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Expanding the doughnut? How the geography of housing demand has changed since the rise of remote work with COVID-19

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The rise of remote working in connection with the COVID-19 pandemic may have reshaped people's preferences on residential locations, thus generating a new geography of housing demand. So far, the literature has mainly focused on what has become known as the "doughnut effect", the hollowing out of large metropolitan centres towards their respective suburban areas ("commuting zones"). However, changes in residential preferences might have affected urban and rural living in more nuanced ways. This paper shows that changes in relative house prices – a proxy for short-term changes in demand for home ownership ("housing demand") – have gone beyond the metropolitan boundaries, consistent with the idea of longer but less frequent home-to-work commuting. Interestingly, we are not seeing a re-emerging preference for rural life as such but, rather, a desire to move to places that combine the benefits of rural and urban life. In the areas outside the main metropolitan centres but within the commuting zones, housing demand has increased the most in low-density, more affordable, settlements (rural). In contrast, beyond the boundaries of large metropolitan areas, where most space tends to be rural, housing demand has increased the most in high-density settlements (cities).

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Keywords: Housing demand, remote working, degree of urbanisation, COVID-19.

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1 Introduction

The COVID-19 pandemic led to a dramatic increase in remote working, in particular during periods of lockdown. Indeed, after more than three years, remote working remains widely used, and is expected to continue to do so (Bloom, Han and Liang, 2023[1]; Barrero, Bloom and Davis, 2021[2]). This shift has potential implications for the spatial organisation of several human activities. Remote working reduces the number of days workers need to commute, allowing people to be less constrained in their choices of where to live, including to live farther away from workplaces located in high-density areas. According to recent studies, new working and commuting arrangements will result in long-term changes in the geography of housing demand (Brueckner, Kahn and Lin, 2023[3]).

An emerging literature suggests that since the start of COVID-19, many large metropolitan areas in developed countries have experienced higher housing demand in their suburbs than in their city centres, also known as the "doughnut effect" (Ramani and Bloom, 2021[4]). This has led to an average flattening of the house price-to-distance gradient – the negative relationship between house prices and distance to the city centre – within many large metropolitan areas (Gupta et al., 2021[5]; Ahrend et al., 2022[6]; Ziemann et al., 2023[7]). These studies provide a first picture of how residential preferences are re-organising between more central and peripheral locations within metropolitan areas, which in most cases already cover quite large areas. But little is known on whether housing demand is increasing even beyond these large metropolitan boundaries (i.e., areas which tend to be relatively far away from the metropolitan centre). In addition to a shift in housing preferences within the metropolitan space, the potential expansion of functional metropolitan boundaries has important implications for urban policies, notably related to housing and transport, and more generally to sustainable urban development (for a detailed discussion on related policy implications see (OECD, 2023[8]; OECD, 2023[9])).

This study fills this void in the literature by showing that changes in home ownership demand (hereafter "housing demand") – proxied through changes in house prices[1] – has been expanding even beyond the boundaries of large metropolitan areas since the COVID-19 outbreak and the related increase of teleworking. It also provides evidence on the specific location characteristics associated with the observed changes in housing preferences.

The analysis builds on quarterly data (from 2018 Q1 to 2021 Q4) on dwelling purchases (including houses and apartments) and related prices (hereafter referred to as "house prices") for small geographical units located in large metropolitan areas (i.e., functional urban areas, FUAs, of at least 1.5 million inhabitants or the largest FUA in the country) and their surroundings in 16 OECD countries. Metropolitan areas are delineated consistently using the OECD-EU definition of functional urban areas (Dijkstra, Poelman and Veneri, 2019[10]), which consist of a densely populated area ("core") and its commuting zone. This allows capturing the relevant extent of local labour markets that were in place before the pandemic (metropolitan areas), as well as their potential area of expansion due to COVID-19 and remote working ("extended" metropolitan areas).

Through different empirical specifications at the small area unit level, while controlling for extended metropolitan areas fixed effects, the paper disentangles changes in house prices before and during COVID-19 across the different rings surrounding metropolitan centres. The paper also looks at the trends

[1] Under the assumption that housing supply is relatively inelastic within short periods of time.

in house prices by type of settlement within specific spatial rings. The use of the degree of urbanisation, DEGURBA (OECD et al., 2021[11]) (based on population estimates at the grid level for 2015[2]), to classify the types of settlements in different spatial rings within and beyond the metropolitan space maximises international comparability and allows a nuanced analysis of the changing housing preferences along the urban-rural continuum.

Results show that once most COVID-19 related lockdowns ended, and people were able to move again, house prices started increasing faster outside metropolitan centres, even beyond their (already large) commuting zones, reaching more distant areas – outside the metropolitan boundaries – referred to as "the buffers". Within commuting zones, rural areas – also characterised by relatively cheaper house prices – have gained attractiveness in terms of higher home ownership demand (reversing pre-pandemic trends), while within the closest buffers around metropolitan boundaries, (smaller) cities have seen a higher house price increase during the pandemic years (2020-2021) – in contrast with the pre-pandemic period (2018-2019).

In the "new normal" characterised by higher adoption of remote working and less frequent commuting, the evidence provided by this study suggests an increasing tendency for people to live (or spend more time) farther away from the most central and dense locations. However, new housing preferences seem to value either close access to a metropolitan centre (the case of more affordable rural areas in commuting zones) or, for the case of locations outside metropolitan boundaries, a minimum density level provided by other (smaller) cities. This indicates that we are not seeing a re-emerging preference for rural life as such, but rather an increased preference for places that combine the benefits of both rural and urban life.

The remainder of the paper is organised as follows: Section 2 presents the data and definitions, while Section 3 provides a statistical overview of recent trends in the geography of housing demand. Section 4 presents the empirical specifications and the results. Finally, Section 5 provides some conclusions and venues for future work.

[2] Population estimates at the 1 km^2 grid level for 2015 come from the Global Human Settlement Layer (GHSL) Data package of 2019 (Florczyk, 2019[13]), which was the latest version available at the time of writing.

2 Data and definitions

Housing data

The Geography of Housing Demand (GHD) database, built by the OECD in collaboration with public and private data providers (see Table 2.1), gathers the total number of dwelling purchases and average prices for 16 OECD countries at the small area unit (SAU) level. It is worth highlighting that the GHD indicators do not cover rents. Thus, the analysis focuses on home ownership demand, which, for simplicity, is also referred to as "housing demand" throughout the paper. Studying dwelling purchases (which tend to be forward looking) rather than rents (which tend to reflect current developments) (Gupta et al., 2021[5]; Van Nieuwerburgh, 2022[12]), might allow capturing more persistent shifts in housing preferences.

Table 2.1. Data sources and coverage

Country	Geographical units	Time coverage	House price indicator	Source
Austria	1 075 municipalities	2015Q1 - 2022Q1	Median price per m^2	Statistik Austria
Belgium	589 municipalities	2010Q1 - 2021Q4	Mean price per m^2	STATBEL
Germany	4 413 postal codes and 80 districts	2018Q1 - 2021Q4	Mean price per m^2	vdpResearch
Denmark	605 postal codes	1992Q1 - 2022Q1	Mean price per m^2	Statistics Denmark
Spain	5 369 municipalities and 31 districts	2007Q1 - 2021Q3	Mean price per m^2	INE
Finland	225 municipalities	2010Q1 - 2021Q4	Mean price per m^2	Statistics Finland
France	33 304 communes	2014Q1 - 2021Q4	Mean price per m^2	Demande de valeurs foncières (DVF)
United Kingdom	8 393 postcode sectors	1995Q1 - 2022Q3	Mean price adjusted by dwelling characteristics	UK Government Price Paid data
Norway	56 municipalities	2006Q1 - 2021Q4	Mean price per m^2	Statistics Norway
Portugal	2 110 parishes	2009Q1 - 2021Q4	Mean price per m^2	Confidencial Imobiliário
United States	27 403 zip codes	1996Q1 - 2022Q3	Mean price adjusted by dwelling characteristics	Zillow Research Institute
Israel	798 cities	2006Q1 - 2021Q4	Mean price per m^2	Central Bureau of Statistics
Korea	250 municipalities	2018Q1 - 2021Q4	Mean price per m^2	MOLIT
Hungary	2 914 settlements and 23 districts	2008Q1 - 2022Q1	Mean price per m^2	Hungarian Central Statistics Office
Sweden	275 municipalities	2015Q1 - 2021Q4	Mean price per m^2	Svensk Mäklarstatistik
Mexico	10 705 zip codes	2016Q1 - 2021Q4	Mean price per m^2	Sociedad Hipotecária Federal (SHF)

For all the countries in the sample, the database covers the first half of 2018 to the second half of 2021, allowing for a look at trends in the geography of home ownership demand before and during the pandemic. Average dwelling prices are expressed as per square-metre, except for two countries (the UK and the US), where prices are adjusted for other observable characteristics. The UK data is adjusted by house types (detached houses, semi-detached houses, terraced houses, and flats or maisonettes), and the US data is seasonally adjusted and considers number of rooms (Ahrend et al., 2022[6]).

As quarterly housing transactions and prices in small area units can be highly volatile, the analysis is based on either semestrial or yearly aggregates. In addition, when the number of transaction is too small, price distributions and time series can be extremely noisy. For this reason, SAUs with less than ten transactions per year are dropped from the sample[3] (for more technical details on data treatment see Annex D).

Geographical units

House prices are measured at the scale of SAUs (small area units). Depending on the country, these units correspond, for example, to zip codes, districts, or municipalities (Table 2.1). SAUs can be mapped to metropolitan areas and their surroundings (buffers), allowing for highly granular analysis within and in the neighbourhood of large urban centres.

Metropolitan areas are defined using the concept of Functional Urban Area (FUA) developed jointly by the OECD and the European Commission (Dijkstra, Poelman and Veneri, 2019[10]). A FUA consists of a densely populated area (also referred to as the "core") and a commuting zone whose labour market is highly integrated with the core through at least 15% of the working force commuting to the core. FUAs are delineated consistently across countries to maximise international comparability. This paper focuses on large metropolitan areas – i.e., FUAs of more than 1.5 million inhabitants or the largest FUA in the country for the cases of Norway and Finland – and their surroundings, expanding the scope of the analysis compared to the recent literature (Ramani and Bloom, 2021[4]; Gupta et al., 2021[5]; Ahrend et al., 2022[6]) that documents spatial changes in housing demand only within the boundaries of large metropolitan areas.

Only small area units belonging to a large metropolitan area or its buffers are considered for the analysis – which yields a sample of almost 45 000 SAUs distributed across 80 metropolitan areas and their buffers. Table 2.2 shows the list of large metropolitan areas covered in this paper, as well as the number of local units, their average population and area. Out of these 80 metropolitan areas, 36 are in the US and 29 in Europe. The granularity of SAUs can differ widely across countries. For example, SAUs in France are much more granular than those in Korea. The average population in French SAUs amounts to around 6 000 people, whereas in Korea it is more than 50 times higher and close to 342 000 people. In terms of density, Korean SAUs are eight times more dense than French SAUs, on average.

[3] Excluding SAUs with less than ten transactions could introduce biases in the analysis (e.g. underestimating home ownership demand in less dynamic, low-density, places). However, the cost of keeping them would be a source of unrealistic values for some SAUs, as well as higher standard errors undermining normality and statistical inference.

Table 2.2. Metropolitan areas covered in the analysis

Country	Metropolitan areas	Number of metropolitan areas	Number of SAUs	Average SAU population	Average SAU area (km²)	Average SAU density (people per km²)
Austria	Vienna	1	643	9 350	33.1	918
Belgium	Brussels/Leuven	1	424	34 409	43.8	2 106
Germany	Berlin, Hamburg, Munich, Köln, Frankfurt am Main, Ruhrgebiet, Stuttgart, Düsseldorf	8	2 861	25 297	37.4	4 009
Denmark	Copenhagen	1	172	23 110	41.6	2 467
Spain	Madrid, Barcelona, Valencia	3	1 156	12 772	40.2	2 033
Finland	Helsinki	1	55	40 278	313.4	305
France	Paris, Lyon, Marseille, Lille, Toulouse	5	9 554	6 156	12.7	1 024
United Kingdom	London, West Midlands urban area, Leeds, Liverpool, Manchester	5	5 639	23 612	13.1	32 620
Norway	Oslo	1	73	27 248	467.7	135
Portugal	Lisbon	1	283	23 776	45.2	3 643
United States	New York (Greater), Los Angeles (Greater), Chicago, Washington (Greater), San Francisco (Greater), Philadelphia (Greater), Dallas, Houston, Miami (Greater), Atlanta, Phoenix, Detroit (Greater), Seattle, Minneapolis, St. Louis, Denver, Portland, Cincinnati, Orange, Jackson (MO), Cuyahoga, New Haven, Charlotte, Sacramento, Jacksonville, Salt Lake, Tampa-Pinellas, Boston, San Diego, San Antonio, Las Vegas, Indianapolis, Austin, Columbus, Milwaukee, Tampa-Hillsborough	36	13 469	26 660	138.5	6 755
Israel	Tel Aviv - Yafo	1	425	26 389	8.1	10 219
Korea	Gimhae, Dalseong, Gwangsan, Seoul, Seo	5	186	341 563	308.4	8 379
Hungary	Budapest	1	804	8 388	32.1	542
Sweden	Stockholm	1	60	79 348	480.5	799
Mexico	Mexico City, Guadalajara, Monterrey, Puebla, Toluca, Tijuana, Leon, Queretaro, Torreon	9	9 102	24 632	17.6	55 374
Total		**80**	**44 906**	**45 812**	**127.1**	**8 208**

Defining spatial buffers

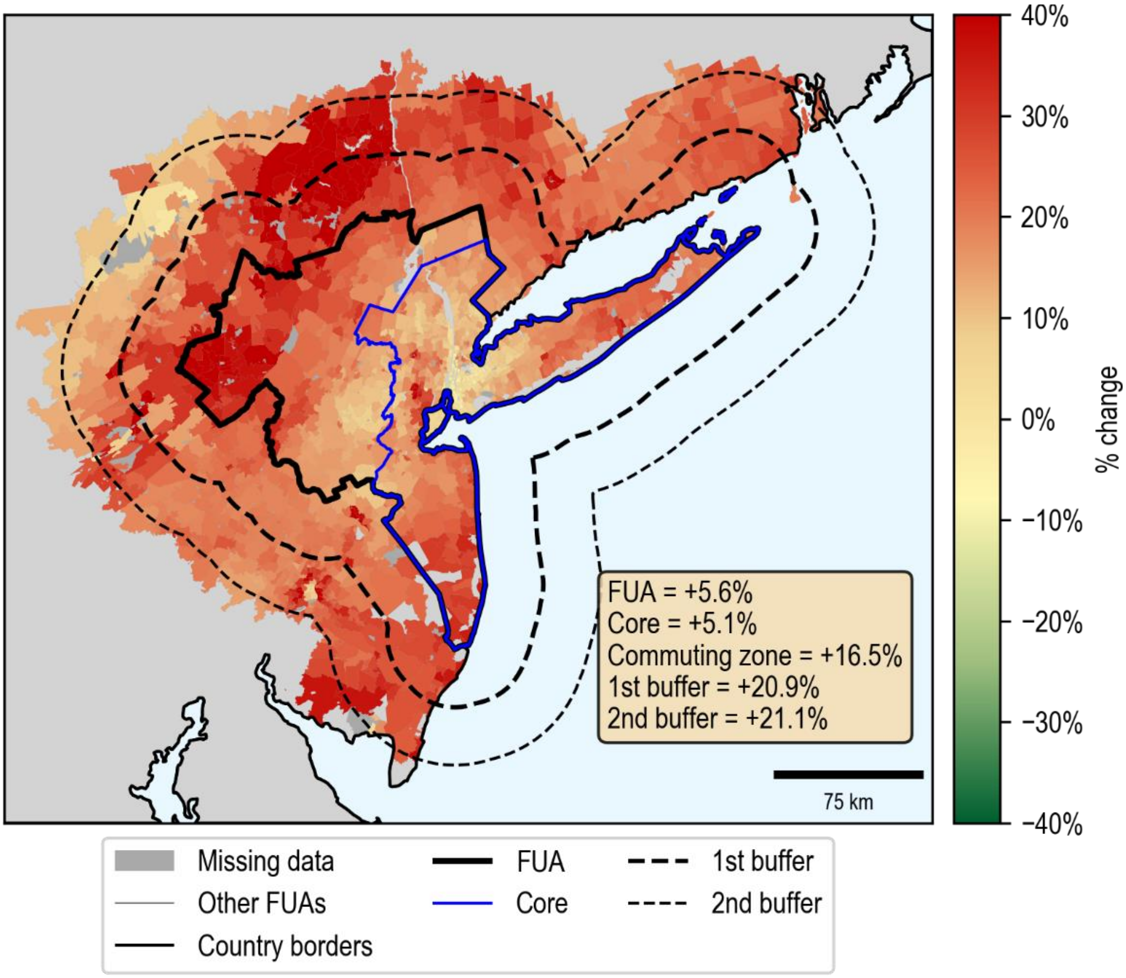
To look at the evolution of house prices beyond the boundaries of metropolitan areas, two concentric buffers were delineated for each FUA with more than 1.5 million inhabitants (or the largest FUA for Norway and Finland). The buffers, which refer to areas around the FUA edges, were demarcarted by a distance (from the edge of the FUA) defined as a proportion of the square root of the FUA area, as follows:

$$Buffer1 = 0.2 * \sqrt{area_{FUA}} \text{ and } Buffer2 = 0.4 * \sqrt{area_{FUA}}$$

These definitions allow for the delineation of buffers that take into account the heterogeneity in area size across OECD metropolitan areas. Commuting zones and buffers are also referred to as “rings”, and metropolitan areas together with their buffers as “extended metropolitan areas”. As an example, Figure 2.1 shows house price changes in the different spatial rings of the extended metropolitan area of New York (see Annex A for a larger selection of extended metropolitan areas).

Figure 2.1. Evolution of house prices in New York’s metropolitan area and their surroundings

House price change (%), from 2019 to 2021

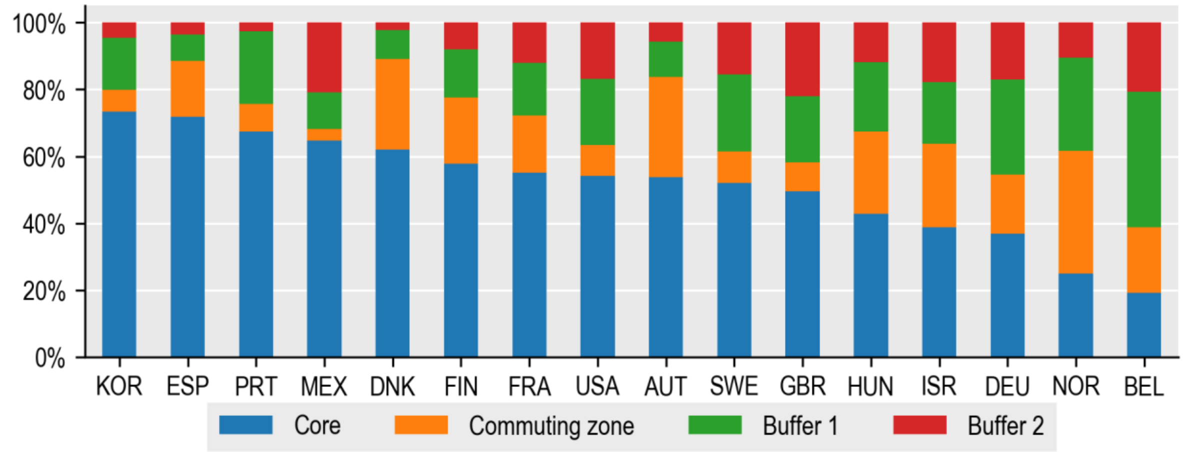


Note: House price change is the percentage change in yearly average house prices. The yearly average house price is obtained at the SAU level by taking the simple average across quarters. Price aggregates for the metropolitan areas (FUA), the cores and the different rings are obtained by taking the population-weighted average house price across SAUs.

The distribution of population across rings within extended metropolitan areas can differ widely across countries due to differences in settlement patterns at the edge and outside of large metropolitan areas. Figure 2.2 shows the distribution of population across metropolitan cores and their respective rings in each country. In Korea and Spain, for example, most of the population is concentrated in the cores, whereas in Belgium, Germany and Norway, the population is more evenly distributed between the zones of the extended metropolitan area (for the distribution of SAUs across the core and the rings by country, see Figure B.1 in the annex).

Figure 2.2. Population distribution by zone, 2020

Share of population across extended large metropolitan areas (core, commuting zone, and buffers)



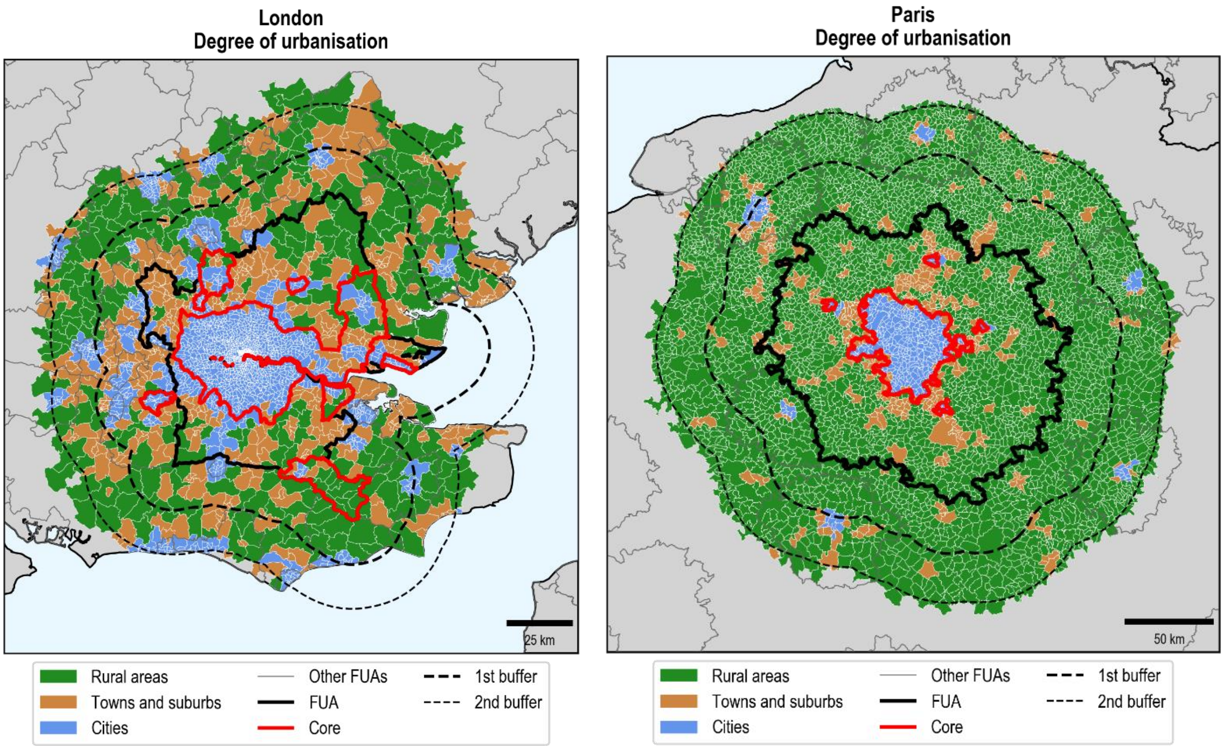
Note: Only geographical units located within large metropolitan areas and their buffers are included.

The degree of urbanisation

To characterise the places experiencing changes in home ownership demand, SAUs are classified by their degree of urbanisation (DEGURBA) (OECD et al., 2021[11]) into either rural areas, towns and suburbs (hereafter referred to as towns for simplicity), or cities (the empirical analysis by DEGURBA looks only at cities outside the centres of large metropolitan areas). The classification of SAUs by DEGURBA is based on 2015 population estimates at the 1 km^2 level (latest year available at the time of writing) from the Global Human Settlement Layer (GHSL) Data Package of 2019 (Florczyk, 2019[13]). The degree of urbanisation is a global methodology endorsed by the United Nations (UN) enabling the delineation of cities, urban and rural areas in an internationally comparable way. While the FUA methodology allows the mapping of SAUs to the metropolitan area they belong to, based on their economic, commuting and labour market integration, the DEGURBA methodology allows to classify each individual SAU by their degree of "urbanity", based on consistent thresholds of population size and density.

The spatial distribution of SAUs by degree of urbanisation is heterogeneous between and within the metropolitan areas and their surroundings. Figure 2.3 displays small units by degree of urbanisation in the extended metropolitan areas of London (UK) and Paris (France). The maps show that the distribution of SAUs is uneven across spatial rings and by degree of urbanisation even within the same extended metropolitan area. For example, in both London and Paris, SAUs are very granular in urban centres. However, relative to SAUs in the metropolitan core, SAUs outside the metropolitan core are larger in London than Paris. In addition, the distribution of SAUs in London's buffers is more balanced between rural areas, towns, and cities, while in Paris's buffers most SAUs are rural.

Figure 2.3. Extended metropolitan areas of London and Paris by degree of urbanisation

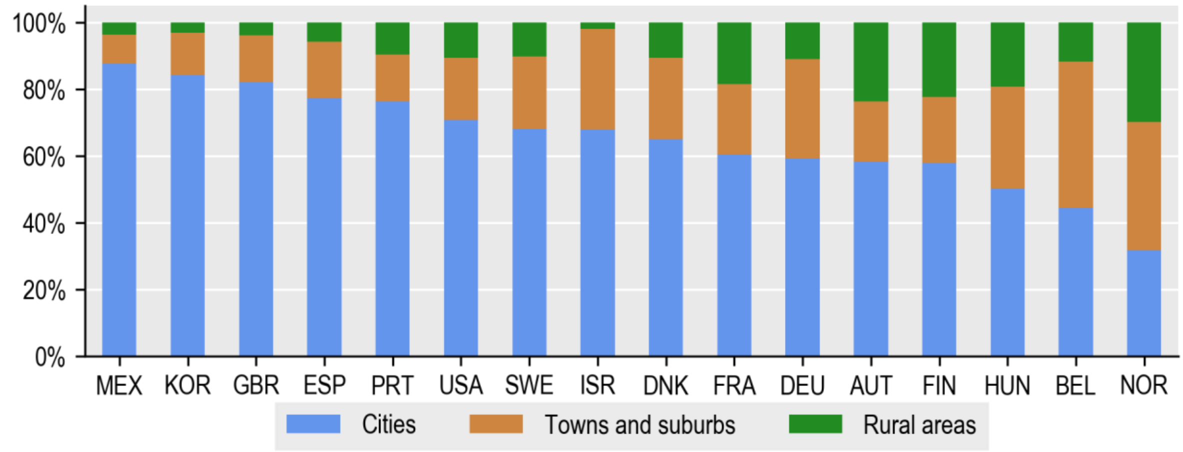


Yet, in most OECD countries with available data, the population of extended metropolitan areas is concentrated in cities rather than in towns or rural areas. Figure 2.4 and Figure 2.5 show the distribution of population across the different degrees of urbanisation and the rings in each country. In 14 out of 16 countries, most of the population located within extended metropolitan areas lives in cities. Only in Belgium and Norway, is the share of population larger outside cities (i.e., in towns and rural areas).

Within commuting zones, most of the population lives in towns, except in the UK, where the population share is higher in cities. In the buffers, the population distribution varies a lot across countries. On the one hand, in countries such as Austria, Denmark and Finland, most people in the buffers live in towns and rural areas. On the other hand, in countries such as Germany, Mexico, the UK and the US, most of the population in the buffers remains concentrated in cities (Figure B.2 and Figure B.3 in the annex also show the distribution of SAUs across the types of settlement and the rings by country).

Figure 2.4. Population distribution by degree of urbanisation, 2020

Share of population across degrees of urbanisation in large metropolitan areas plus their buffers



Note: Only geographical units located within large metropolitan areas and their buffers are included.

Figure 2.5. Population distribution by metropolitan ring and degree of urbanisation, 2020

Share of population across degrees of urbanisation for different zones in extended metropolitan areas

Note: Only geographical units located within large metropolitan areas and their buffers are included.

3 Spatial changes in housing demand

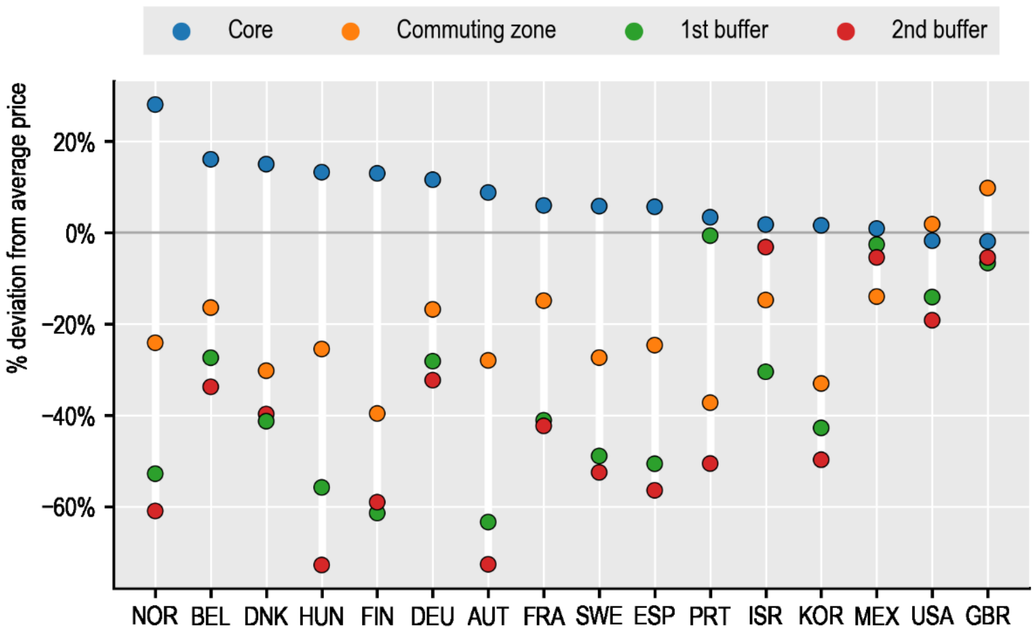
Stylised facts on the geography of housing demand

Traditional urban economics theory predicts that land prices peak in central business districts – typically located within the metropolitan core – and decrease with distance from them (Alonso, 1964[14]). Indeed, house prices tend to be highest in dense city centres, mainly due to relative land scarcity, lower home-to-work commuting costs and higher access to urban amenities (Duranton and Puga, 2020[15]). In OECD countries with available data, average house prices in the metropolitan core are close to 8% higher than average house prices in the whole metropolitan area (i.e., core and commuting zone, Figure 3.1).

The house price gap between metropolitan centres and outer rings holds in most OECD countries, with few exceptions. In 14 out of 16 countries, price levels in the cores are higher than in the commuting zones and the buffers. Only in the UK and the US, are house prices slightly higher (or at least similar) in the commuting zones than in the cores. In the UK, this might come from a limitation of its data, which doesn't control for house size, while in the US, this might be related to a long-term trend of growing preferences for suburban life since the second half of the 20th century (Kruse and Sugrue, 2006[16]) (Figure 3.1).

Figure 3.1. House price disparities across the zones of the extended metropolitan areas

Average percentage deviation (%) from the average house price in the metropolitan area, 2021



Note: Only geographical units located within large metropolitan areas and their buffers are included. Yearly average house prices at the SAU level are obtained by taking the simple average across quarters. Price aggregates for the metropolitan areas (FUA), the cores and the different rings are obtained by taking the population-weighted average house price across SAUs.

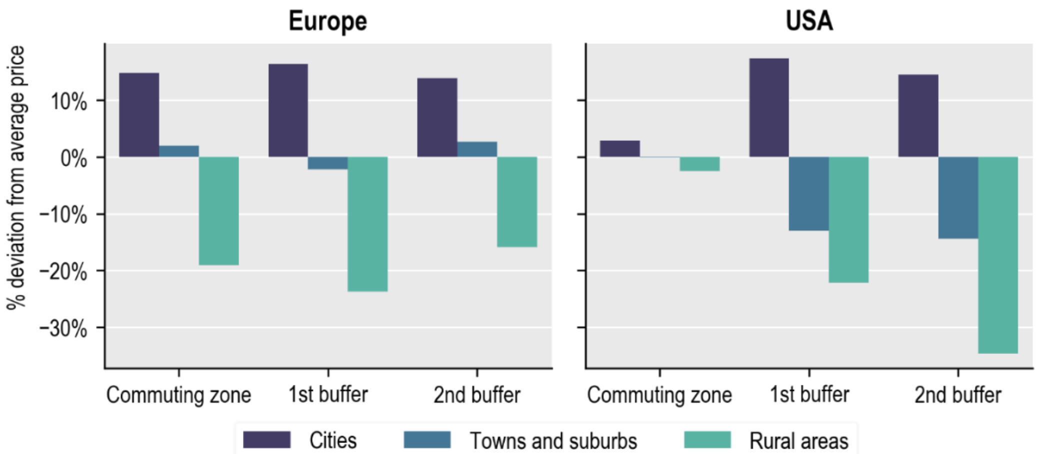
The data collected for this study reveal that house prices tend to decrease markedly as one moves from the metropolitan cores to the outer rings. The average difference in relative house prices (percentage deviations from the metropolitan area average) between the core (typically the highest price deviation) and the commuting zone is of around 30 percentage points (pp), while the differences between the core and the first and second buffers (typically the lowest price deviations) are close to 40 and 50 pp, respectively. The price-to-ring distance relationship – which captures and expands the price-to-distance gradient within metropolitan areas – also holds for most extended metropolitan areas in the sample. Indeed, in 69 out of 80 extended metropolitan areas, prices are higher in the core and decrease until the second buffer (see Table B.1-Table B.4).

Price differentials across concentric rings might reflect high commuting and transport costs in outer areas (Duranton and Puga, 2019[17]), as well as preferences and cultural factors, which can vary across countries. For example, discrepancies in price levels between metropolitan cores and buffers (e.g., rings outside commuting zones) are particularly large in Austria, Hungary and Norway – above 80 pp. In countries such as the UK and the US, the price disparity is much lower – below 20 pp – which could be partly explained, if not by lower transport costs, by a more prevalent culture of long commutes and car-dependency (OECD, 2022[18]) (Figure 3.1).

House prices also change significantly by degree of urbanisation *within* a given metropolitan ring, revealing substantial differences across settlement density. In both Europe and the US, house prices in cities tend to be much higher than in towns and rural areas, on average. In Europe, in all rings, house prices in cities are on average between 14% and 16% higher than the average house price, whereas in rural areas, prices are between 16% and 24% lower. This pattern is stable across rings. In the US, the dispersion of prices across settlement types tends to increase with a ring's distance to the core. While prices by degree of urbanisation are relatively similar in the commuting zone, those in the second buffer are very uneven – where prices in rural areas are 35% below the average and those in cities are 17% above the average (Figure 3.2). Wider dispersion in house prices in the US buffers, relative to Europe, could reflect higher income segregation (OECD, 2018[19]), as well as important disparities in access to public services and amenities across settlement types.

Figure 3.2. House price disparities across degrees of urbanisation and rings

Percentage deviation (%) from the average house price in each ring, 2021



Note: The panel for Europe only covers the European countries in the database, excluding the UK. Only geographical units located within large metropolitan areas and their buffers are included. Yearly average house prices at the SAU level are obtained by taking the simple average across quarters. Price aggregates for the metropolitan areas and the different rings are obtained by taking the population-weighted average house price across SAUs.

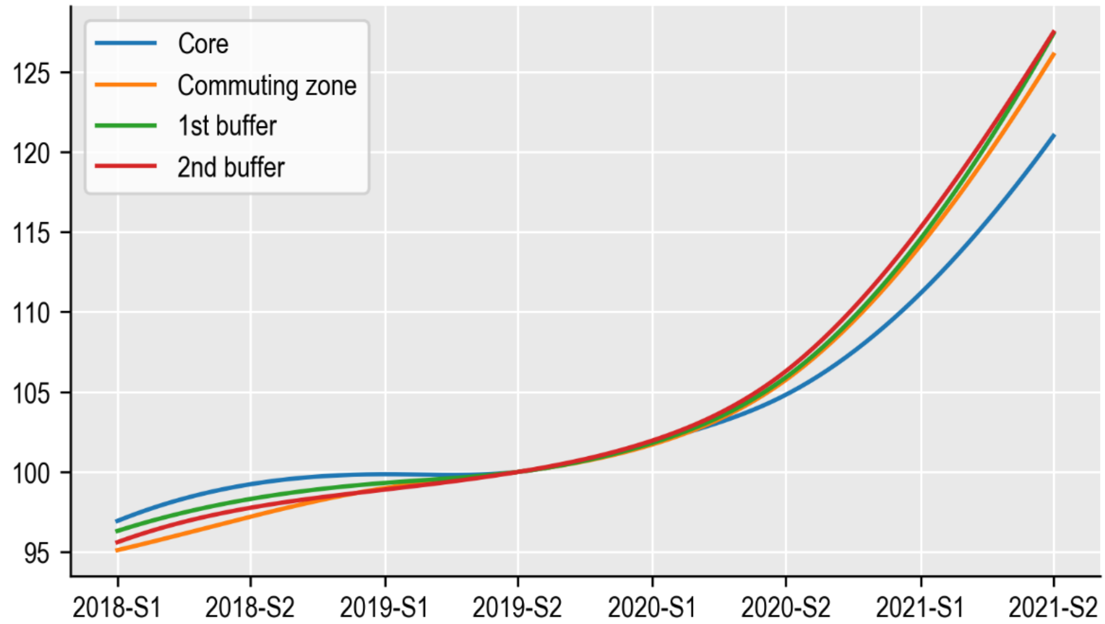
New trends in the geography of housing demand

In the 20 years before the COVID-19 pandemic, house prices increased dramatically in most OECD countries, especially in large cities (OECD, 2021[20]) and even more so in the central areas of those large cities (Glaeser, Gottlieb and Tobio, 2012[21]). Yet, trends such as the "housing booms of city centres" – which to a large extent were the result of prolonged periods of low interest rates, high attractiveness of central locations, and inelastic housing supply (Gyourko, Mayer and Sinai, 2013[22]) – occurred in a context of very limited adoption of remote working compared to more recent times. Indeed, the prevalence of working from the office heightened workers' willingness to pay for central locations to reduce commuting costs and times.

With COVID-19 and the rise of remote work practices (even if only for a few days during the week), the need for commuting has declined as also indicated by falling commuting hours (Barrero, Bloom and Davis, 2021[2]; Bloom, 2020[23]), allowing some workers to live in less central and dense locations. Recent OECD work documented that since 2020, house prices within large metropolitan areas have been growing faster in the commuting zones (12%) relative to the central neighbourhoods (7%) (OECD, 2022[18]). This paper completes the picture by showing that housing demand increases were not limited to commuting zones, but also reached areas beyond the metropolitan boundaries.

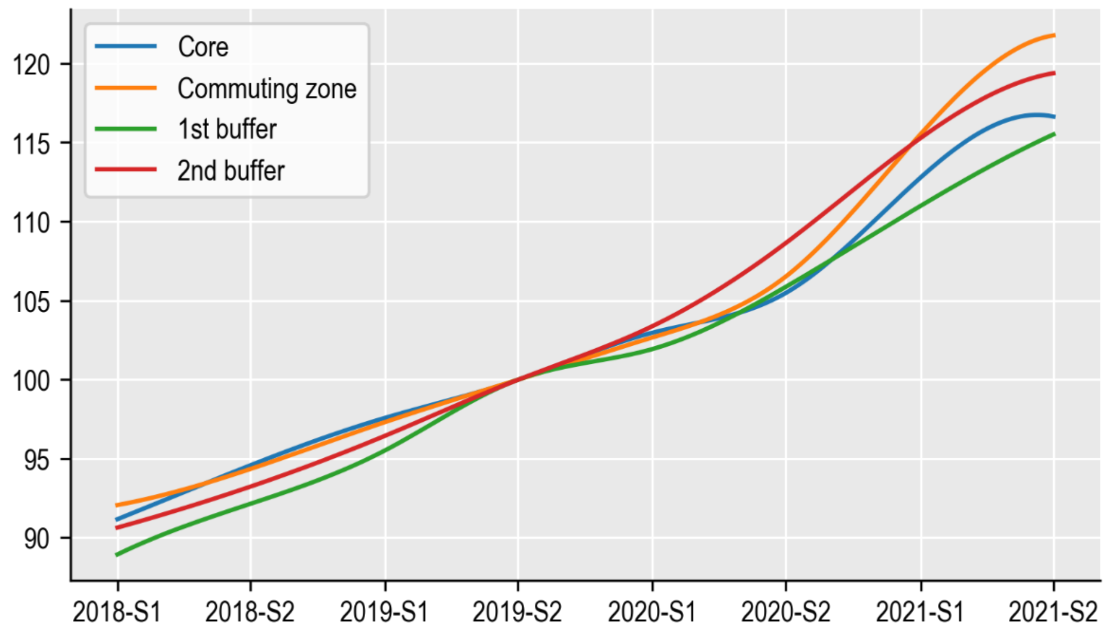
In 2021, when most lockdowns ended and partial working from home (i.e., people working some days at home and some days at the office) became "the new normal" (Bloom, Han and Liang, 2023[1]; Aksoy et al., 2023[24]), housing demand in large metropolitan areas started increasing faster in the commuting zones and surroundings (buffers) relative to the city centres, on average. Figure 3.3 and Figure 3.4 show the evolution of house prices in extended large metropolitan areas in the US and Europe since the first semester of 2018 (2018-S1). In the US, house prices increased much faster during the pandemic than before, and at a higher rate in the commuting zones and the buffers than in the cores. Between 2019-S2 and 2021-S2, house prices increased by 21% in the cores of US large metropolitan areas, by 26% in the commuting zones and by 27% in the buffers. EU large metropolitan areas show a similar, albeit less clear, pattern. From 2019-S2 to 2021-S2, house prices in the EU increased by 17% in the cores, by 22% in the commuting zones and by around 19% in the second buffers. This suggests that in Europe the commuting zones experienced the highest gains in attractiveness, whereas in the United States the highest gains were in the buffers.

Figure 3.3. Average house prices in US extended metropolitan areas (2019-S2 = 100).



Note: Only geographical units located within large metropolitan areas and their buffers are included. Average house prices at the semester level are obtained by taking the simple average across quarters. Price aggregates for the different rings are obtained by taking the population-weighted average house price across SAUs.

Figure 3.4. Average house prices in European extended metropolitan areas (2019-S2 = 100)

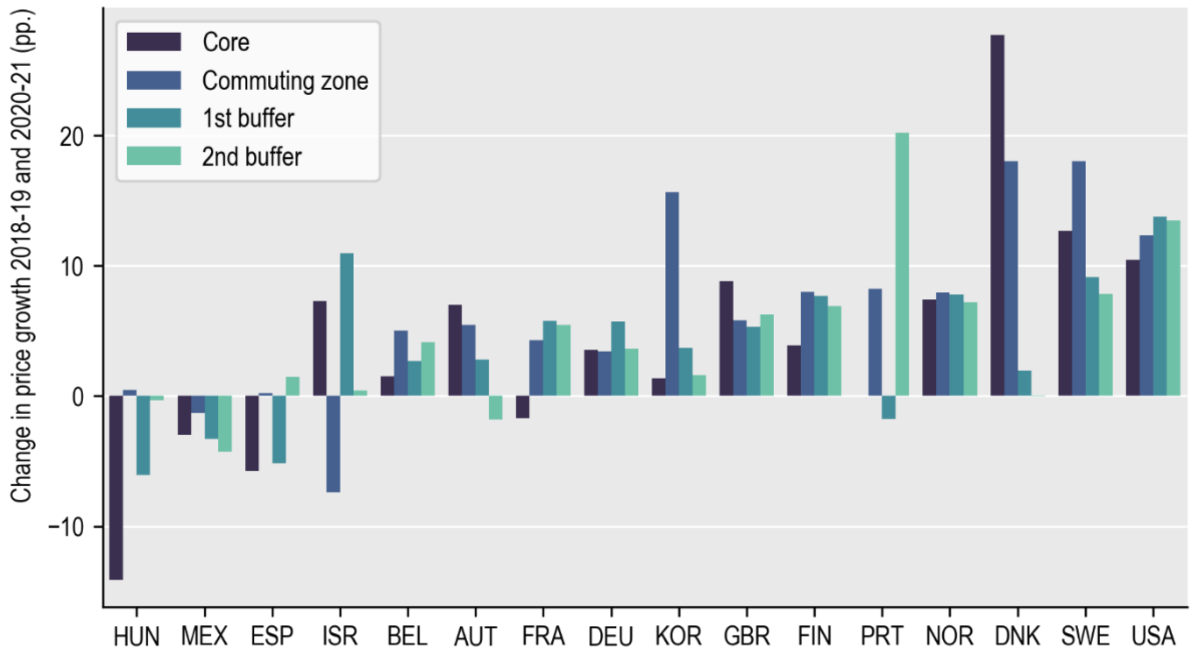


Note: Average house prices refer to price per m^2. This chart only covers the European countries in the database excluding the UK. Only geographical units located within large metropolitan areas and their buffers are included. Average house prices at the semester level are obtained by taking the simple average across quarters. Price aggregates for the different rings are obtained by taking the population-weighted average house price across SAUs.

The acceleration of house price growth since the beginning of the pandemic is observed in most countries and zones within extended metropolitan areas and was higher outside the metropolitan cores. As higher price growth outside the metropolitan centres could be part of a longer pre-COVID trend, Figure 3.5 shows the difference between COVID and pre-COVID house price growth rates (i.e., the simple difference in year-on-year price growth rates between 2018-19 and 2020-21). In 13 out of 16 countries, price growth sped up in most of the extended metropolitan space – i.e., including both the cores and the rings – since the beginning of the pandemic. The figure also shows that in 10 of those 13 countries, price growth rates in the commuting zones and outer rings increased faster compared to the cores.

Figure 3.5. Difference in house price growth rates between 2018-19 and 2020-21 by country and by ring

Price growth rate from 2020 to 2021 minus Price growth rate from 2018 to 2019, in percentage points

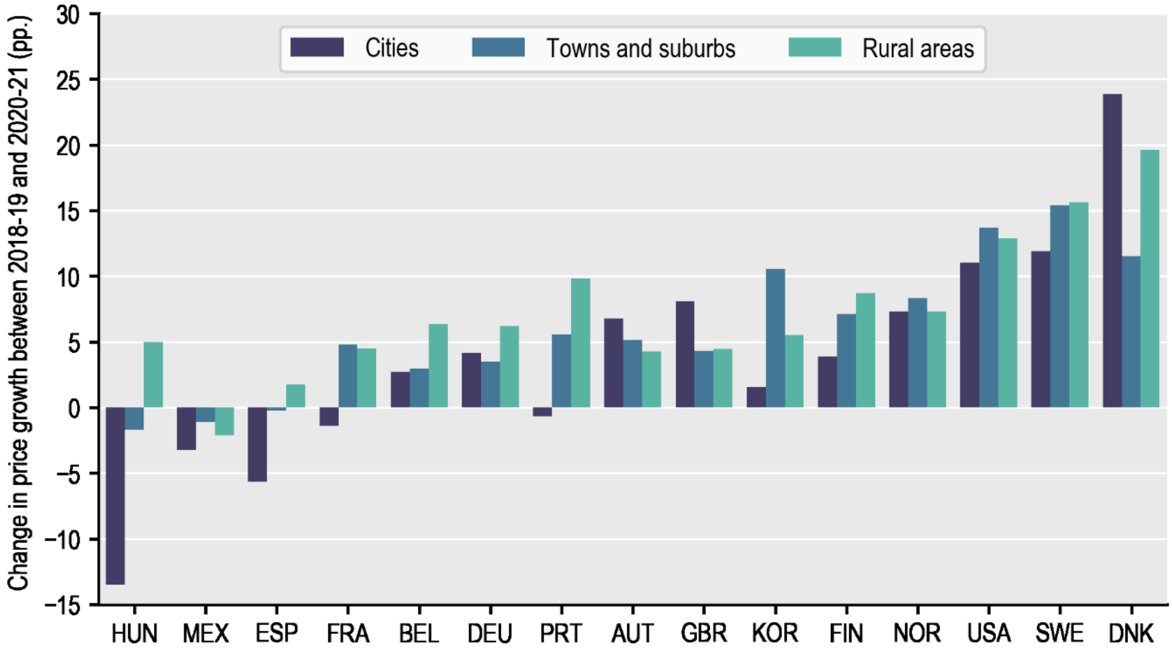


Note: Only geographical units located within large metropolitan areas and their buffers are included. Average house prices at the yearly level are obtained by taking the simple average across quarters. Price aggregates for the different rings are obtained by taking the population-weighted average house price across SAUs.

The shift in housing demand away from the metropolitan centres since the emergence of remote work might also be partially visible across settlements by degree of urbanisation. On average, within extended large metropolitan areas, house price growth accelerated more in towns and rural areas (6 and 7 pp, respectively) than in cities (3.5 pp) from 2018-2019 to 2020-2021. Only Austria, Denmark, and the UK recorded a higher price growth acceleration in cities than in other areas (Figure 3.6).

Figure 3.6. House price growth rates from 2019 to 2021 by country and by degree of urbanisation in extended metropolitan areas

Price growth rate from 2020 to 2021 minus Price growth rate from 2018 to 2019, in percentage points



Note: Only geographical units located within large metropolitan areas and their buffers are included. Average house prices at the yearly level are obtained by taking the simple average across quarters. Price aggregates for the different types of settlements are obtained by taking the population-weighted average house price across SAUs.

These patterns provide a first statistical overview of house prices developments across metropolitan rings and types of settlements, before and during COVID-19. The following section provides a more precise assessment of shifts in housing demand across the different zones of the extended metropolitan areas, as well as by degree of urbanisation within each of the rings surrounding the large metropolitan centres. It does so through different econometric specifications estimating average house price growth differentials, while controlling for several confounders.

4 Empirical specifications and results

Is the doughnut extending?

A first question addressed in this section is whether, after the COVID-19 shock, house prices increased faster in areas outside the metropolitan centre and beyond metropolitan boundaries, i.e., in the commuting zones and in the outer rings (buffers). To this aim, a linear regression model was set up as in Equation 1:

$$\boldsymbol{\Delta(price_i) = \alpha * Commuting_i + \beta * Buffer1_i + \gamma * Buffer2_i + ExtMA_{j(i)} + Country_{c(i)} + \varepsilon_i} \quad (1)$$

Where $\Delta(price_i)$ stands for house price changes (%) – based on annual average house prices – at SAU level (each SAU *i* is in an extended metropolitan area *j*, ExtMA). House price changes are regressed on a set of dummies ($Commuting_i$, $Buffer1_i$ and $Buffer2_i$) indicating if the SAU is in the commuting zone, the first buffer or the second buffer (where the reference group is the metropolitan core), while controlling for extended metropolitan area and country fixed effects (i.e., $ExtMA_{j(i)}$ and $Country_{c(i)}$). Country fixed effects are included to account for the cases in which some SAUs are in the buffer of another's country metropolitan area, e.g., a Hungarian SAU in the buffer of Vienna, Austria. To identify changes pre- and during COVID-19, the regressions are performed for yearly changes from 2018 to 2021.

The results of Equation 1 are presented in Table 4.1, where changes from 2018 to 2019 are denoted as changes in the pre-COVID-19 period. Price developments from 2019 to 2020 are considered as part of a period of transition from the pre-COVID-19 era to the new COVID-19 normality – referred to as the first year of COVID-19. This period includes the first COVID-19 outbreak and the strongest lockdowns. Finally, the period from 2020 to 2021 – denoted as the second year of COVID-19 – is understood as a period already reflecting most effects from COVID-19, including the normalisation of partial remote work.

Table 4.1. Housing demand beyond the metropolitan centres

Dependent variable: House price changes (%), for different periods

	(1)	(2)	(3)	(4)	(5)	(6)
	Pre-COVID-19 2018-2019	1st year of COVID-19 2019-2020	2nd year of COVID-19 2020-2021	Pre-COVID-19 2018-2019	1st year of COVID-19 2019-2020	2nd year of COVID-19 2020-2021
Commuting zone	-0.186	0.200	0.992***	-0.209	0.131	1.040***
	(0.164)	(0.168)	(0.185)	(0.163)	(0.168)	(0.185)
Buffer 1	0.180	-0.121	0.579***	0.075	-0.212	0.622***
	(0.139)	(0.135)	(0.151)	(0.139)	(0.135)	(0.151)
Buffer 2	0.211	0.040	0.339**	0.027	-0.166	0.435***
	(0.159)	(0.152)	(0.166)	(0.159)	(0.151)	(0.166)
Ext. MA FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	No	No	No	Yes	Yes	Yes
Observations	29,524	29,524	29,524	29,524	29,524	29,524
Adjusted R2	0.109	0.053	0.174	0.114	0.061	0.176

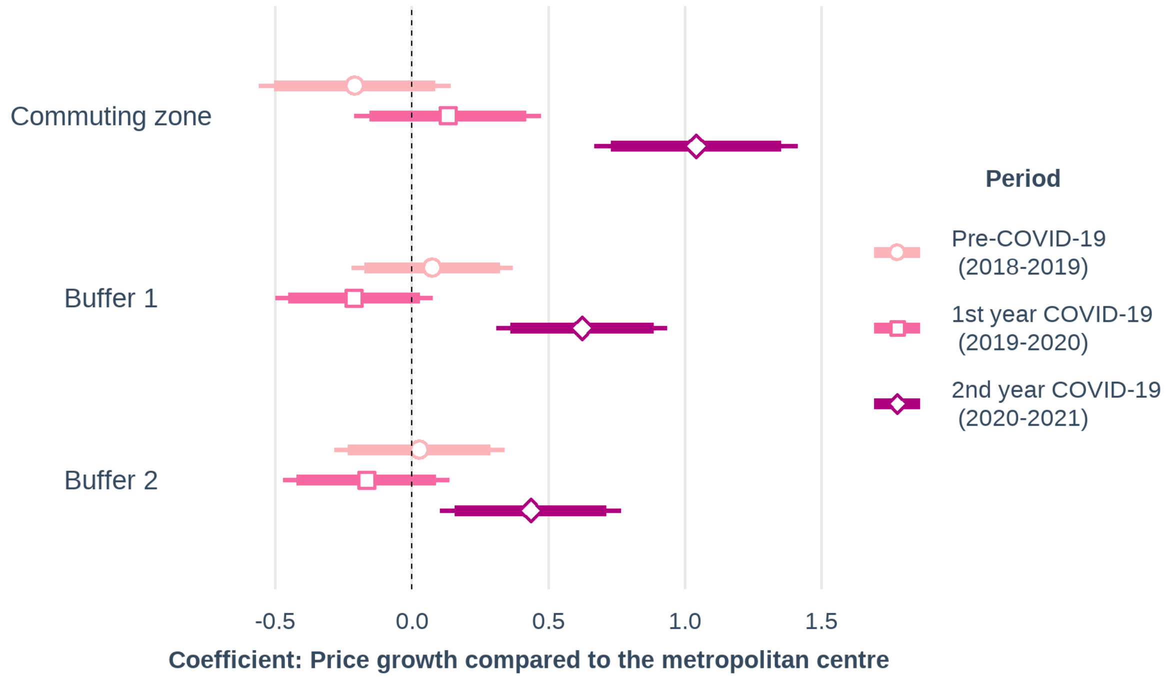
Note: *p<0.1; **p<0.05; ***p<0.01. Robust standard errors.

Overall, the results of this specification show that when most COVID-19 lockdowns ended (from 2020 to 2021), house prices started increasing faster outside metropolitan centres, even beyond the metropolitan boundaries (Table 4.1). The effects are statistically significant (at the 99%) for all the rings, and particularly large for commuting zones. The coefficients of interest are robust to the inclusion of country fixed effects (on top of extended metropolitan area fixed effects, Table 4.1, Columns 4 to 6). In addition, country fixed effects seem to slightly improve the model fit – as they might capture some time-invariant effects associated to the country of origin (including some national housing market characteristics).

Although series of year-to-year price growth at the SAU level could appear to be noisy, some patterns emerge from the estimation of Equation 1. First, before COVID-19 hit (and even during the COVID-19 early phase), house price growth was either lower or non-statistically different in the rings (commuting zones and buffers) compared to metropolitan cores. Second, from 2020 to 2021, house prices started increasing faster in the surroundings of metropolitan cores, including in the commuting zones and in the buffers. Third, average effects seem to decrease with the average distance of the ring to the metropolitan core (although differences between subsequent rings do not seem statistically different at the 95%). While the growth differential in commuting zones was around 1 pp (percentage points) relative to the city centre, the growth differentials in buffer 1 and buffer 2 were, respectively, around 0.6 and 0.4 pp (Figure 4.1). Overall results are robust to excluding specific countries from the sample (such as the UK, for which house prices are not expressed as per square metre), and to splitting the sample between Europe and the US (see Annex C).

Figure 4.1. During the COVID-19 period, prices grew faster outside the metropolitan centres

Regression coefficients from Equation 1: Price growth differentials in percentage points



Note: Inner segment represents confidence intervals at the 90%, while whole segment covers confidence intervals at the 95%.

Within the extended doughnut, who is experiencing higher housing demand?

A second set of regressions explores what are the places – by degree of urbanisation – experiencing higher home ownership demand within each ring in the surroundings of metropolitan centres. This is expressed through Equation 2, where, for each ring (commuting zone, buffer 1 and buffer 2) separately, house price changes (%) at SAU level are regressed on dummies for both cities and rural areas (where the reference group is towns), while controlling for extended metropolitan area and country fixed effects. These regressions are also tested using different periods (see Table 4.2).

$$\boldsymbol{\Delta(price_i) = \delta * Cities_i + \theta * RuralAreas_i + ExtMA_{j(i)} + Country_{c(i)} + \varepsilon_{i,j}} \quad (2)$$

Table 4.2. Housing demand in each ring, by degree of urbanisation

Dependent variable: House price changes (%), for different periods

	In commuting zone			In buffer 1			In buffer 2		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Pre-COVID-19 2018-2019	1st year of COVID-19 2019-2020	2nd year of COVID-19 2020-2021	Pre-COVID-19 2018-2019	1st year of COVID-19 2019-2020	2nd year of COVID-19 2020-2021	Pre-COVID-19 2018-2019	1st year of COVID-19 2019-2020	2nd year of COVID-19 2020-2021
Cities	0.693*	0.078	0.319	-0.045	-0.390	1.405***	0.766**	0.448	1.574***
	(0.382)	(0.412)	(0.411)	(0.278)	(0.269)	(0.281)	(0.339)	(0.300)	(0.315)
Rural areas	0.129	1.131***	0.830**	0.113	0.070	0.893***	0.013	0.088	0.455
	(0.319)	(0.326)	(0.356)	(0.289)	(0.267)	(0.281)	(0.354)	(0.317)	(0.341)
Ext. MA FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5,051	5,051	5,051	8,395	8,395	8,395	6,898	6,898	6,898
Adjusted R2	0.178	0.056	0.203	0.104	0.061	0.194	0.082	0.076	0.163

Note: *p<0.1; **p<0.05; ***p<0.01. Robust standard errors.

The results of estimating this specification for SAUs in commuting zones suggest that since the start of COVID-19, rural areas close to metropolitan cores have gained attractiveness in terms of housing demand compared to towns. This is in contrast with the pre-pandemic period when price growth in rural areas was not significantly different to towns (Table 4.2, Columns 1 to 3). More precisely, in the first year of COVID-19 (2019-2020), house prices jumped in rural areas located in commuting zones and kept increasing faster than in towns even when most lockdowns were removed and vaccination campaigns were taking place (2020-2021) (see Figure 4.2).

Figure 4.2. In commuting zones, rural areas had higher housing demand since COVID-19 hit

Regression coefficients from Equation 2: Price growth differentials within commuting zones, in percentage points

Note: Inner segment represents confidence intervals at the 90%, while whole segment covers confidence intervals at the 95%.

In the buffers, house prices increased faster in both cities and rural areas relative to towns during COVID-19, but differently depending on distance to the metropolitan boundaries. Table 4.2, Columns 4 to 6 show that within the first buffers, the space at the edge of the metropolitan boundaries next to the commuting zones, both cities and rural areas experienced higher increases in home ownership demand during the second year of COVID-19 (2020-2021) compared to towns. For rural areas in the closest buffers (first buffers), this pattern is similar to that observed in the commuting zones. However, the effect disappears when moving to farther away rings (second buffers) (Table 4.2, Columns 7 to 9).

At farther distance from the metropolitan boundaries, within second buffers, house prices have been growing faster in cities compared to towns. However, this trend is not necessarily specific to the COVID-19 period as it also occurred before the pandemic (Table 4.2, Columns 7 to 9). This suggests that, overall, outside metropolitan areas people start valuing access to more density at larger distances from the metropolitan cores. Indeed, these (smaller) cities outside the metropolitan boundaries provide people with access to services and urban amenities that would otherwise be too far, regardless of the new forms of work arrangements accelerated by the pandemic (for better visualisation of the estimates in the buffers, see Figure 4.3 and Figure 4.4).

Figure 4.3. In buffer 1, house prices increased the most in cities, from 2020 to 2021

Regression coefficients from Equation 2: Price growth differentials within 1st buffers, in percentage points

Note: Inner segment represents confidence intervals at the 90%, while whole segment covers confidence intervals at the 95%.

Figure 4.4. In buffer 2, housing demand has been rising in cities, but even pre-pandemic

Regression coefficients from Equation 2: Price growth differentials within 2nd buffers, in percentage points

Note: Inner segment represents confidence intervals at the 90%, while whole segment covers confidence intervals at the 95%.

Finally, when including the initial price as an extra control in Equation 2[4], the significance and sense of the coefficients of interest (i.e., being a city, or a rural area, relative to a town) hold for the buffers but not for the commuting zones. In this sense, the results of Table 4.2 and Table 4.3 (Columns 1 to 3) for commuting zones suggest that after COVID-19, less expensive places in terms of housing – which also tended to be rural areas – are the ones gaining more home ownership demand. Overall, initial house prices are negatively and significantly related to house price growth, which to some extent might denote a convergence pattern (places with initial low prices can grow at faster rates) that became stronger during COVID-19 and the rise of remote work, and to some degree a relative shift in preferences in the COVID-19 period towards more affordable and rural areas in the commuting zones, and towards (smaller) cities in the first buffers.

Table 4.3. Housing demand in each ring, by degree of urbanisation and initial house price

	In commuting zone			In buffer 1			In buffer 2		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Pre-COVID-19 2018-2019	1st year of COVID-19 2019-2020	2nd year of COVID-19 2020-2021	Pre-COVID-19 2018-2019	1st year of COVID-19 2019-2020	2nd year of COVID-19 2020-2021	Pre-COVID-19 2018-2019	1st year of COVID-19 2019-2020	2nd year of COVID-19 2020-2021
Initial house price	-0.166***	-0.172***	-0.204***	-0.168***	-0.131***	-0.144***	-0.162***	-0.137***	-0.125***
	(0.016)	(0.017)	(0.019)	(0.016)	(0.013)	(0.012)	(0.017)	(0.014)	(0.015)
Cities	0.675*	0.116	0.394	-0.068	-0.422	1.354***	0.760**	0.450	1.582***
	(0.382)	(0.408)	(0.399)	(0.274)	(0.266)	(0.277)	(0.339)	(0.297)	(0.314)
Rural areas	-0.522*	0.406	-0.020	-0.024	-0.055	0.736***	-0.191	-0.100	0.279
	(0.314)	(0.321)	(0.349)	(0.289)	(0.266)	(0.279)	(0.365)	(0.321)	(0.344)
Ext. MA FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5,051	5,051	5,051	8,395	8,395	8,395	6,898	6,898	6,898
Adjusted R2	0.200	0.083	0.231	0.127	0.079	0.211	0.100	0.091	0.175

Note: Initial house price is normalised from 0 to 100, where 100 is the highest house price in the extended metropolitan area. *p<0.1; **p<0.05; ***p<0.01. Robust standard errors.

[4] Initial house prices are not included as controls in Equation 1 since they are highly correlated with distance to the FUA centre (the relationship known as the house price-to-distance gradient), which is already captured through the dummies for the different spatial rings (i.e., adding initial house prices would introduce severe multicollinearity issues in this model). In Equation 2, where regressions are performed separately for each ring, initial house prices can enter the model as controls since distance to the city centre is relatively constant for all the SAUs located in the same ring.

5 Conclusion

In many large metropolitan areas, the COVID-19 pandemic and the emergence of working from home practices have slowed down housing demand in metropolitan centres, relative to other areas. This paper shows that when most COVID-19 lockdowns ended, house prices in the commuting zones and outer rings of large metropolitan areas started increasing faster compared to the metropolitan cores. This shift in home ownership demand was particularly pronounced in the commuting zones and, although it decreases with distance to the metropolitan centre, it remained significant even in faraway buffers. The observed trends reflect an "extended doughnut" effect, suggesting an enlargement of the area of influence of metropolitan areas.

The use of the degree of urbanisation to characterise space at more granular scales allowed identifying the characteristics of places experiencing a shift in housing demand. Such a shift was likely driven by a willingness to move to low-density – and more affordable – areas while keeping a certain proximity to urban services and amenities. Results suggest that people were keen on moving to less expensive housing in rural areas if they could benefit from the proximity to a large metropolitan centre. When moving farther away from a metropolitan centre, preferences shift to cities rather than to rural areas to ensure a certain level of urban benefits.

Further work could investigate the types of infrastructures, services and amenities driving these trends in housing demand within the "extended doughnut". Indeed, the accessibility to transport networks and digital infrastructures – including proximity to train stations, public transport costs and performance (ITF, 2019[25]), and Internet speed (OECD, 2021[26]) – as well as the availability of key amenities such as healthcare facilities and schools, could help explain the attractiveness of certain places in zones relatively far from the commuting zones. Finally, as this work analyses changes in the geography of housing demand only for the first two years of COVID-19, future work should also document the persistency of those trends and its consequences on a potential new spatial equilibrium (a new configuration of rural and urban spaces and their linkages) within and beyond metropolitan areas (OECD, 2021[27]).

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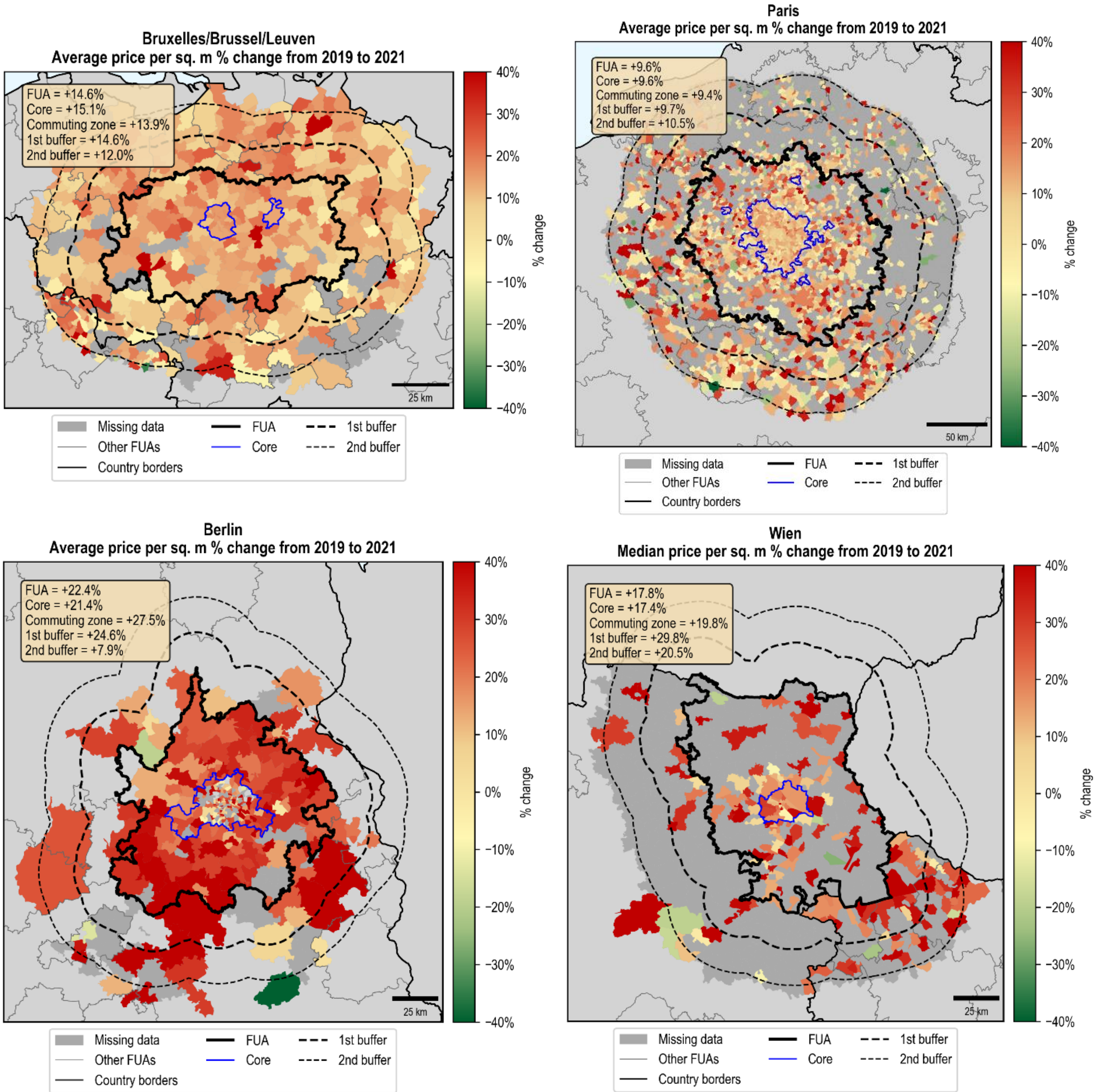
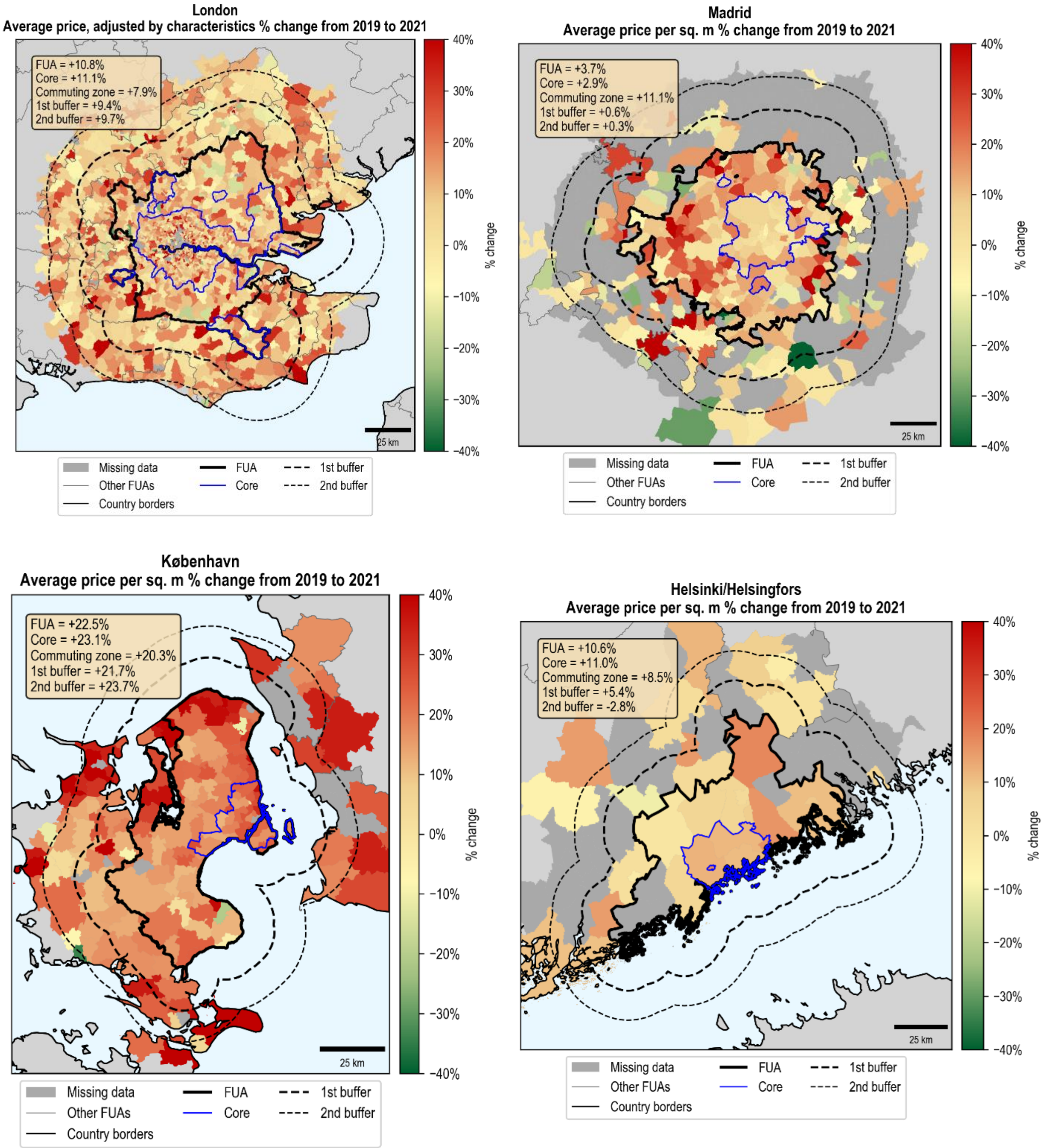
Annex A. Evolution of house prices in selected extended large metropolitan areas

Figure A.1. House price changes from 2019 to 2021 in Brussels, Paris, Berlin and Vienna.



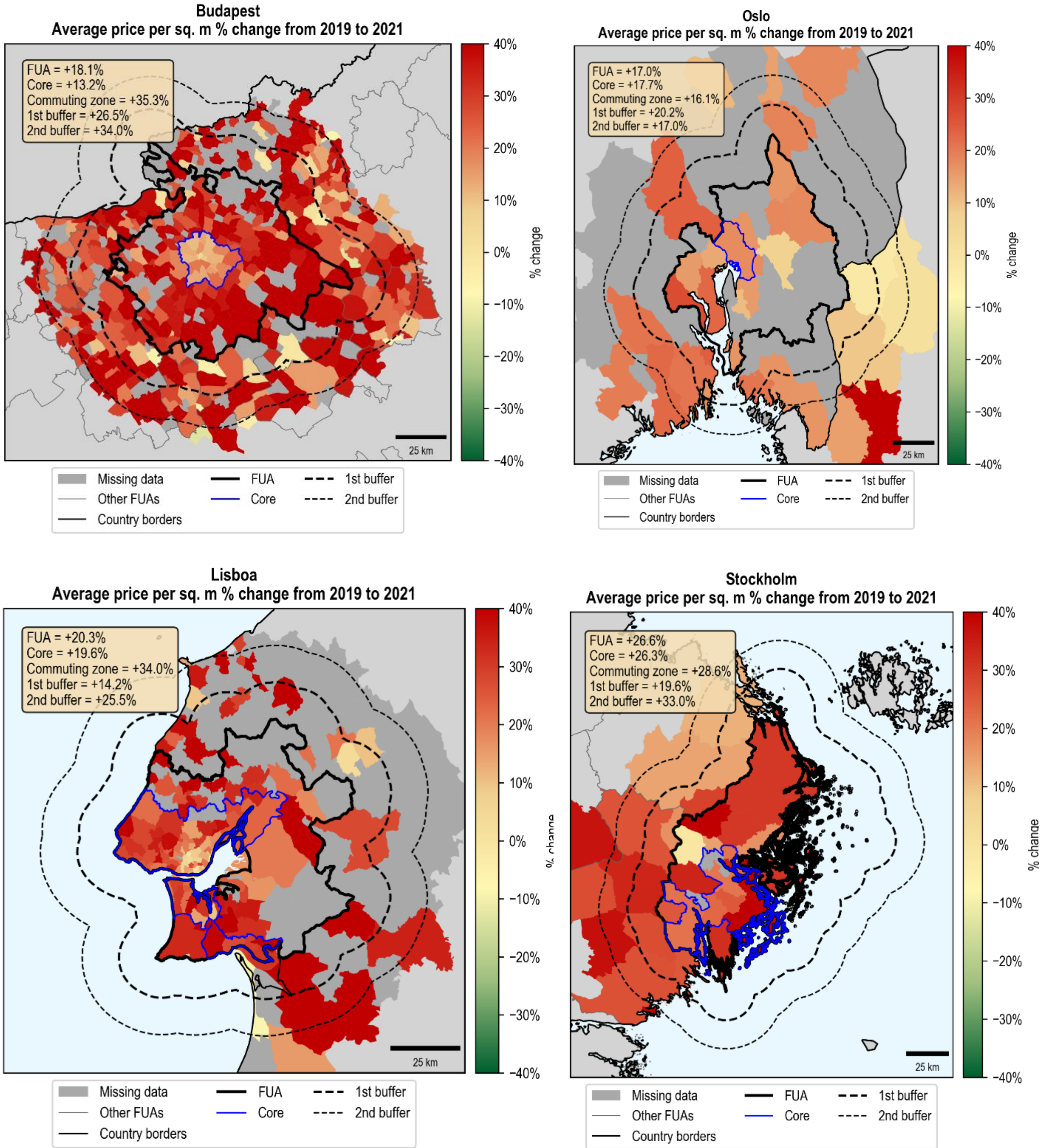
Note: House price change is the percentage change in yearly average house prices. The yearly average house price is obtained at the SAU level by taking the simple average across quarters. Price aggregates for the metropolitan areas (FUA), the cores and the different rings are obtained by taking the population weighted average house price across SAUs.

Figure A.2. House price changes from 2019 to 2021 in London, Copenhagen, Madrid and Helsinki.



Note: House price change is the percentage change in yearly average house prices. The yearly average house price is obtained at the SAU level by taking the simple average across quarters. Price aggregates for the metropolitan areas (FUA), the cores and the different rings are obtained by taking the population weighted average house price across SAUs.

Figure A.3. House price changes from 2019 to 2021 in Budapest, Oslo, Lisbon and Stockholm.

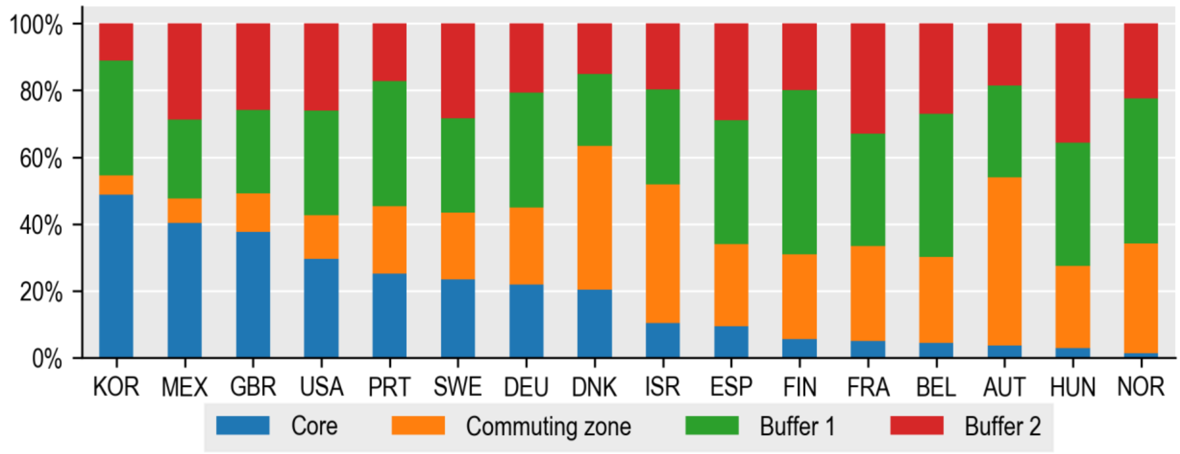


Note: House price change is the percentage change in yearly average house prices. The yearly average house price is obtained at the SAU level by taking the simple average across quarters. Price aggregates for the metropolitan areas (FUA), the cores and the different rings are obtained by taking the population weighted average house price across SAUs.

Annex B. Complementary descriptive statistics

Figure B.1. SAU distribution by zone

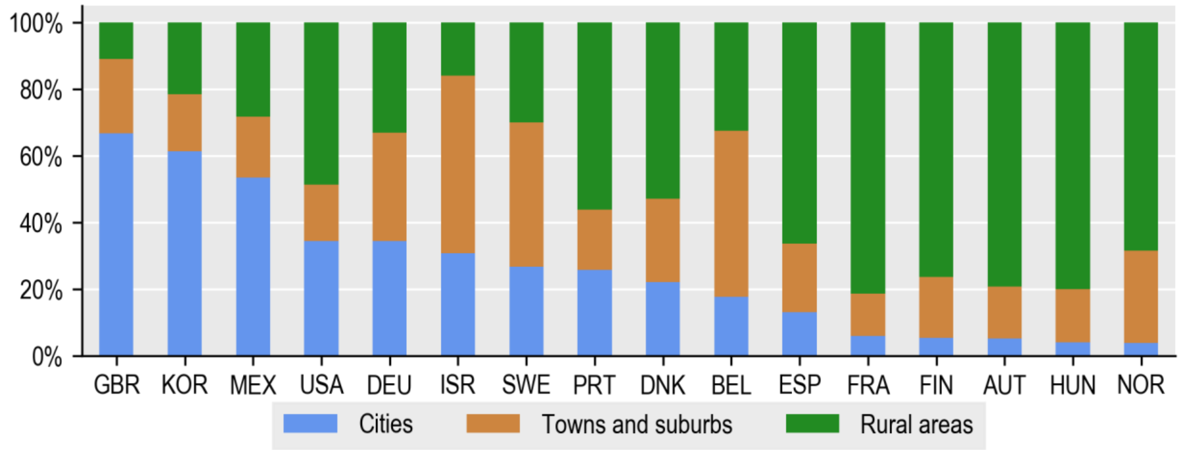
Share of geographical units across extended large metropolitan areas (core, commuting zone, and buffers)



Note: Only geographical units located within large metropolitan areas and their buffers are included.

Figure B.2. SAU distribution by degree of urbanisation

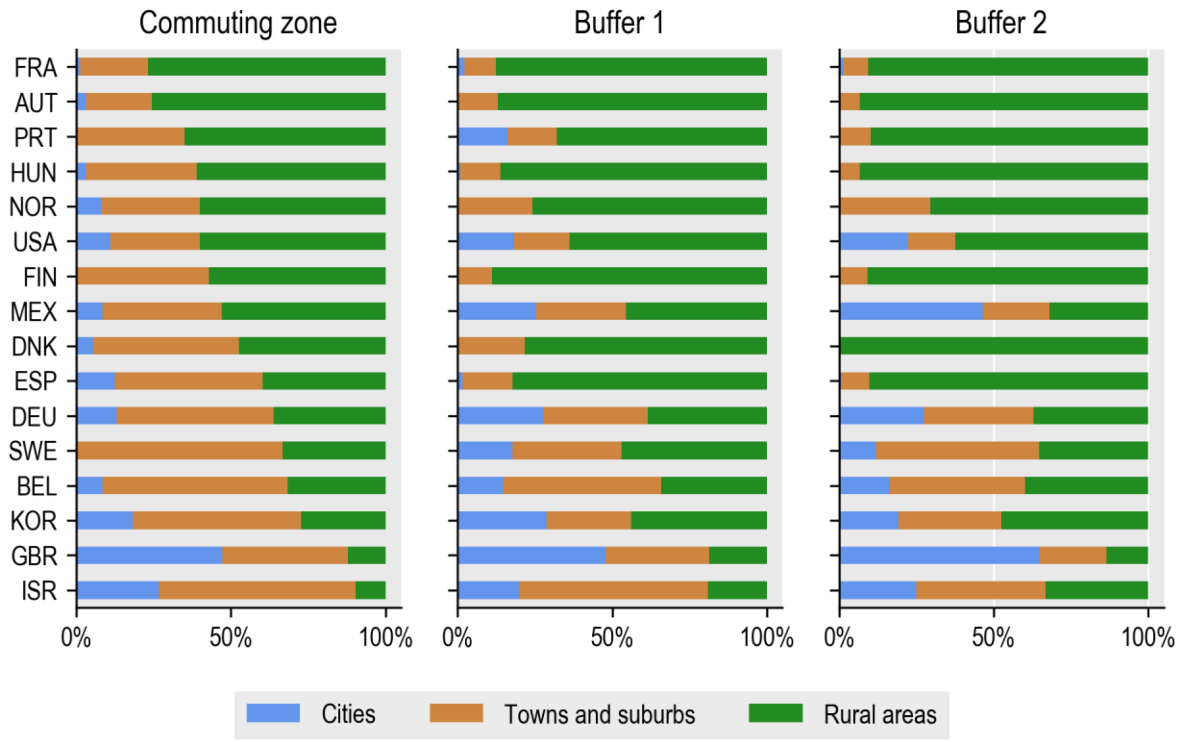
Share of geographical units across degrees of urbanisation in large metropolitan areas plus their buffers



Note: Only geographical units located within large metropolitan areas and their buffers are included.

Figure B.3. SAU distribution by metropolitan ring and degree of urbanisation

Share of geographical units across degrees of urbanisation for different zones in extended metropolitan areas



Note: Only geographical units located within large metropolitan areas and their buffers are included.

Table B.1. House prices statistics by large metropolitan area and by ring in Europe

Average prices per m² in 2021 (EUR)

Country	Metropolitan area name	Large metropolitan area	Large metropolitan area and buffers	SAU bottom 10%	SAU median	SAU top 10%	Core	Commuting zone	1st buffer	2nd buffer
Austria	Wien	4 641	4 197	397	2 167	5 623	5 049	3 343	1 638	1 164
Belgium	Brussels	2 662	2 193	1 091	1 865	3 098	3 090	2 225	1 933	1 763
Germany	Berlin	4 617	4 397	1 525	3 969	6 698	4 932	3 455	1 882	1 447
	Hamburg	4 398	3 660	1 542	2 653	6 804	5 425	3 346	2 577	2 366
	München	8 130	6 845	2 776	5 013	10 521	8 889	6 712	4 478	3 626
	Köln	3 750	3 260	1 689	2 914	5 532	4 050	3 026	2 935	3 052
	Frankfurt am Main	4 527	3 809	1 580	2 942	6 216	5 537	3 612	3 323	2 395
	Ruhrgebiet	2 200	2 525	1 568	2 274	4 505	2 199	2 203	2 725	3 001
	Stuttgart	4 267	3 760	2 345	3 418	4 985	4 724	3 900	3 202	2 991
	Düsseldorf	3 892	3 060	1 640	2 674	5 255	4 372	3 115	2 716	2 763
Denmark	Copenhagen	5 191	4 624	1 116	2 911	7 034	5 970	3 621	3 066	3 154
Spain	Madrid	2 571	2 455	421	1 077	3 133	2 754	1 675	1 005	595
	Barcelona	2 747	2 598	855	1 731	3 427	2 909	2 126	1 331	1 497
	Valencia	1 330	1 233	489	835	1 616	1 383	1 111	806	705
Finland	Helsinki	4 142	3 683	1 047	1 944	4 716	4 680	2 501	1 598	1 697
France	Paris	5 926	5 330	1 159	2 308	6 178	6 383	3 056	2 055	1 960
	Lyon	4 044	3 389	1 283	2 315	4 738	4 482	3 261	1 941	1 886
	Lille	2 700	2 075	1 165	1 777	3 247	2 866	2 396	1 551	1 574
	Marseille	3 415	3 406	2 084	3 430	5 698	3 158	4 018	3 332	3 523
	Toulouse	3 007	2 573	1 023	1 763	3 356	3 388	2 614	1 709	1 419
Hungary	Budapest	1 739	1 469	166	525	1 921	1 969	1 296	768	473
Norway	Oslo	6 840	5 786	1 134	3 416	6 782	8 759	5 190	3 233	2 684
Portugal	Lisbon	2 371	2 358	910	1 676	4 597	2 451	1 488	2 356	1 172
Sweden	Stockholm	6 572	5 818	2 515	3 880	8 309	6 955	4 773	3 357	3 121

Note: Average house prices at the yearly level are obtained by taking the simple average across quarters. Price aggregates for the different rings are obtained by taking the population-weighted average house price across SAUs.

Table B.2. House prices statistics by large metropolitan area and by ring in Israel, Korea and Mexico

Average prices per m² in 2021 (local currency)

Country	Metropolitan area name	Large metropolitan area	Large metropolitan area and buffers	SAU bottom 10%	SAU median	SAU top 10%	Core	Commuting zone	1st buffer	2nd buffer
Israel	Tel Aviv - Yafo	26 312	25 285	12 895	20 850	34 564	26 782	22 432	18 294	25 480
Korea	Seoul	7 990 140	7 320 268	1 587 155	4 962 543	14 731 041	8 331 817	4 852 823	2 813 224	1 984 308
	Gimhae	3 905 797	3 561 894	1 667 486	2 934 366	5 322 880	3 965 789	3 173 782	3 094 827	2 284 972
	Dalseong	4 084 136	3 481 306	1 435 474	2 066 201	6 540 073	4 084 136		1 945 406	2 091 648
	Gwangsan	3 328 170	2 870 781	1 083 679	1 611 160	3 726 090	3 401 230	1 960 215	1 879 005	1 561 764
	Seo	3 799 426	3 279 797	1 537 493	2 433 680	5 576 021	3 799 426		2 569 844	2 652 824
Mexico	Mexico City	22 612	21 658	9 756	20 042	51 376	22 681	11 288	12 423	14 264
	Guadalajara	17 461	17 434	9 447	17 360	38 581	18 266	13 505	12 952	12 055
	Monterrey	13 320	13 062	9 246	12 847	36 878	13 509	10 904	11 647	10 958
	Puebla	13 367	12 724	8 490	11 948	20 716	13 326	16 284	9 929	8 948
	Toluca	14 036	27 430	10 860	26 187	58 134	14 245	12 841	33 328	31 290
	Tijuana	17 703	17 651	11 871	15 576	35 339	17 703		13 539	14 032
	Leon	11 389	11 410	7 644	11 460	21 417	11 389		13 112	11 350
	Queretaro	16 329	14 024	8 642	12 872	25 245	16 428	15 280	10 714	11 996
	Torreon	8 947	8 899	6 728	8 418	14 614	8 947		8 159	

Note: Prices are expressed in local currency: Exchange rates for Israeli New Shekel (1 ISL = 0.26 USD), Mexican Pesos (1 MXN = 0.0417 USD), and South Korean Won (1 KRW = 0.000739 USD). Average house prices at the yearly level are obtained by taking the simple average across quarters. Price aggregates for the different rings are obtained by taking the population-weighted average house price across SAUs.

Table B.3. House prices statistics by large metropolitan area and by ring in the UK

Average prices in 2021 (GBP)

Metropolitan area name	Large metropolitan area	Large metropolitan area and buffers	SAU bottom 10%	SAU median	SAU top 10%	Core	Commuting zone	1st buffer	2nd buffer
London	636 438	564 629	267 191	446 553	1 075 933	656 840	511 039	408 549	358 865
West Midlands urban area	215 254	225 481	146 146	222 766	408 524	206 612	261 781	235 297	265 104
Leeds	198 425	210 119	112 897	206 215	401 633	186 386	251 340	202 099	223 606
Liverpool	189 064	190 902	98 379	188 056	402 394	190 006	185 017	192 632	194 740
Manchester	228 947	202 757	103 881	194 688	396 674	221 868	280 369	204 954	177 577

Note: Average house prices at the yearly level are obtained by taking the simple average across quarters. Price aggregates for the different rings are obtained by taking the population-weighted average house price across SAUs.

Table B.4. House prices statistics by large metropolitan area and by ring in the US

Average prices in 2021 (USD)

Metropolitan area name	Large metropolitan area	Large metropolitan area and buffers	SAU bottom 10%	SAU median	SAU top 10%	Core	Commuting zone	1st buffer	2nd buffer
New York (Greater)	692 159	577 673	147 277	396 406	1 319 280	711 386	433 169	380 062	285 884
Los Angeles (Greater)	795 027	747 037	199 409	642 556	2 011 946	795 027		679 740	595 262
Chicago	296 637	279 009	88 847	222 757	545 868	301 052	260 743	265 599	207 400
Washington (Greater)	506 516	427 527	148 153	322 588	833 426	530 201	424 589	282 697	294 941
San Francisco (Greater)	1 440 492	1 155 898	337 507	979 151	2 827 179	1 441 716	1 398 542	729 429	512 733
Philadelphia (Greater)	312 835	347 899	152 647	326 739	846 634	289 089	370 094	334 526	426 036
Dallas	335 026	308 642	89 380	213 574	519 370	343 181	287 344	183 192	162 127
Houston	279 623	269 816	118 080	214 287	513 102	278 341	284 611	204 818	196 935
Miami (Greater)	362 569	366 860	169 932	351 764	895 065	361 388	402 421	410 378	309 117
Atlanta	334 264	306 938	106 883	233 892	520 138	349 274	320 100	247 067	159 380
Boston	704 817	580 498	280 811	479 635	1 276 730	723 549	521 441	421 439	373 449
Phoenix	396 350	377 601	138 747	348 055	778 250	403 411	341 765	285 931	371 093
Detroit (Greater)	222 950	217 033	61 831	208 262	431 938	218 760	257 976	220 995	162 443
Seattle	719 302	670 422	321 153	524 041	1 270 192	719 302		590 310	482 301
Minneapolis	351 307	327 933	164 718	278 358	504 886	346 969	358 679	249 692	246 924
San Diego	794 534	793 630	303 467	693 260	2 241 217	794 534		848 174	762 727
St. Louis	232 229	218 116	57 864	160 674	416 231	254 290	182 996	160 884	134 029
Denver	544 985	530 577	200 456	484 182	956 350	541 537	636 632	563 246	432 865
San Antonio	254 245	371 354	118 985	296 016	841 829	237 297	331 717	350 331	594 915
Portland	525 823	489 600	256 795	431 862	712 394	515 996	564 364	400 587	382 989
Cincinnati	239 848	212 763	87 231	179 439	352 842	228 003	249 397	180 724	163 743
Las Vegas	336 083	337 364	132 807	327 088	579 593	336 371	270 617	352 904	333 256
Orange	305 696	276 087	148 418	247 700	456 000	311 556	289 625	247 373	253 235
Jackson (MO)	266 992	238 589	70 216	164 317	406 379	270 904	255 783	183 746	135 203
Indianapolis	239 143	211 681	81 758	166 309	330 503	236 516	244 094	173 942	159 953
Cuyahoga	193 368	184 247	68 694	188 907	360 044	176 590	236 344	182 372	161 564
New Haven	415 582	528 024	195 763	474 435	1 443 746	279 461	560 773	589 140	548 428
Charlotte	338 689	289 054	75 044	208 614	533 399	361 421	306 970	220 316	178 972
Sacramento	521 621	700 823	277 895	530 503	1 582 588	514 747	616 734	634 027	890 894
Austin	545 161	428 357	153 409	351 543	865 868	557 260	421 468	299 522	280 602
Columbus	272 179	228 590	80 362	173 937	361 472	255 367	296 967	157 827	187 291
Milwaukee	236 480	239 822	126 003	256 276	454 360	175 932	350 248	260 469	202 866
Jacksonville	267 890	256 699	103 357	214 321	605 850	249 507	297 862	254 819	209 093
Salt Lake	514 221	490 255	238 186	438 404	830 651	507 548	622 318	474 222	340 507
Tampa-Pinellas	268 153	295 708	173 773	277 033	694 051	278 950	252 452	339 711	272 325
Tampa-Hillsborough	316 280	297 861	170 563	286 137	681 574	316 280		296 020	272 106

Note: Average house prices at the yearly level are obtained by taking the simple average across quarters. Price aggregates for the different rings are obtained by taking the population-weighted average house price across SAUs.

Table B.5. Price growth statistics by large metropolitan area and by ring

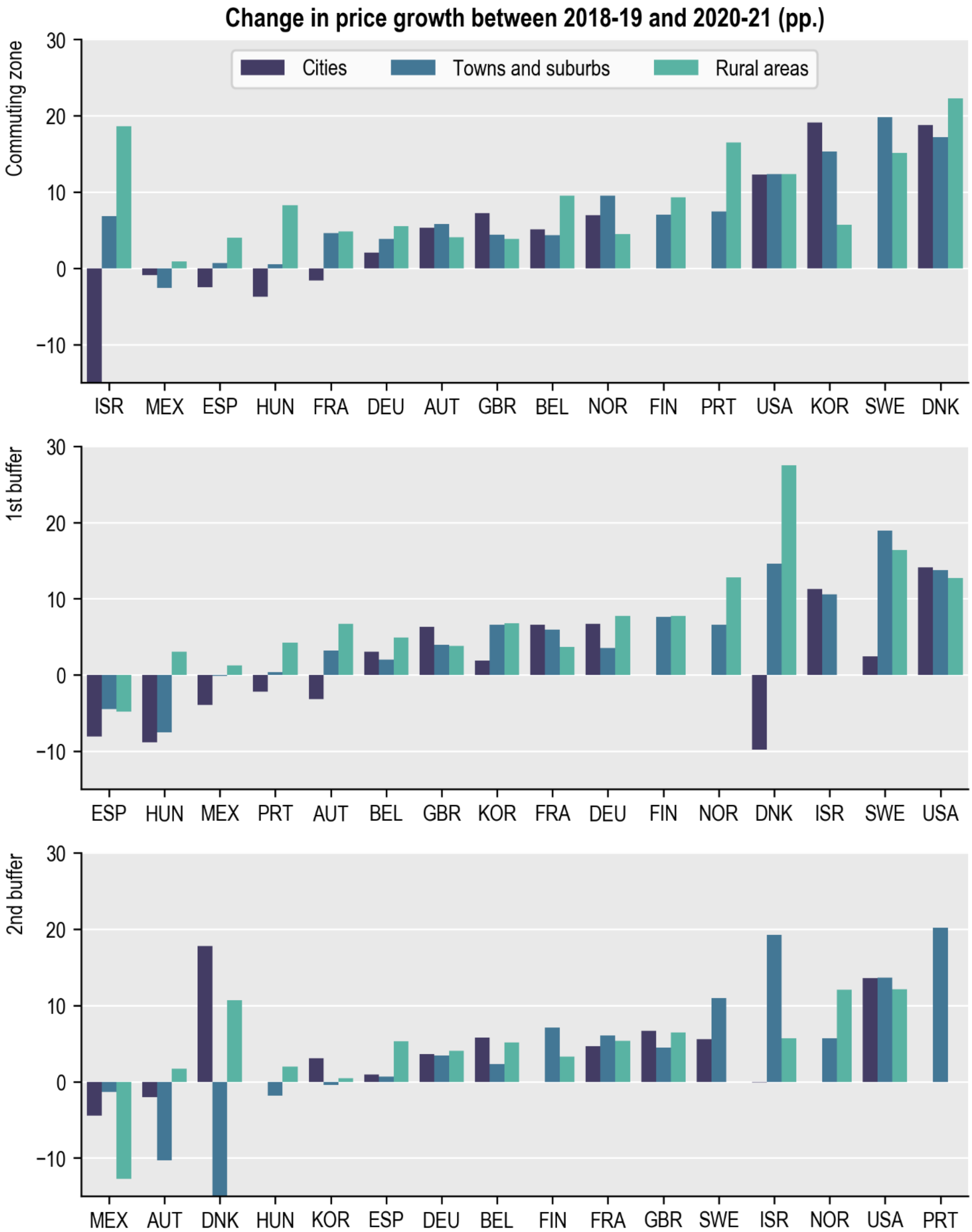
Average price per m² growth rates between 2019 and 2021.

Country	Metropolitan area name	Large metropolitan area	Large metropolitan area and buffers	Core	Commuting zone	1st buffer	2nd buffer
Austria	Vienna	17.8%	18.2%	17.4%	19.8%	29.8%	20.5%
Belgium	Brussels	14.6%	14.1%	15.1%	13.9%	14.6%	12.0%
Germany	Berlin	22.4%	22.3%	21.4%	27.5%	24.6%	7.9%
	Hamburg	22.6%	24.2%	21.5%	24.5%	30.1%	26.0%
	München	18.1%	19.5%	18.6%	17.0%	25.3%	23.0%
	Köln	25.5%	26.1%	25.3%	26.1%	26.5%	26.6%
	Frankfurt am Main	23.9%	23.1%	23.6%	24.2%	22.0%	21.9%
	Ruhrgebiet	21.5%	23.4%	21.1%	23.0%	24.6%	25.2%
	Stuttgart	20.5%	21.3%	19.6%	21.3%	22.0%	24.5%
	Düsseldorf	27.5%	25.5%	27.7%	27.0%	24.0%	25.0%
Denmark	Copenhagen	22.5%	22.5%	23.1%	20.3%	21.7%	23.7%
Spain	Madrid	3.7%	3.6%	2.9%	11.1%	0.6%	0.3%
	Barcelona	4.3%	4.8%	2.2%	17.5%	12.4%	11.9%
	Valencia	13.4%	13.2%	12.9%	16.4%	10.3%	18.5%
Finland	Helsinki	10.6%	9.9%	11.0%	8.5%	5.4%	-2.8%
France	Paris	9.6%	9.6%	9.6%	9.4%	9.7%	10.5%
	Lyon	16.6%	15.9%	16.3%	17.4%	12.7%	12.6%
	Lille	12.7%	11.9%	12.5%	13.2%	11.4%	9.1%
	Marseille	8.0%	9.1%	6.4%	11.1%	10.8%	13.6%
	Toulouse	11.1%	11.2%	10.2%	12.2%	10.7%	13.3%
Hungary	Budapest	18.1%	19.2%	13.2%	35.3%	26.5%	34.0%
Israel	Tel Aviv - Yafo	11.0%	10.3%	11.3%	8.9%	12.8%	7.0%
Korea	Seoul	28.7%	28.3%	28.1%	39.2%	20.6%	12.6%
	Gimhae	15.3%	15.2%	15.3%	15.3%	16.3%	8.3%
	Dalseong	18.3%	17.3%	18.3%		4.8%	25.6%
	Gwangsan	19.7%	17.8%	19.6%	23.9%	11.1%	7.1%
	Seo	30.6%	27.6%	30.6%		25.5%	16.4%
Mexico	Mexico City	3.6%	3.8%	3.6%	10.3%	5.1%	7.2%
	Guadalajara	20.2%	20.2%	20.4%	18.2%	33.1%	26.5%
	Monterrey	17.5%	17.5%	17.5%	18.5%	15.7%	17.2%
	Puebla	11.5%	11.3%	11.5%	9.8%	10.9%	8.3%
	Toluca	0.4%	0.7%	-0.4%	6.0%	-3.7%	1.3%
	Tijuana	29.8%	29.9%	29.8%		37.6%	31.2%
	Leon	16.0%	15.8%	16.0%		20.1%	9.6%
	Queretaro	13.7%	13.1%	13.5%	15.9%	12.2%	11.9%
	Torreon	15.8%	15.7%	15.8%		13.2%	
Norway	Oslo	17.0%	17.2%	17.7%	16.1%	19.7%	17.0%
Portugal	Lisbon	20.3%	19.0%	19.6%	34.0%	14.2%	25.5%
Sweden	Stockholm	26.6%	26.3%	26.3%	28.6%	19.6%	33.0%
UK	London	10.8%	10.5%	11.1%	7.9%	9.4%	9.7%
	West Midlands urban area	11.6%	9.7%	11.4%	12.6%	6.2%	7.7%
	Leeds	10.4%	13.2%	10.9%	8.9%	15.1%	14.1%
	Liverpool	13.9%	12.2%	13.6%	15.1%	10.9%	8.7%
	Manchester	14.1%	12.9%	14.7%	10.6%	12.1%	12.0%
US	New York (Greater)	5.6%	8.1%	5.1%	16.5%	20.9%	21.1%
	Los Angeles	20.6%	21.6%	20.6%		21.9%	28.4%

(Greater)						
Chicago	12.4%	13.4%	11.9%	16.7%	13.0%	21.9%
Washington (Greater)	14.8%	15.5%	14.3%	16.8%	18.0%	17.7%
San Francisco (Greater)	13.5%	14.9%	13.3%	18.9%	19.1%	25.4%
Philadelphia (Greater)	19.6%	18.7%	19.8%	19.2%	19.6%	16.9%
Dallas	20.6%	20.1%	20.5%	21.2%	17.3%	14.1%
Houston	15.8%	15.6%	15.6%	16.7%	12.8%	15.4%
Miami (Greater)	18.8%	18.5%	18.6%	23.3%	16.7%	21.2%
Atlanta	22.9%	22.7%	20.9%	25.0%	22.7%	19.2%
Boston	13.7%	16.8%	13.0%	23.6%	24.7%	26.3%
Phoenix	40.1%	39.1%	40.2%	40.0%	33.9%	34.1%
Detroit (Greater)	19.7%	18.8%	19.9%	18.5%	16.7%	20.5%
Seattle	26.5%	26.5%	26.5%		26.6%	26.5%
Minneapolis	16.6%	16.9%	15.0%	19.4%	18.8%	17.8%
San Diego	29.5%	25.3%	29.5%		23.1%	21.4%
St. Louis	17.7%	17.3%	17.9%	17.0%	16.4%	11.5%
Denver	21.3%	21.9%	21.2%	23.2%	23.4%	22.4%
San Antonio	18.5%	30.2%	18.4%	18.8%	30.4%	41.1%
Portland	20.6%	21.6%	20.2%	22.0%	24.6%	27.2%
Cincinnati	23.0%	22.5%	25.4%	21.3%	21.8%	21.0%
Las Vegas	22.1%	23.5%	22.1%	20.3%	34.9%	29.0%
Orange	20.4%	22.5%	20.4%	20.3%	24.0%	25.8%
Jackson (MO)	20.5%	20.3%	20.7%	20.0%	19.6%	18.0%
Indianapolis	23.0%	21.8%	23.3%	22.4%	19.5%	19.2%
Cuyahoga	21.9%	21.5%	23.6%	18.8%	21.0%	21.2%
New Haven	20.9%	14.7%	24.7%	19.0%	14.5%	12.7%
Charlotte	28.5%	27.2%	27.4%	30.2%	25.3%	20.4%
Sacramento	26.3%	23.2%	26.0%	29.4%	23.0%	22.0%
Austin	42.7%	34.9%	43.1%	37.1%	23.1%	17.7%
Columbus	22.1%	21.4%	24.2%	19.4%	19.5%	20.8%
Milwaukee	22.8%	21.8%	26.5%	19.6%	20.4%	19.3%
Jacksonville	24.4%	23.3%	25.7%	22.7%	21.7%	21.6%
Salt Lake	32.4%	32.8%	32.5%	31.1%	34.2%	27.4%
Tampa-Pinellas	32.5%	29.8%	32.1%	33.2%	28.4%	29.1%
Tampa-Hillsborough	28.3%	29.4%	28.3%		29.5%	31.3%

Note: Average house prices at the yearly level are obtained by taking the simple average across quarters. Price aggregates for the different rings are obtained by taking the population-weighted average house price across SAUs.

Figure B.4. Change in house price growth rates between 2019-20 and 2020-21 by country, ring and degree of urbanisation



Note: Only geographical units located within large metropolitan areas and their buffers are included. Average house prices at the yearly level are obtained by taking the simple average across quarters. Price aggregates for the different types of settlements and rings are obtained by taking the population-weighted average house price across SAUs.

Annex C. Robustness checks

Table C.1. Robustness checks: Housing demand beyond the metropolitan centres

	Excluding the UK			Only Europe			Only the US		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Pre-COVID-19 2018-2019	1st year of COVID-19 2019-2020	2nd year of COVID-19 2020-2021	Pre-COVID-19 2018-2019	1st year of COVID-19 2019-2020	2nd year of COVID-19 2020-2021	Pre-COVID-19 2018-2019	1st year of COVID-19 2019-2020	2nd year of COVID-19 2020-2021
Commuting zone	-0.135	0.170	1.851***	-0.314	1.154***	2.464***	-0.006	-0.286***	1.548***
	(0.163)	(0.166)	(0.186)	(0.371)	(0.381)	(0.400)	(0.094)	(0.084)	(0.139)
Buffer 1	0.054	-0.162	1.208***	-0.400	0.464	1.557***	0.420***	-0.203***	1.219***
	(0.137)	(0.126)	(0.147)	(0.465)	(0.427)	(0.441)	(0.077)	(0.071)	(0.123)
Buffer 2	-0.058	0.096	0.761***	-0.842	1.232**	1.186**	0.396***	-0.209**	0.720***
	(0.161)	(0.150)	(0.167)	(0.577)	(0.537)	(0.540)	(0.085)	(0.082)	(0.133)
Ext.MA FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Not applicable	Not applicable	Not applicable
Observations	23,816	23,816	23,816	7,309	7,309	7,309	14,140	14,140	14,140
Adjusted R2	0.130	0.086	0.200	0.102	0.045	0.111	0.192	0.129	0.212

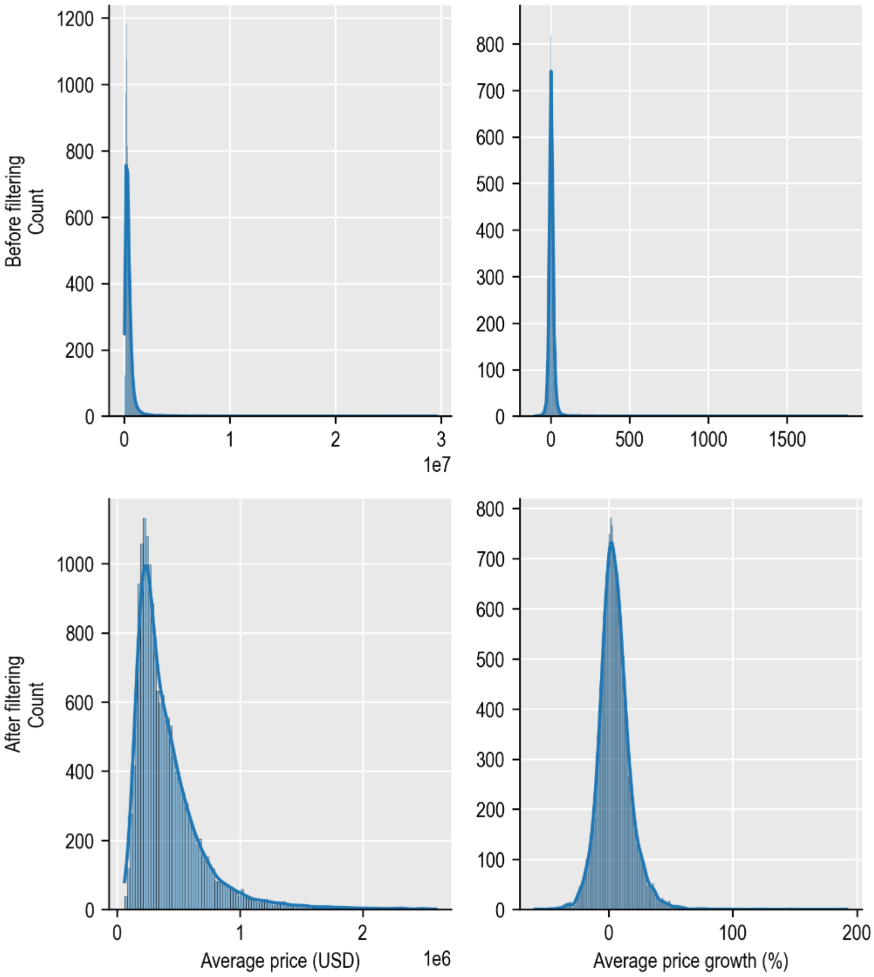
Note: *p<0.1; **p<0.05; ***p<0.01. Robust standard errors.

Annex D. Data quality and limitations

To cope with data quality issues, the following pre-processing steps were applied on the transactions data:

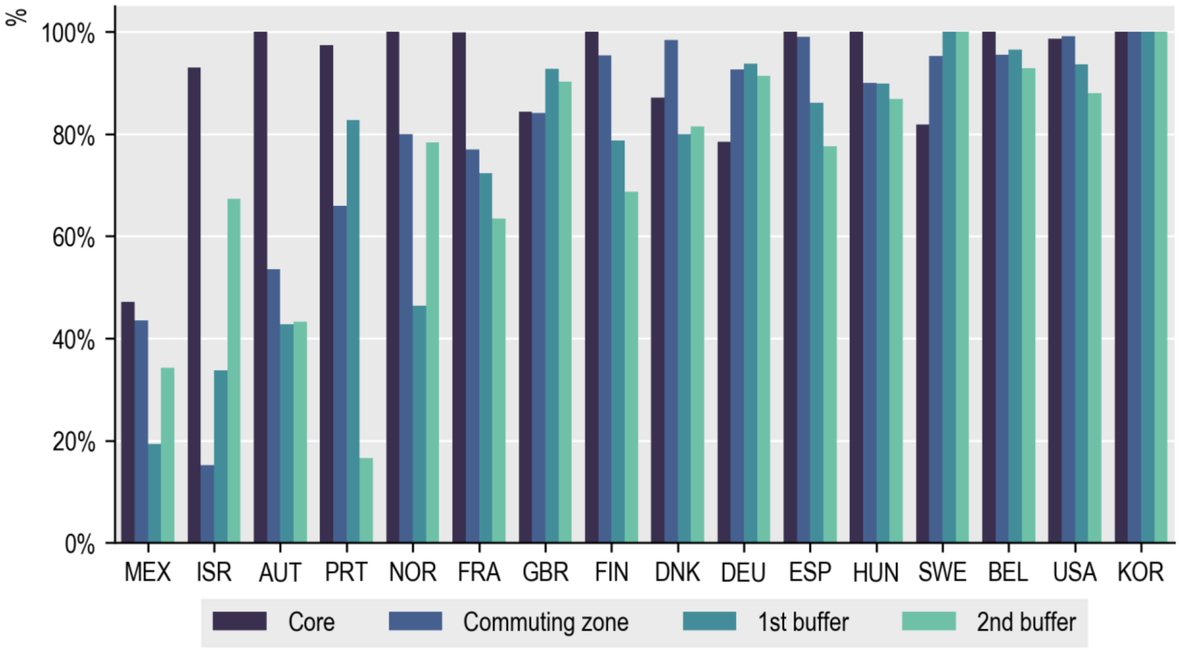
- Transactions within the time frame 2018-Q1 to 2021-Q4 are first selected and then aggregated at the yearly level. The year-on-year price growth is then computed for all time intervals available within this time frame.
- In a few countries, the distributions of house prices or of price growth rates are skewed due to outliers. This is the case of France for the price growth distribution and of the UK for price levels. Let *k* the country index, h_k the average house price, g_k the year-on-year price growth. House price growth rates outside of $[\overline{g_k} - 3\sigma_k, \overline{g_k} + 3\sigma_k]$ and price levels outside of $[\overline{p_k} - 3\sigma_k, \overline{p_k} + 3\sigma_k]$ are considered as outliers and filtered out. Figure D.1 shows the average price level and price growth distribution across SAUs in the UK after and before this filtering step. For the UK, filtering outliers on the price levels also removes the outliers on the price growth distribution.
- In many countries, because of privacy concerns, average prices are not communicated at the SAU level when the number of transactions is too low. To reduce the noise, this study filters average prices that were not computed on at least 10 transactions.
- Geographical units that do not have price data for all timestamps between 2018 and 2021 are then filtered out.

Figure D.1. House prices in the UK, levels (left) and year-on-year growth (right) distributions before (top) and after (bottom) filtering



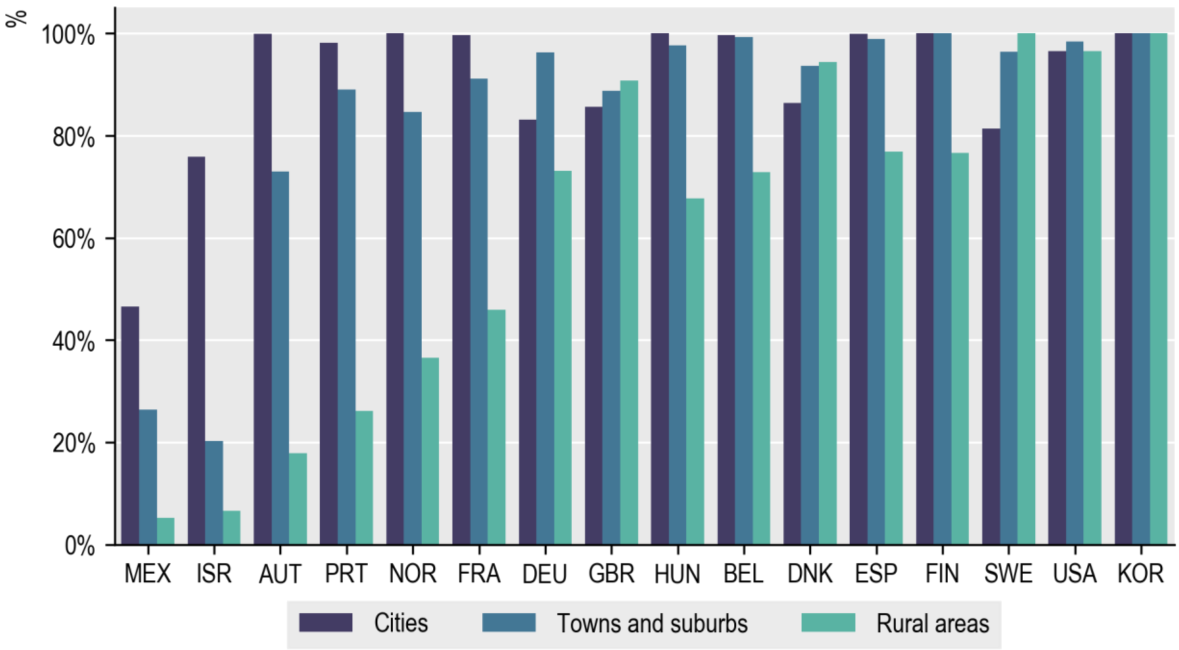
These different processing steps have an impact on the geographical coverage of the database. Figure D.2 shows for each country the data coverage by buffer and Figure D.3 by degree of urbanisation. In 11 countries, the data coverage is high both within and outside the metropolitan boundaries, as well as in the different types of settlements, although in rural areas the coverage is on average lower than in cities towns and suburbs. However, in Mexico, Israel, Portugal and Austria, the data coverage is lower than in other countries and is particularly low in rural areas and in the buffers.

Figure D.2. Share of population covered by metropolitan area ring in the Geography of Housing Demand database



Note: Only geographical units located within large metropolitan areas and their buffers are included.

Figure D.3. Share of population covered by DEGURBA in the Geography of Housing Demand database



Note: Only geographical units located within large metropolitan areas and their buffers are included.