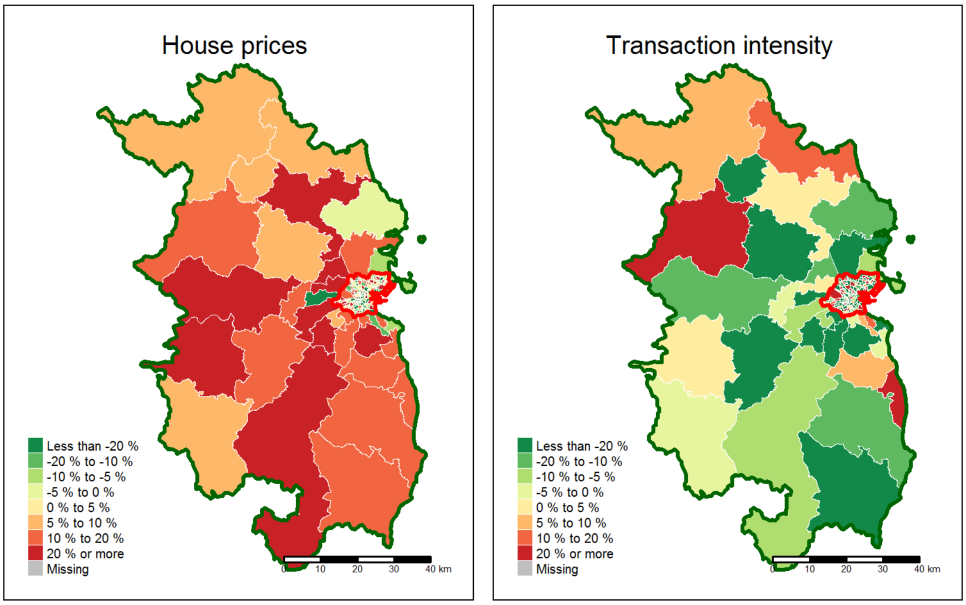
Copenhagen



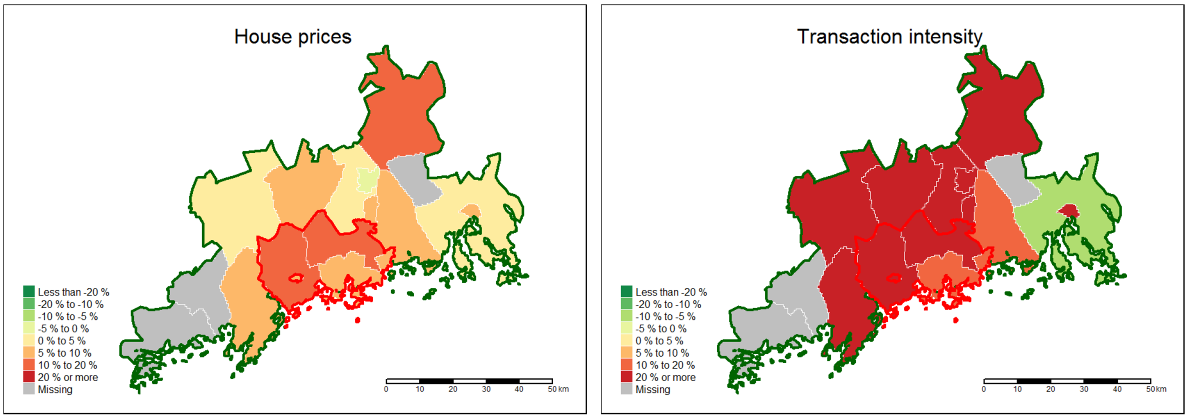
Dallas



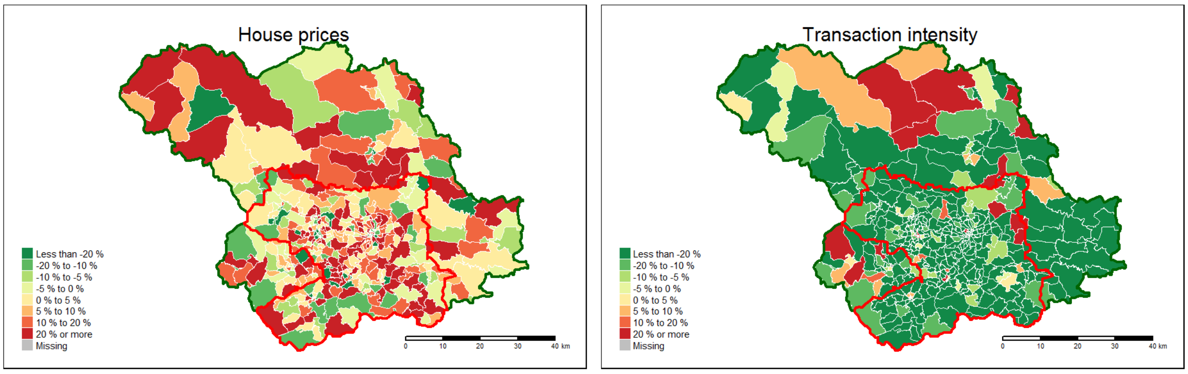
Dublin



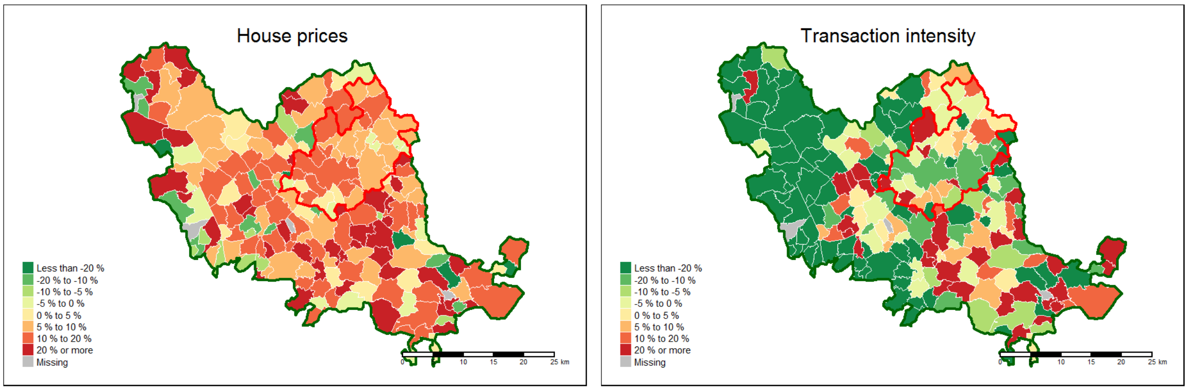
Helsinki



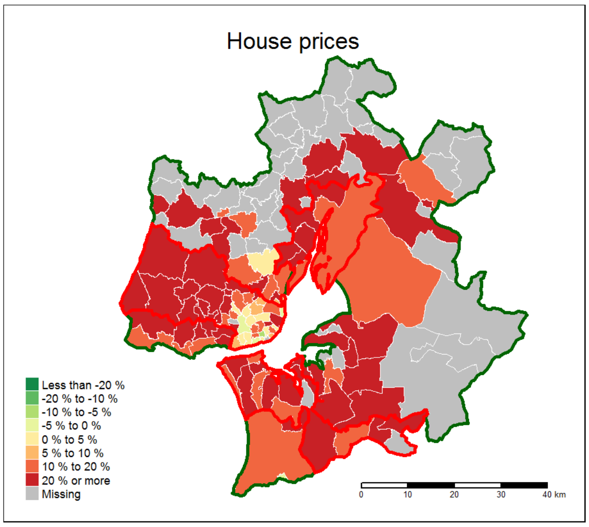
Leeds

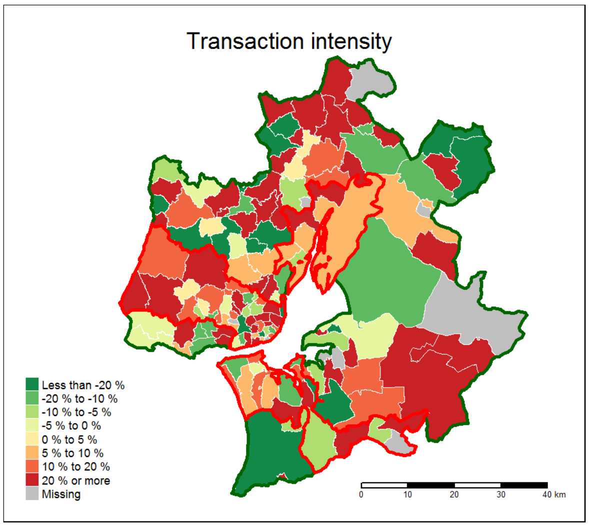

House prices
Transaction intensity
Less than -20 %
-20 % to -10 %
-10 % to -5 %
-5 % to 0 %
0 % to 5 %
5 % to 10 %
10 % to 20 %
20 % or more
Missing
0 10 20 30 40 km

Lille

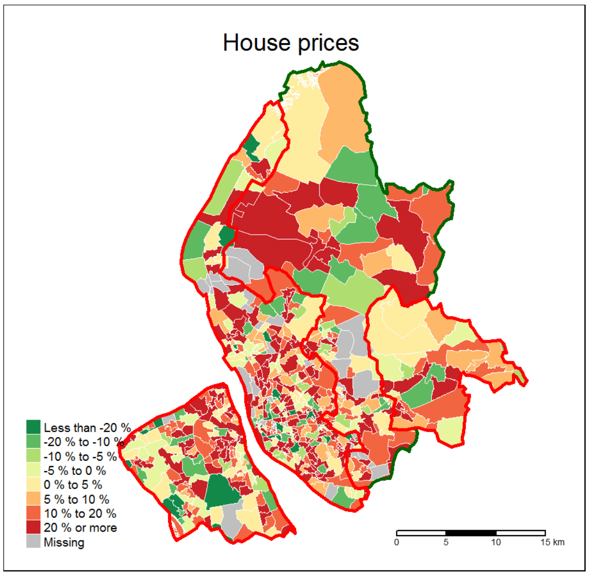

House prices
Transaction intensity
Less than -20 %
-20 % to -10 %
-10 % to -5 %
-5 % to 0 %
0 % to 5 %
5 % to 10 %
10 % to 20 %
20 % or more
Missing
0 10 15 20 25 km

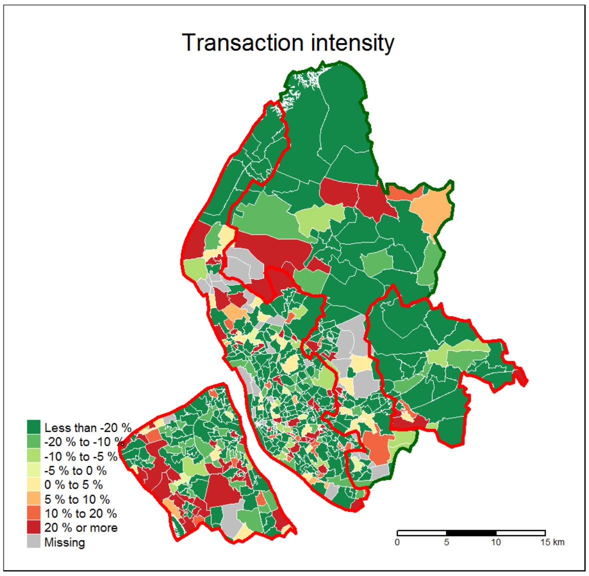
Lisbon



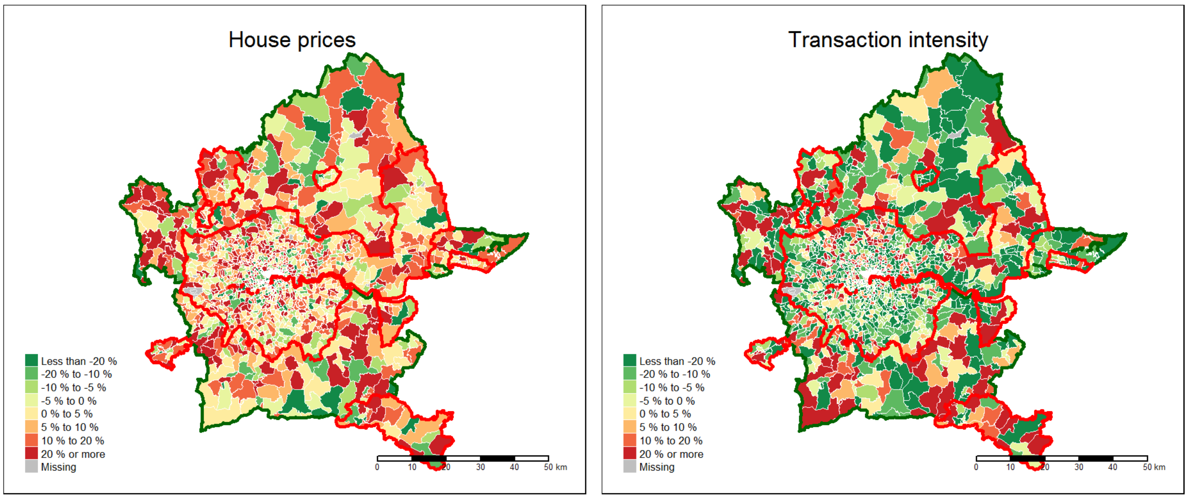


Liverpool

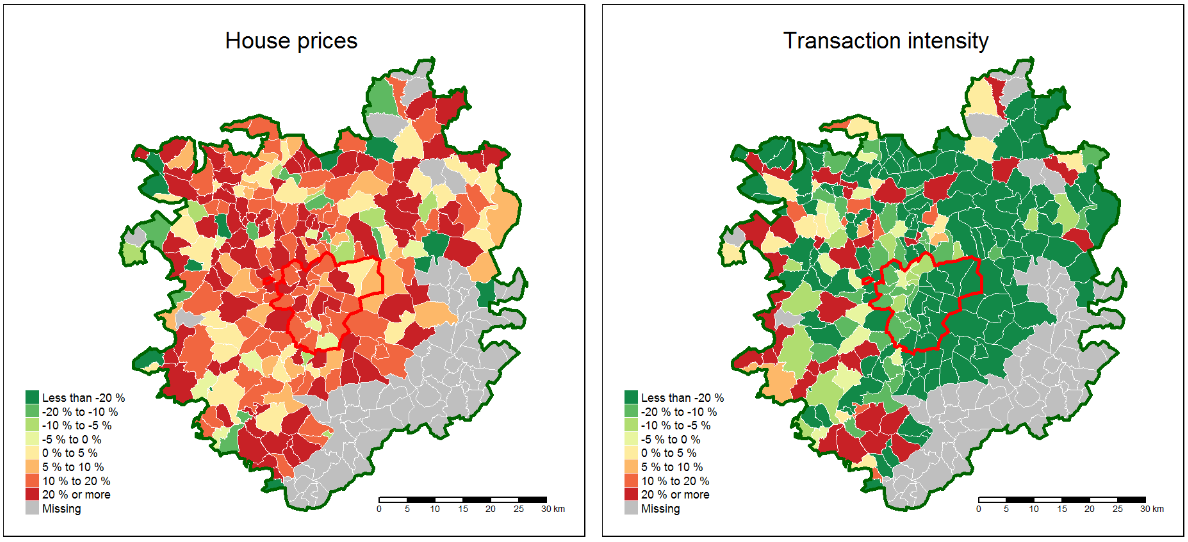




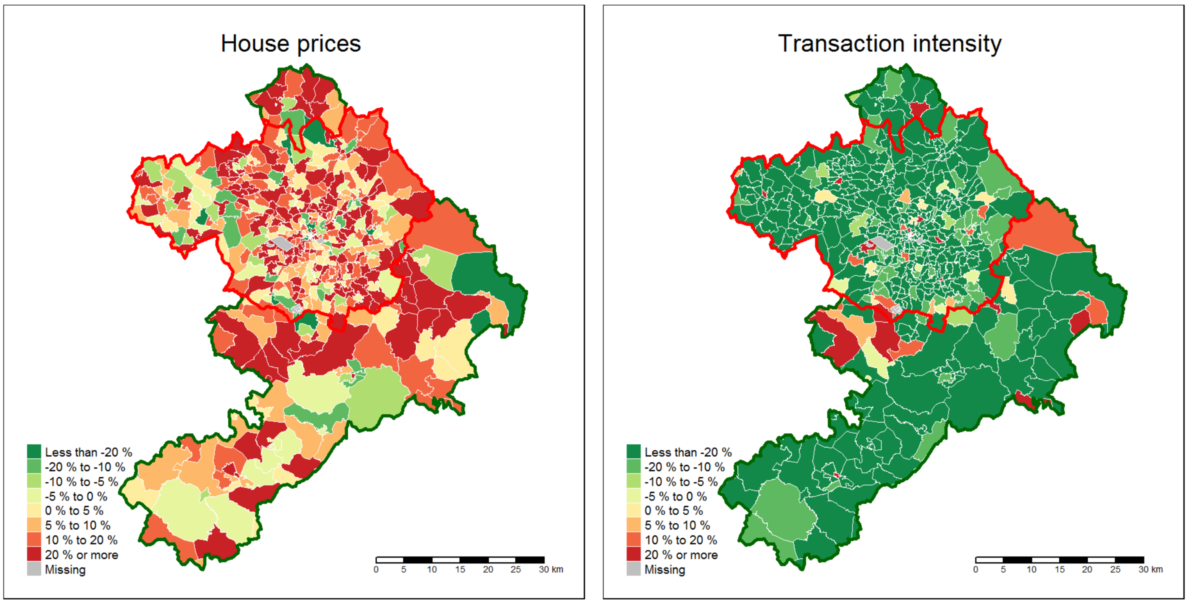
London


House prices
Transaction intensity
Less than -20 %
-20 % to -10 %
-10 % to -5 %
-5 % to 0 %
0 % to 5 %
5 % to 10 %
10 % to 20 %
20 % or more
Missing
0
10
20
30
40
50 km

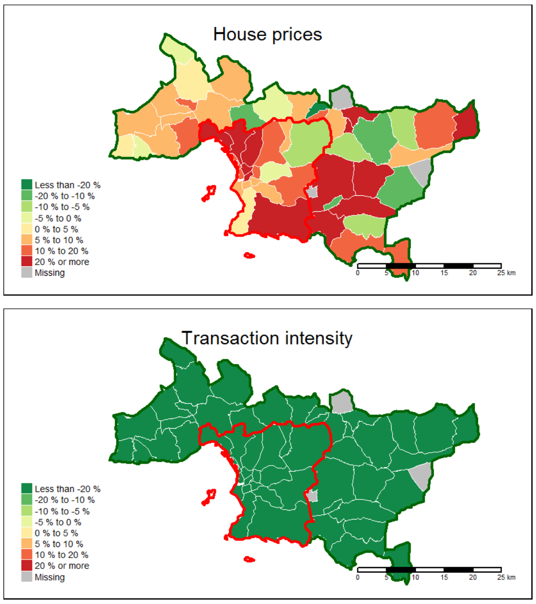
Lyon


House prices
Transaction intensity
Less than -20 %
-20 % to -10 %
-10 % to -5 %
-5 % to 0 %
0 % to 5 %
5 % to 10 %
10 % to 20 %
20 % or more
Missing
0
5
10
15
20
25
30 km

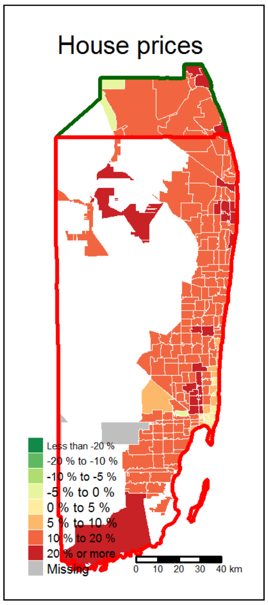
Manchester



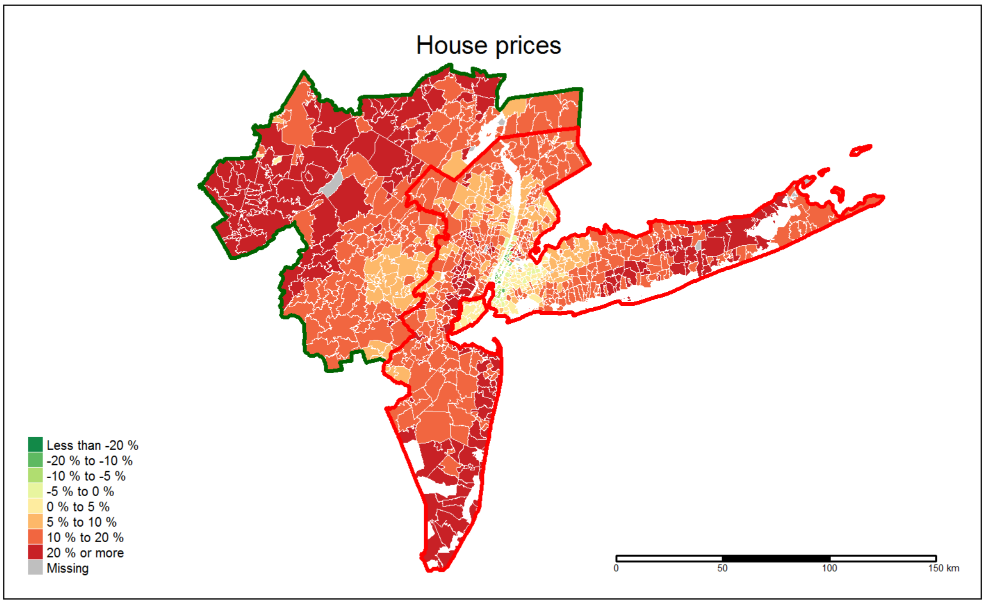
Marseille

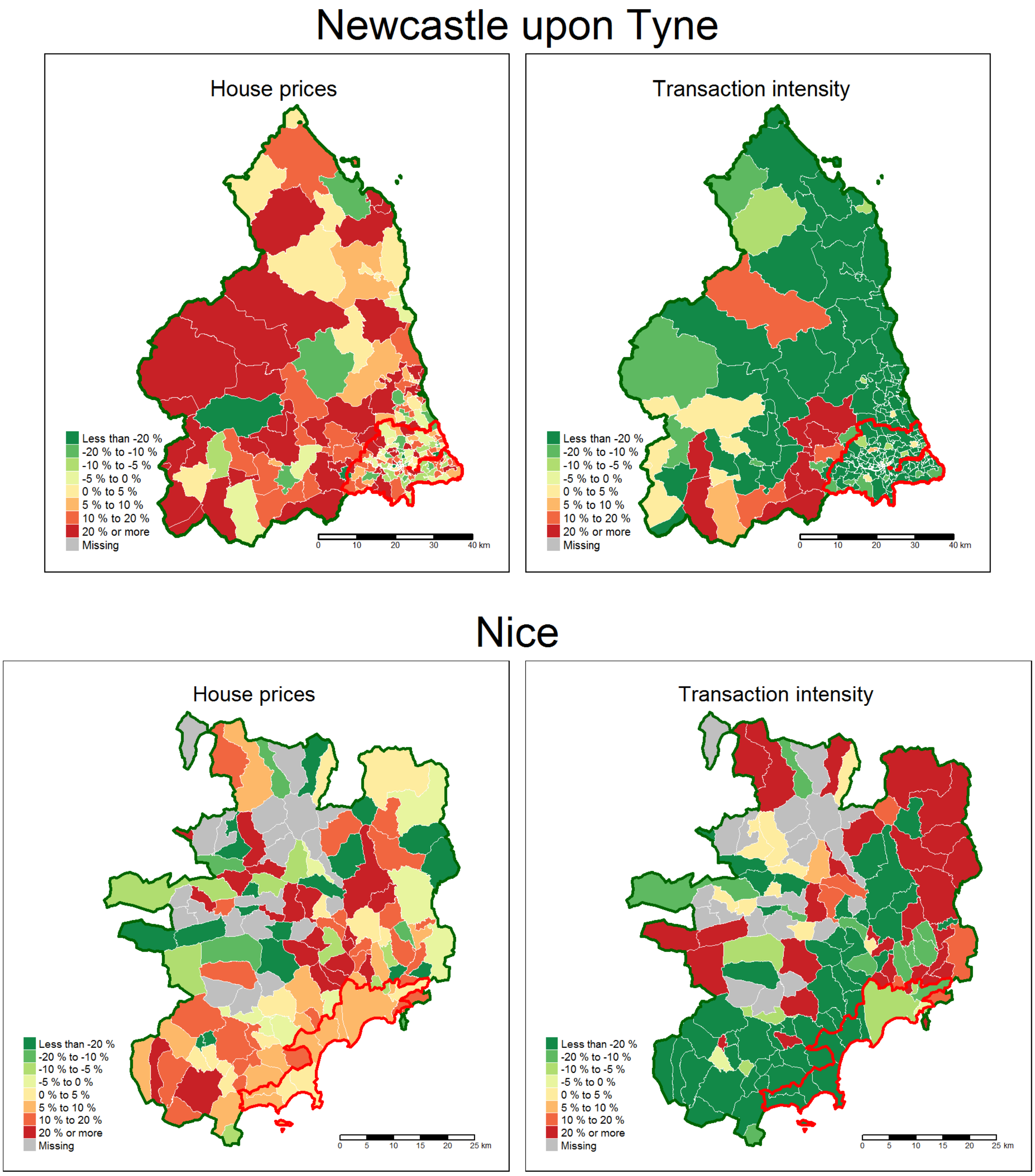


iami (Greate



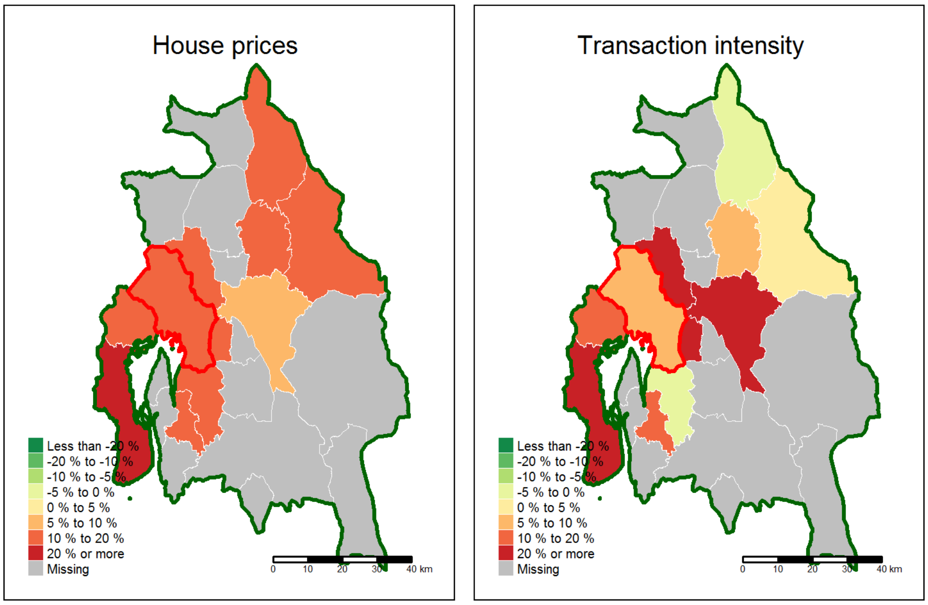
New York (Greater)



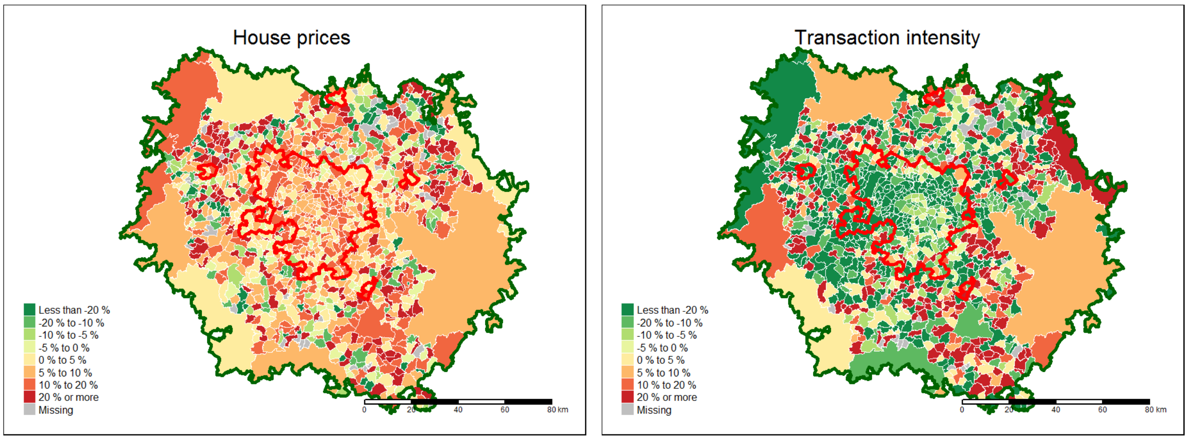


Newcastle upon Tyne
House prices
Transaction intensity
Less than -20 %
-20 % to -10 %
-10 % to -5 %
-5 % to 0 %
0 % to 5 %
5 % to 10 %
10 % to 20 %
20 % or more
Missing
0 10 20 30 40 km
Nice
House prices
Transaction intensity
Less than -20 %
-20 % to -10 %
-10 % to -5 %
-5 % to 0 %
0 % to 5 %
5 % to 10 %
10 % to 20 %
20 % or more
Missing
0 5 10 15 20 25 km

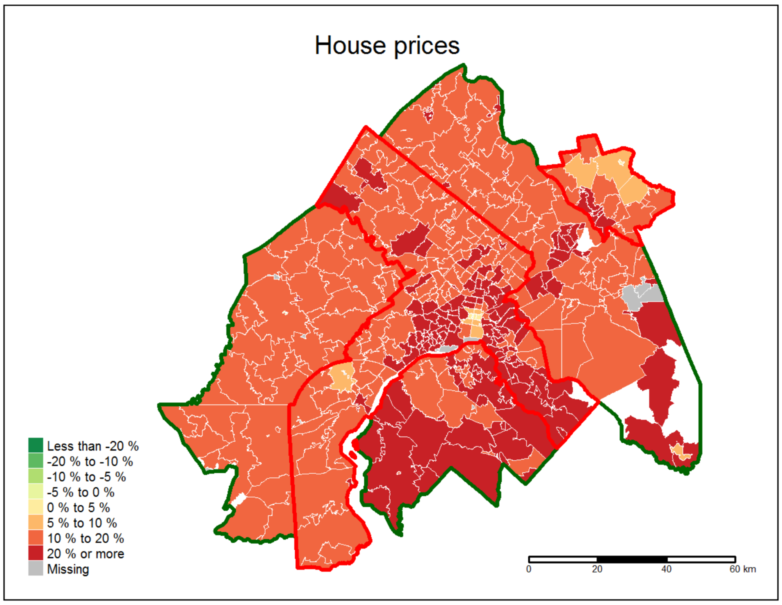
Oslo


House prices
Transaction intensity
Less than -20 %
-20 % to -10 %
-10 % to -5 %
-5 % to 0 %
0 % to 5 %
5 % to 10 %
10 % to 20 %
20 % or more
Missing
0
10
20
30
40 km

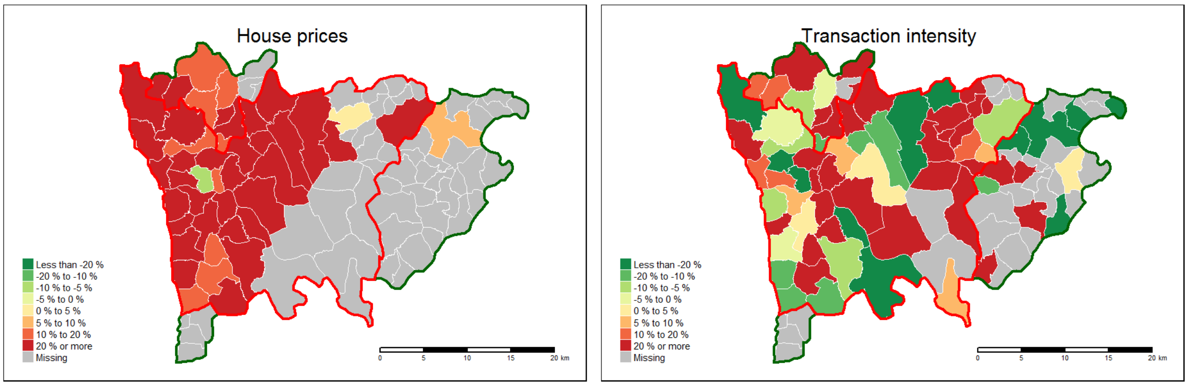
Paris


House prices
Transaction intensity
Less than -20 %
-20 % to -10 %
-10 % to -5 %
-5 % to 0 %
0 % to 5 %
5 % to 10 %
10 % to 20 %
20 % or more
Missing
0
20
40
60
80 km

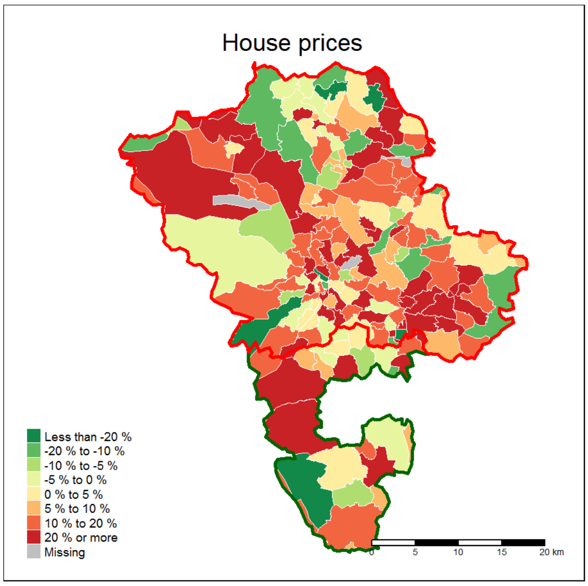
Philadelphia (Greater)

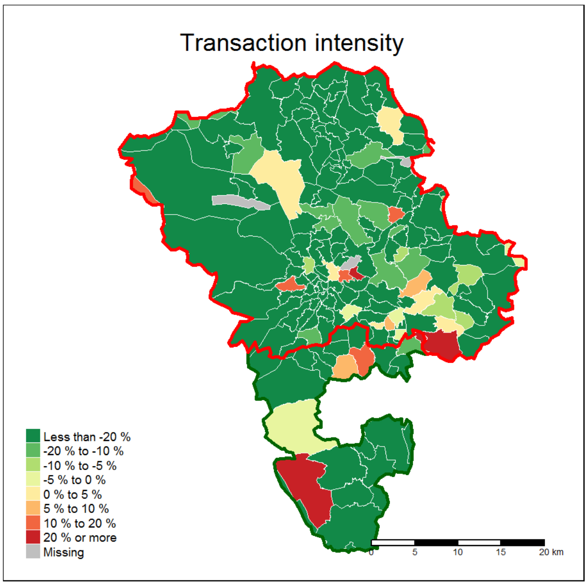


Porto

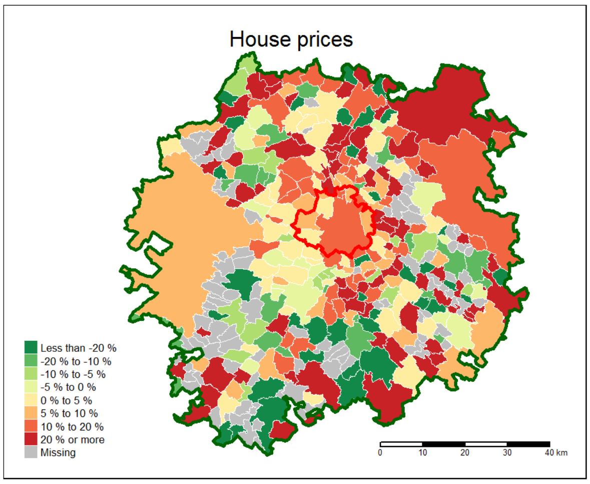


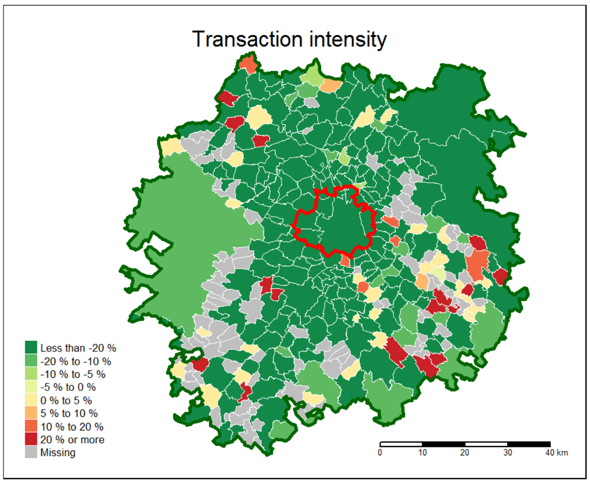
Sheffield



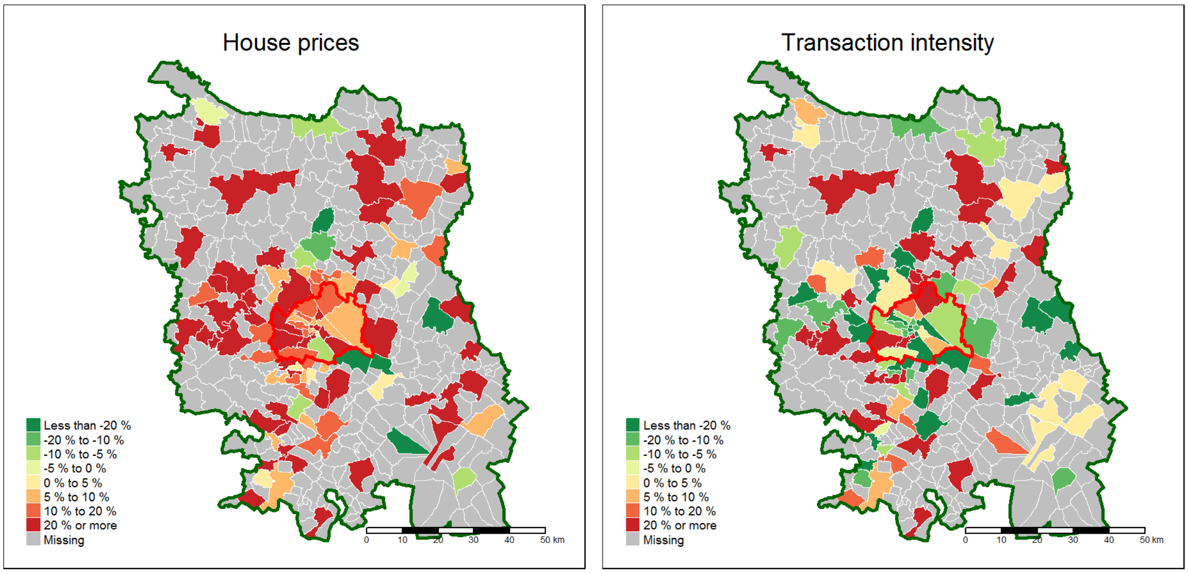


Toulouse

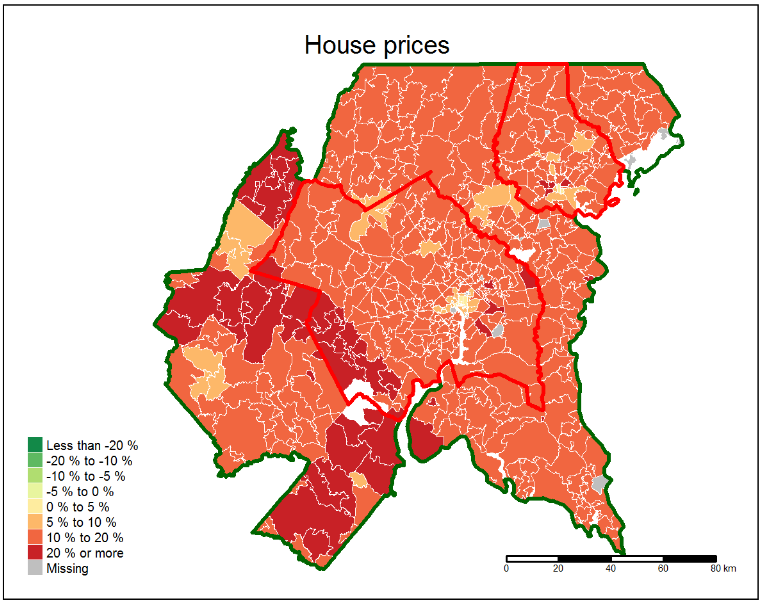




Vienna



Washington (Greater)



West Midlands urban area