# From Crown Jewel to Problem Child? The Evolution of Inner Cities in German Housing Markets

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**Abstract**

Urban Economists view cities as monocentric entities centered around a Central Business District (CBD). This paper investigates the slope and the evolution of the price gradient between the CBD and the rest of the settlement area for 1,108 cities in Germany. In our empirical work, we employ a novel definition of CBD that relies on the density and distribution of commercial activity within a city. We find that urban gradients are highly heterogeneous within Germany, with around 27 % of German cities even featuring a negative gradient. We find that around 70 % of the CBD-premium can be attributed to apartment quality, neighborhood characteristics and access to transport infrastructure. CBD-premiums decreased considerably between 2013 and 2016, but have registered an uptick since the Covid pandemic.

**Keywords:** Monocentric City Model, Urban Dynamics, Gentrification, Urban Flight

**JEL Classification:** O18, P25, R12

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# Extended Abstracted

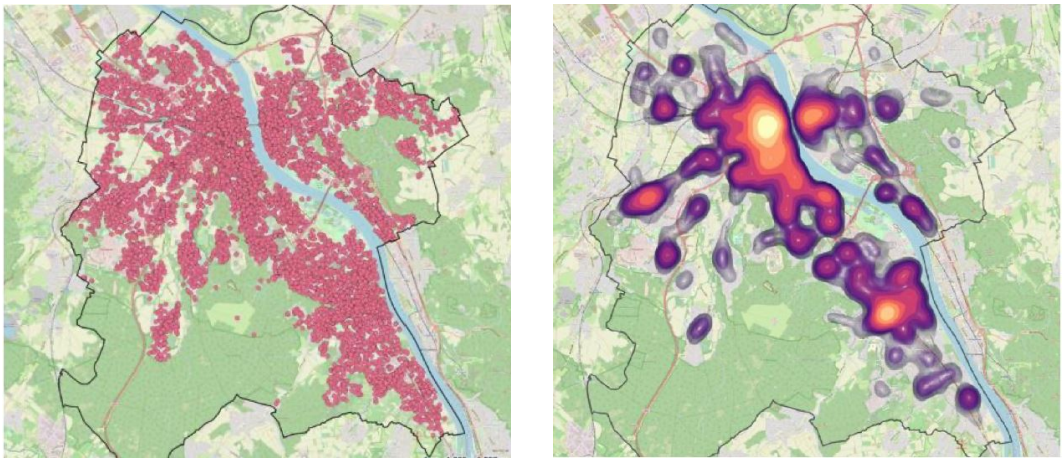
Since the foundational work of Alonso (1960); Mills (1967); Muth (1969) urban economists have viewed cities as monocentric entities centered around a Central Business District (CBD). As it is costly to travel from the periphery to the Center, prices are naturally lower in the periphery to compensate. While quite intuitive, the monocentric city model has often been scrutinized, as cities in reality are often polycentric and take a variety of shapes and forms. Economists have therefore been investigating if urban gradients actually exist as postulated by theory. Lately, there has also been a lot of interest in how urban gradients evolve over time. In the light of the rise of online retail and working from home in the last decade, has the shine come off in inner cities?

We tackle this question with a novel methodological approach to define the CBD. Using the universe of registered German businesses, we define the urban center via density thresholds akin to McMillen (2001). We then investigate the price difference between inner and outer city, which we term *CBD-premium*, for the entirety of all 1.108 cities in Germany. In our analysis we find that there is a large heterogeneity among German cities. On average, urban centers are 11 % more expensive than the rest of the city. However, among cities with more than 250,000 inhabitants, the gradient is 18 %, while 27 % of German cities even exhibit negative urban gradients. Around 70 % of this CBD-premium can be assigned to superior apartment quality, more desirable neighborhood characteristics, and better access to transport infrastructure in the inner city. We find that the CBD-premium decreased markedly between 2012 and 2016 but has surprisingly increased since the Covid pandemic, particularly in large cities. This increase in the CBD-premium can be attributed to a higher valuation of apartment characteristics and transport infrastructure.

Our contribution is three-fold: firstly, we add to the recent literature that revisited the structure of urban gradients (Ahlfeldt, 2011; Duranton and Puga, 2022; Liotta et al., 2022; Noebauer, 2023). We complement these papers by investigating the extent to which degree urban gradients can be attributed to apartment quality, neighbor characteristics, and access to transport infrastructure. Secondly, we also add to the literature that investigates the effect of the Covid-19 pandemic on urban structure. Several studies had found that the pandemic led to reduced amenities in the city center and a declining role of commuting costs and therefore decreased urban gradients (e.g. Gupta et al. (2022); Duranton and Handbury (2023); Ramani et al. (2024) for the US and Biljanovska and Dell'Ariccia (2023); Ziemann et al. (2023) for international

overviews). We are the first to investigate this issue with a suitable definition of CBDs in Germany and confirm the finding of Ziemann et al. (2023) that the Covid effects in the US might not accurately describe the dynamics in other countries.

Our third contribution is a novel methodology for identifying the CBD. In most theoretical models, the CBD is typically represented as a single point at the city's center, primarily for reasons of analytical tractability (Brueckner et al., 1987). Almost all empirical studies follow this simplification to date. Recent years have seen marked improvements in how the city center is defined. Today, only a few studies use the geographic centroid of a center as the center, which often induces considerable measurement error and, for example, severely bias the results of Beze and Thiel (2024), which was the first empirical investigation of Covid effects on cities in Germany. More recently, studies define the city center by use of the city hall location (Liotta et al., 2022; Biljanovska and Dell'Ariccia, 2023), tag location in Google Maps or OSM (Duranton and Handbury, 2023; Noebauer, 2023) or job density (Ahlfeldt et al., 2024). We follow this but instead construct CBDs based on the density of commercial establishments. These include retail, private and public services, restaurants and bars, companies, hotels and cultural institutions. The dataset originates from Nexiga GmbH and contains over 8 million observations. For each city we determine the point with the maximum density of commercial establishments.

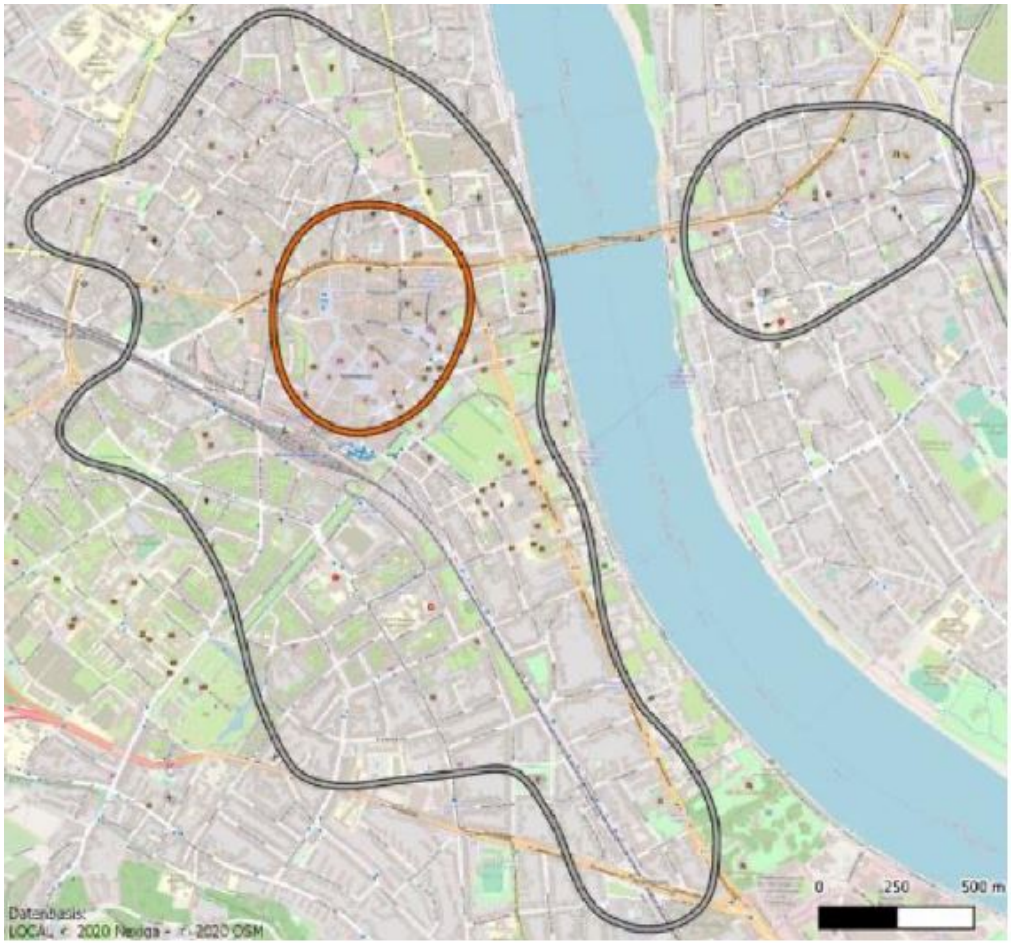


(a) Distribution of Establishments. (b) Density of Establishments.

Figure 1: Commercial Establishments in the City of Bonn

We then however take the next step away from theoretical simplifications and bring cities back from the Point to the Plane by defining *areas* with high density around this point of maximal density. We define the densest area that

contains 10 % of a city's establishments as the commercial center (orange circle in Figure 2). This area covers on average 0.33 % of a city's total area. We then define an additional 30 % area as residential center (grey circle in Figure 2). This area covers on average an additional 2.7 % of a city's area. The following diagrams illustrate the procedure for the city of Bonn.




*Source: Nexiga GmbH (2024)*

Figure 2: Resulting Definition of Urban Structure in Bonn

In many ways, our work resonates with the global center definitions proposed by Ahlfeldt et al. (2024), who identify prime locations across 125 cities worldwide. Like their approach, our methodology detects urban centers with global, rather than merely local, dominance. We also share with them the capacity to identify multiple centers within a single city. However, our contribution diverges in several important respects. The areas we define are considerably larger, reflecting a broader conception of urban centrality. Moreover, while Ahlfeldt et al. (2024) focus on high-prestige business establishments - particularly law, accounting, and financial firms - our approach captures a

more comprehensive range of economic activity. As a result, our CBDs more closely align with what might be considered the broader, everyday notion of "downtown" in the urban imagination.

We use our results to benchmark existing approaches in the literature to define the CBD, such as the population-weighted centroid (Nanda et al., 2024), the location of the historic city hall (Liotta et al., 2022; Biljanovska and Dell'Ariccia, 2023), or the tagged location from Google Maps or OpenStreetMap (Duranton and Handbury, 2023; Noebauer, 2023).

In the German case, we find that the tagged location clearly outperforms the other methods in identifying the city center. On average, the distance between the OSM tag and the point of highest business density is only about 300 meters. By contrast, historic city halls are on average located 580 meters away (across the 101 cities where such a building could be identified), while population-weighted centroids are on average 850 meters away. Our data also reveals the sharp decay of urbanity when using conventional methods that draw concentric circles around the identified center. For example, in German cities the innermost circle around OSM tag locations contains only 38 % CBD, while 62 % of the area does not reach the top-40 percentile of business density. In cities with more than 100,000 inhabitants, the CBD share in the innermost circle increases to 60 %. Yet even in these larger cities, only 20 % of the second ring (1–2 km from the center) is CBD, and the third ring consists almost entirely of non-CBD areas (6 %). In smaller cities, the decay is even more pronounced: 3 % of the second ring and just 1 % of the third ring are CBD. Variation across cities is substantial. In Stuttgart, 93 % of the third ring around the OSM tag location does not contain the CBD, compared to 76 % in the slightly smaller city of Leipzig.

We proceed by applying these new definitions of urban structure to a dataset of all German apartment postings that were (1) posted online between January 2012 and December 2024, (2) are located in a city and (3) contain an address that allows for geocoding and precise location within the city. The final dataset contains around 6.1 million apartment postings. Of these postings, around 4 percent are located in the commercial center, 29 % in the residential center and 67 % in the remaining part of the respective cities. In our work, we aggregate the commercial and residential center.

In line with the hypothesis of Cheshire and Sheppard (1995) that urban gradients are only observable when controlling for other factors, we account for a wide range of control variables. Aside from a range of apartment and

neighborhood characteristics, we also control for within- and between-city differences in social structure, economic structure and labor market characteristics. Furthermore, in some regressions we also include access to transport infrastructure. The resulting variations in the urban gradient are interesting in and of itself, as they reveal the composition of the urban premium and how it reflects centrality, superior apartment or appealing neighborhood quality.

We find a considerable variety of urban gradients in Germany. On average, apartments in the center are 11 % more expensive than those in the periphery in German cities. However, in cities with more than 250,000 inhabitants, the urban premium in the specification without controls is 18.5 %, while it is 4.6 % in cities with fewer than 100,000 inhabitants. Around 73 % of all cities exhibit positive CBD-premiums, while an apartment is cheaper in the center than in the periphery in 27 % of the cities. Controlling for apartment quality, neighborhood characteristics and the access to transport infrastructure decreases the average rent gradient from 11 to 3.7 %. Interestingly, CBD-premiums have decreased by 17 % between 2013 and 2016 and by 13.5 % in large cities above 250,000 inhabitants, but have not taken a further hit in the aftermath of the Covid-pandemic. Instead they have increased in large cities by 31 % since 2020. Controlling for changed valuations of apartment quality and access to transport infrastructure reduces this increase to around 10 %.

Our findings are highly relevant for policymakers and the real estate industry. Firstly, it is important to note that even though city centers are facing some struggles due to the rise of online retail and working from home and the related drop in traffic, urban premia are not disappearing but seem to be persisting. Secondly however, in many cities these premia are relatively small, especially after accounting for apartment quality. This should serve as a word of caution for those who argue that expensive real estate projects, such as converting office buildings into residential space, will always be economically viable. It is important to keep costs in mind, as residents may not be willing or able to pay significantly more for living in the center. Thirdly, the extra willingness to pay stems not from urbanity per se, but from centrality and good access to transport infrastructure. These factors should have absolute priority when planning new neighborhoods and real estate.

We hope that our methodology of bringing inner cities back from the point to the plane opens new avenues for research on the role and the functioning of cities. Our methodology is scalable across geographies and datasets.

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