Capital Shocks and UK Regional Divergence

Authors:
Michiel Daams
University of Groningen
Philip McCann
The University of Manchester
Paolo Veneri
OECD, Paris, and GSSI, Italy
Richard Barkham
CBRE, Dallas

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Authors' contacts:
philip.mccann@manchester.ac.uk

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Abstract

This paper uses uniquely-detailed large-scale commercial real estate investment data to examine how financial markets perceived the attractiveness of investing in UK regions during the last two decades. Using data from 2003-2015, our analysis demonstrates that prior to the 2008 global financial crisis, all regions of the UK were perceived in a similar manner in terms of risks and expected growth rates. However, the 2008 crisis engendered a flight to safety of capital into London, largely at the expense of other UK regions. The London economy enjoyed a surge of capital inflows at very low prices also enhancing the collateral and leveraging positions of local real estate owners. The recovery of investors' confidence in London's recovery was rapid. In contrast, in the immediate aftermath of the 2008 crisis other UK regions shifted rapidly into junk bond territory, and have remained there ever since. These asymmetric capital shocks led to profound and adverse impacts on the subsequent productivity growth of the UK regional economies.

1. Introduction

Nowadays it is understood that the UK exhibits high spatial productivity inequalities by OECD-wide standards (McCann 2016; 2020), and that these inequalities have been increasing markedly in recent years (Carrascal-Incera et al. 2020). UK spatial inequalities display primarily a core-periphery regional structure, which is almost entirely independent of the local industrial structure (Martin et al. 2018; Harris and Moffat 2022). Once London is excluded, UK cities and regions display almost no local scale-productivity relationships of a type associated with agglomeration effects (McCann and Yuan 2022). As such, many large UK cities do not perform in productivity terms anything like they would be expected to do on the basis of international comparisons (McCann 2016). Instead, one of the key features of the last two decades, is that while there are no economy-wide agglomeration scale-related effects, growth tends to be cumulative, in the sense that places that were already prosperous two decades ago have also enjoyed higher productivity growth rates in the subsequent years (McCann and Yuan 2022). In other words, regional divergence rather than convergence has recently been a key feature of the UK interregional system (McCann 2016). Yet, why exactly this is the case is still a matter of debate.

This paper puts forward a new explanation as to the UK regional divergence problems, based on the argument that the 2008 global financial crisis triggered profound capital market shocks which were asymmetric across UK regions, and which subsequently favoured the UK's most prosperous regions, and most notably London. The underlying signals of how financial markets evaluate different places in terms of relative pricing are obtained from uniquely-detailed commercial real estate investment data. Covering the period 2003-2015, based on the pricing of these investments, we argue that in the years prior to the 2008 crisis, the investment attractiveness of different UK regions differed very little. However, in the immediate aftermath of the crisis the London economy benefitted from a surge of cheap capital inflows associated with a 'flight to safety'. In contrast, the UK's economically weaker regions suffered severe and persistent increases in risk pricing which in turn led to adverse long-term impacts on productivity and population growth.

This study, in essence, examines the "External Finance Premium" (Bernanke 2022), namely the difference between the perceived risks priced-in by capital market investors and the official yields on sovereign bonds and central bank discount rates, and ties this capital market phenomenon to UK regional performance. In documenting this, the rest of the paper is organised as follows. The next section discusses the data at our disposal and shows how these can be used and interpreted to discuss regional capital markets. In the third section we build an analytical and empirical framework around the CAPM Capital Asset Pricing Model to examine in detail the risk-related features of the UK urban system and in the fourth section we show how these risk-related features played out with respect to the different UK regions and cities both prior to, and post, the 2008 global financial crisis. In the fifth section we develop a two-stage econometric model to examine the specific aspects of these shocks, and in combination with the CAPM framework, we demonstrate that the 2008 crisis was associated with a profound 'flight to safety' capital shock in favour of central London. The sixth section shows that these shocks subsequently had major impacts on the productivity and population growth of UK regions. The seventh section provides some conclusions and future directions for research.

2. Background to The Data and Evidence

In this paper we use detailed real estate investment data to examine the investment attractiveness of regions, from the perspective of investors. An important feature of the pricing processes in real estate investment markets is that investors continuously evaluate local growth opportunities in the context of broader financial markets. Large scale commercial real estate investments are typically long-term in focus, and generally funded by combinations of different money market channels, and therefore reflect the various intertwined channels between capital markets and localities, including credit availability and interest rates. Our approach is to examine how investors consider the pricing and risk-related features of real estate investments located either inside or outside of specific commercial or industrial clusters within individual city centres and surrounding 'metropolitan' areas. We then build up the wider regional capital market pictures by aggregating these investments to assess city-wide effects and then region-wide effects.

To begin with we define local commercial or industrial clusters based on long-term locational patterns that we observe in their investments, as described in Appendix A.1. Our method allows us to also identify clusters not only in city centres but also in sub-centres outside of the most densely clustered cores of the city, as well as in smaller cities and towns. The comprehensive real estate dataset used in this study consists of 7,465 transactions of commercial properties, including offices, retail and industrial property[1], across the UK from January 2003 to July 2015. The data all come from the secondary market, whereby investors buy existing real estate assets with a view to re-letting them or redeveloping them for future sale. The secondary market accounts for the vast majority of commercial real estate transactions. We were provided with access to these data by Real Capital Analytics Inc (RCA). RCA tracks and analyses information on investment-grade real estate transactions for all the main property types, and in the UK, RCA tracks all transactions of offices with selling prices of US$10,000,000 and higher. As a result, the data observed in this study closely approximate the population of existing commercial transactions that have been completed during the 2003-2015 time period. Any portfolio-level deals are dropped from the data to ensure that a non-intertwined pricing of individual properties is observed from the data. The transactions with yield values are all geocoded and each allocated to one of the 88 Functional Urban Areas (FUAs) across the United Kingdom[2] as delineated by the OECD and the European Commission (Moreno-Monroy, Schiavina and Veneri 2020; Dijkstra, Poelman, and Veneri 2019). In this definition, metropolitan areas are delineated from regular grid cells of one square kilometre each, so capturing cities of at least 50,000 inhabitants as well as their respective commuting zones. This allows city boundaries to be independent from the shapes and sizes of counties or census tracts, which are not homogenous across the UK. As listed and operationalized in Table 2, we also enrich the dataset with regional measures of undevelopable land, quality of governance, as well with OECD-standardized information on the economic performance of FUAs.

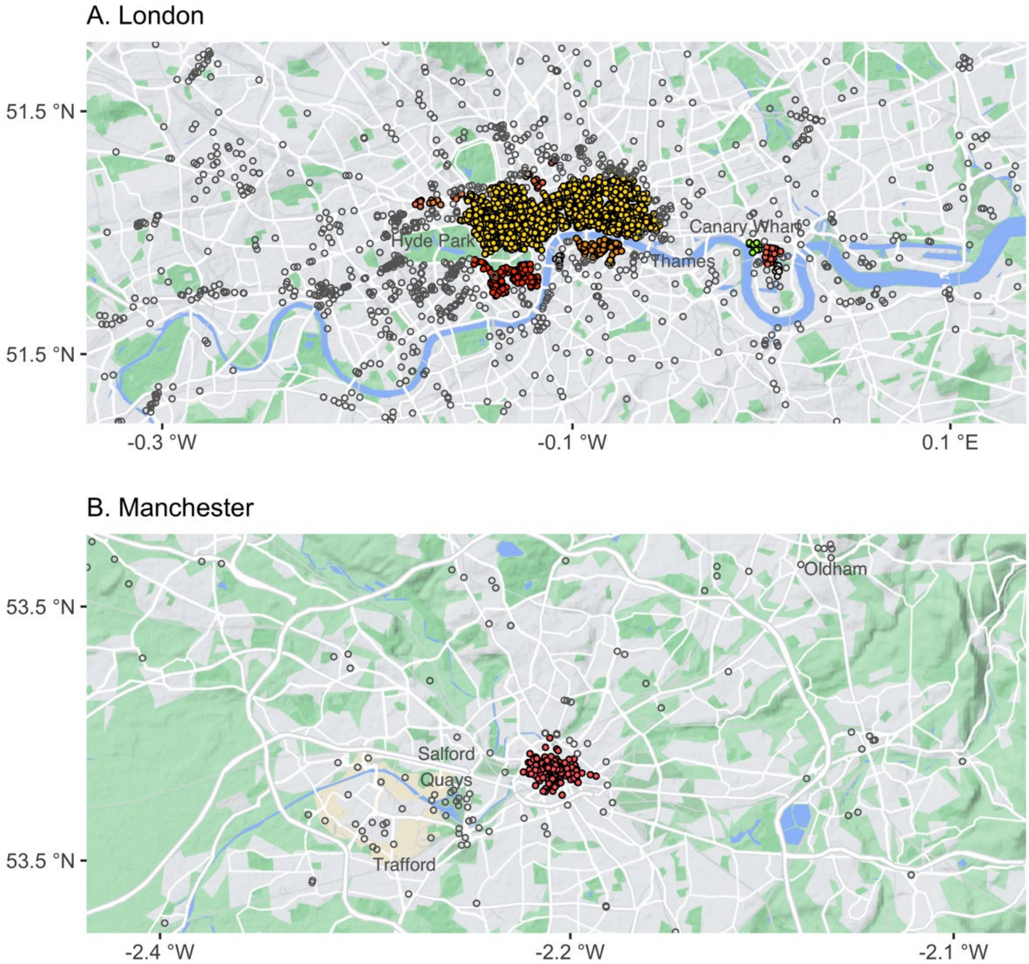
To understand the possibilities afforded by these data it is useful to begin by comparing what they tell us about different cities. Using our clustering algorithm applied to our real estate data, we are able to plot the map of the spatial density of large commercial investments across cities in unparalleled detail. As we see in Figure 1a, London has a huge central commercial core, comprised of huge dense clusters of commercial investments immediately north and south of the River Thames as well as Canary Wharf-Docklands further east, along with some much smaller clusters of investments in other outer parts of the city both north and south of the River Thames. In addition, there are many large commercial real estate investments scattered around the city in all directions. Meanwhile, as we see in Figure 1b, Manchester, whose functional urban economy in population terms is one quarter of the size of London and one sixth in terms of output, has a much smaller central core than London. The central commercial core of the city is also accompanied by significant commercial investments west of the central city at Salford Quays, albeit outside of the city's most central part. The major commercial centre is also

[1] Our dataset contains 7,465 transactions for all property types comprising: 3,666 offices (49%); 2,308 retail (31%); 1,196 industrial (16%); 169 hotels (~2%); 118 residential (~2%); and 8 seniors' housing and care.

[2] There are 89 FUAs in total in the UK according to the OECD datasets, all of which have transactions included in our dataset, and 88 have transactions with yield values also included.

accompanied by less than half a dozen small commercial centres at various outer locations across the city, as well as many other commercial investments scattered across the city.

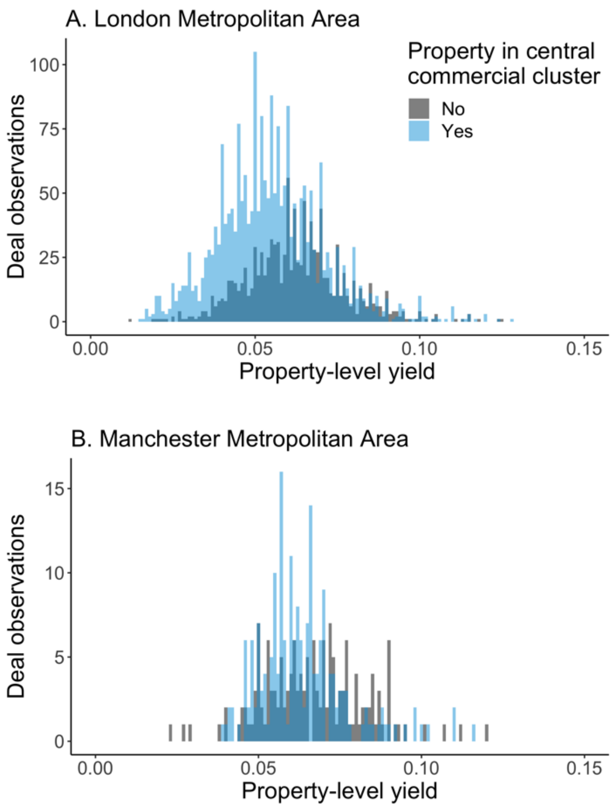
Figure 1. Central city (within-CBD) clusters of commercial real estate investment.



Figures 2a and 2b plot the distribution of real estate investment yields within each city during the time period 2003-2015. The 'yield' associated with each investment is a financial measure of the perceived risk of the investment by investors, and is calculated as the annual rental value of the investment to commercial tenants divided by the purchase price of the investment. In the few situations where the property is to be re-sold on, the imputed rental value is the annuity-equivalent of the expected capital gain after any additional redevelopment costs. Lower yield values are associated with lower perceived risks and higher yields with higher risks.

In both London and Manchester, the distribution of investments is approximately normally distributed around a mean yield value. As we see in Figure 2a, in the case London, all investments across London exhibit a mean yield value of approximately 5%, with those located in local clusters dominating the distribution of investments displaying lower yield values, whereas investments located outside of local clusters typically dominating the investments displaying higher yield values. In contrast, in the case of Manchester, the overall distribution of investments displays a mean value of just over 7%, a couple of percentage points higher than London. This confirms that investors perceive Manchester to be systematically more risky than London. However, in the case of Manchester, there is no clearly observable difference between the mean value for investments inside local commercial clusters versus those located outside of local commercial clusters. This suggests that investors do not perceive investment risks in the central Manchester core areas to be noticeably less risky than those located in other non-clustered or outer areas. As we see in Appendix A.2, this is also the case for other UK cities, except for London. In Figures A.7 and A.8 of the Appendix we see that in the post-crisis period there was already evidence that Manchester was beginning to be perceived more favourably by the capital markets than other UK cities, but the point remains that the markets perceive London differently.

Figure 2. Investment Yield Distributions Inside or Outside of Central Commercial Clusters.



One of the key arguments regarding industrial clustering and agglomeration economies is that they reduce the financial risk from the perspective of investors. This is because agglomeration processes maximise knowledge spillovers and also labour matching mechanisms as well as allow for the sharing of costs. In financial terms, agglomerations therefore minimise the likelihood of missing out on key market and technological knowledge, and they also minimise the costs associated with good job-matching processes, while allowing for lower risk sharing costs on key inputs. Clustering and agglomeration ought to be associated with lower risks, and therefore lower yield values (Mills 1971, 2000), and textbook arguments imply that this ought to be most noticeable in central business districts (CBDs) of cities.

This is indeed very clearly evident in the case of London, whereas there is little or no evidence of this in the case of Manchester. This suggests that clustering and agglomeration effects in central London are an important source of investment attractiveness, in particular for ‘blue-chip’ investors. On the other hand, in the case of Manchester, the local clustering and agglomeration effects during the period 2003-2015 are still not strong enough to systematically attract investors in search of safe long-term investments. Instead, the higher local mean yield values allied with the lack of any systematic clustering-related yield-reduction effects, implies that investors in Manchester are more primarily characterised by high yield investors searching for lower real estate prices to underpin higher returns. There is already evidence that the economic size of the city centre of Manchester is small in comparison to other European cities of similar overall population sizes (Rodrigues and Breach 2021), so it may well be that the size, or alternatively the structure, of Manchester's commercial centre is not yet large enough to drive lower perceived risk on the part of investors in a manner akin to what is evident in London.

Importantly, these data allow us to begin to discuss the nature of different places in terms of investor perceptions and sentiment, something which is essential if we are to investigate the role played by capital markets, and in particular by capital shocks, in the economic performance of UK cities and regions. None of the major systems-of-cities schema (Fujita et al. 1999; Gabaix 1999a,b; Batty 2013; Bettencourt 2013) allow us to do this because they do not incorporate portfolio theory into their frameworks, and nor does mainstream portfolio theory explicitly relate to urban and regional structures. Similarly, unlike individual stocks, for which high-frequency price series are available to assess investment risks in fine detail, the market for real estate is characterized by a relative infrequency of transactions. While for real estate investment trusts (REITs) higher-frequency price series can be observed, these do not provide the in-depth detail on returns-by-location as captured in our direct investment data, and which our analysis requires. As such, in order to examine capital shocks on UK regions and cities we need to adopt a somewhat different approach from either mainstream urban economics or standard real estate economics frameworks.

3. The Capital Asset Pricing Model (CAPM) of Investments in UK Clusters and Cities

There are many different and sophisticated approaches to modelling urban and regional economic performance and also real estate investment risks and returns. Yet, for our purposes, the simplest and most parsimonious framework is the Capital Asset Pricing Model (CAPM), which as we will demonstrate here, works surprisingly well in this context. However, the analysis in this paper is not meant to be either a test of the efficacy of the CAPM, or to make direct inferences of causality. Rather, it is to explain the nature and patterns of the changes in yield dispersion and risk profiles of different types of UK regions and cities from the perspective of investors. For these purposes, the CAPM model is the most parsimonious framework.

The simple CAPM can be written as (Armitage 2005):

(1) $$E(R_i) - R_f = \beta_i[E(R_m) - R_f]$$

or:

(2) $$E(R_i) - R_f = \rho_{im}\frac{\sigma_i}{\sigma_m}[E(R_m) - R_f]$$

where:

$E(R_i)$ = Expected return on investment *i*;
$E(R_m)$ = Expected return on market *m*;
R_f = Expected return on risk-free investment *f* (government bonds);
σ_i = Standard deviation of investment *i*;
σ_m = Standard deviation of market *i*;
ρ_{im}= Correlation between investment *i* and market *m*;

and where the investment beta can be written as:

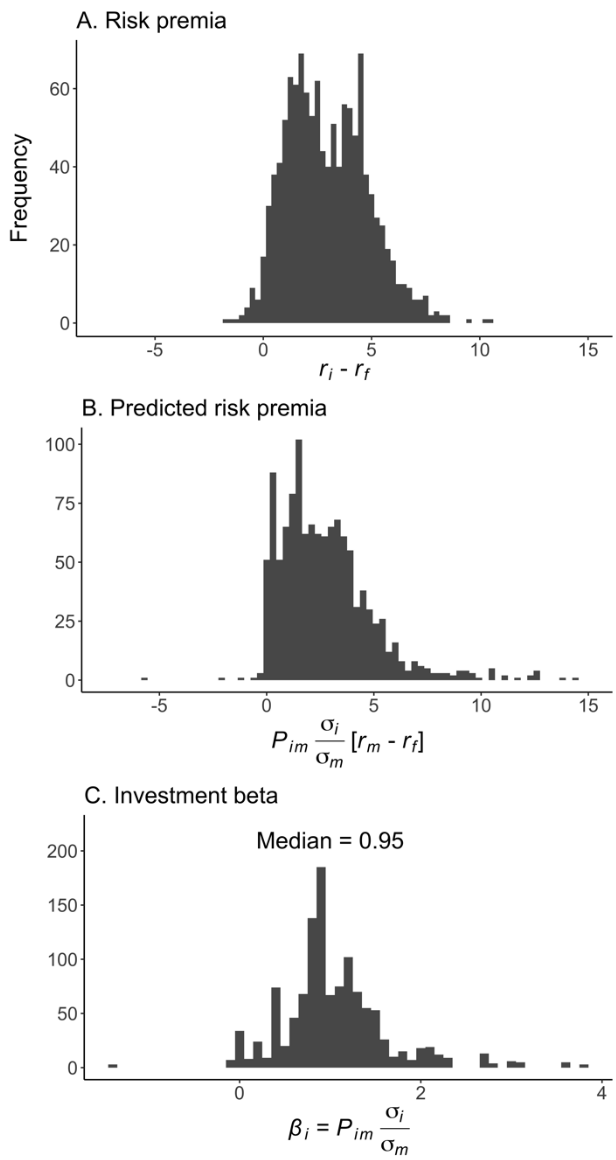
(3) $$\beta_i = \rho_{im}\frac{\sigma_i}{\sigma_m}$$

If we treat each cluster, respectively, as i, and we can calculate all of the UK-wide market m values in the real estate investment sector as the average values across all cities, then the average yield in each cluster i, as observed by year, is denoted as r_i and the average year-specific yield across the whole UK market is denoted as r_m. Given that the yields reflect the expected return on each investment, across the whole system of UK clusters we can now write a CAPM equation of:

$$r_i - r_f = \rho_{im} \frac{\sigma_i}{\sigma_m} [r_m - r_f]. \quad (4)$$

For each cluster i and also for the UK real estate market as a whole m, from our dataset we know the values for r_i , r_m , r_f, σ_i and σ_m , and we can also calculate the value of ρ_{im}. This allows us to plot the relationships between the observed risk premium $(r_i - r_f)$ for the ith cluster and its risk premium predicted by the CAPM ($\rho_{im} \frac{\sigma_i}{\sigma_m} [r_m - r_f]$), and also to examine the beta values $\rho_{im} \frac{\sigma_i}{\sigma_m}$ for individual clusters.

Figure 3. The Data Elements of the CAPM Model.

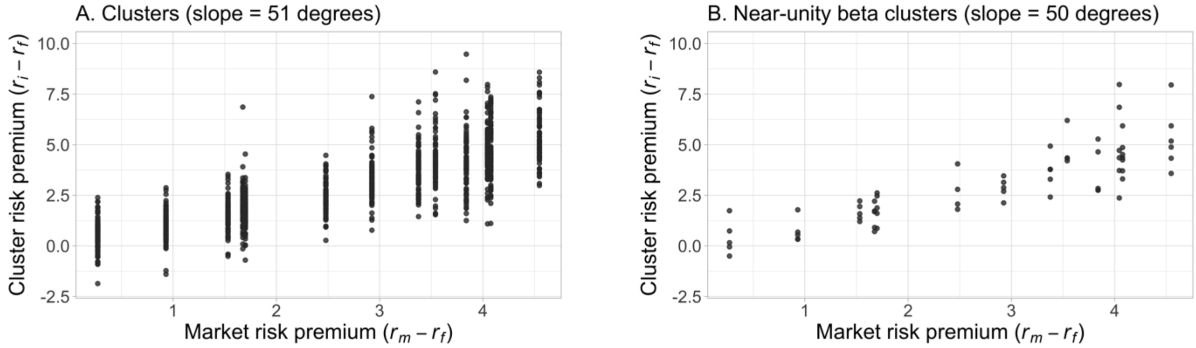


If changes in the expected returns on an individual investment in a particular cluster exactly mirror the movement in the expected returns in the market as a whole, then the value of the cluster's beta will be equal to unity. Alternatively, if the calculated beta value is less or more than unity, the observed rate of return on the individual investment will have deviated away from the market-wide average. As such, beta here captures the systematic market risk associated with clusters, and the extent to which they follow market-wide movements. The distributions of the various CAPM elements generated from our dataset are plotted in Figure 3.

More specifically, Figure 3a plots the left-hand side of the CAPM model, Figure 3b plots the right-hand side of the CAPM model, and Figure 3c plots the first element of the right-hand side, namely the investment beta values. What we see is that the dispersion around a 'correct' underlying value is a feature of each of the specific elements in the CAPM model whose distributions closely follow what would be expected from the CAPM framework. As such, the CAPM model captures the main features of the real estate market, even allowing for imperfect information. Over-performance and under-performance of investment returns are typical characteristics of the real estate investment industry, and the fact that each of the elements of the CAPM model displays high dispersion around the expected values suggests that imperfect information and product heterogeneity are all key characteristics of the market.

In Figure 3c we see that the investment beta values are approximately normally distributed around a mean value very close to unity, as would be expected in a CAPM framework. In Figure 4 we can see this even more clearly by plotting the relationship between the left-hand side of the CAPM model against the second right-hand side of elements of the CAPM model. In Figure 4a we do this for all commercial and industrial clusters in our UK dataset. The observed the slope of the relationship between these two elements of the CAPM model is 51 degrees, which is very close to the 45-degree slope associated with a dataset that perfectly reflects the CAPM model. In Figure 4b we repeat this exercise, but now just for the commercial and industrial clusters whose individual beta values are close to unity. Again, the observed slope of the relationship between these two elements of the CAPM model is 51 degrees for this sub-set of clusters. As with Figure 3, Figure 4 therefore also provides further evidence that the properties of the transactions data in our dataset closely reflect the properties of a standard textbook investment model, and that this is a feature of the whole dataset, and not just particular sub-samples of the data.

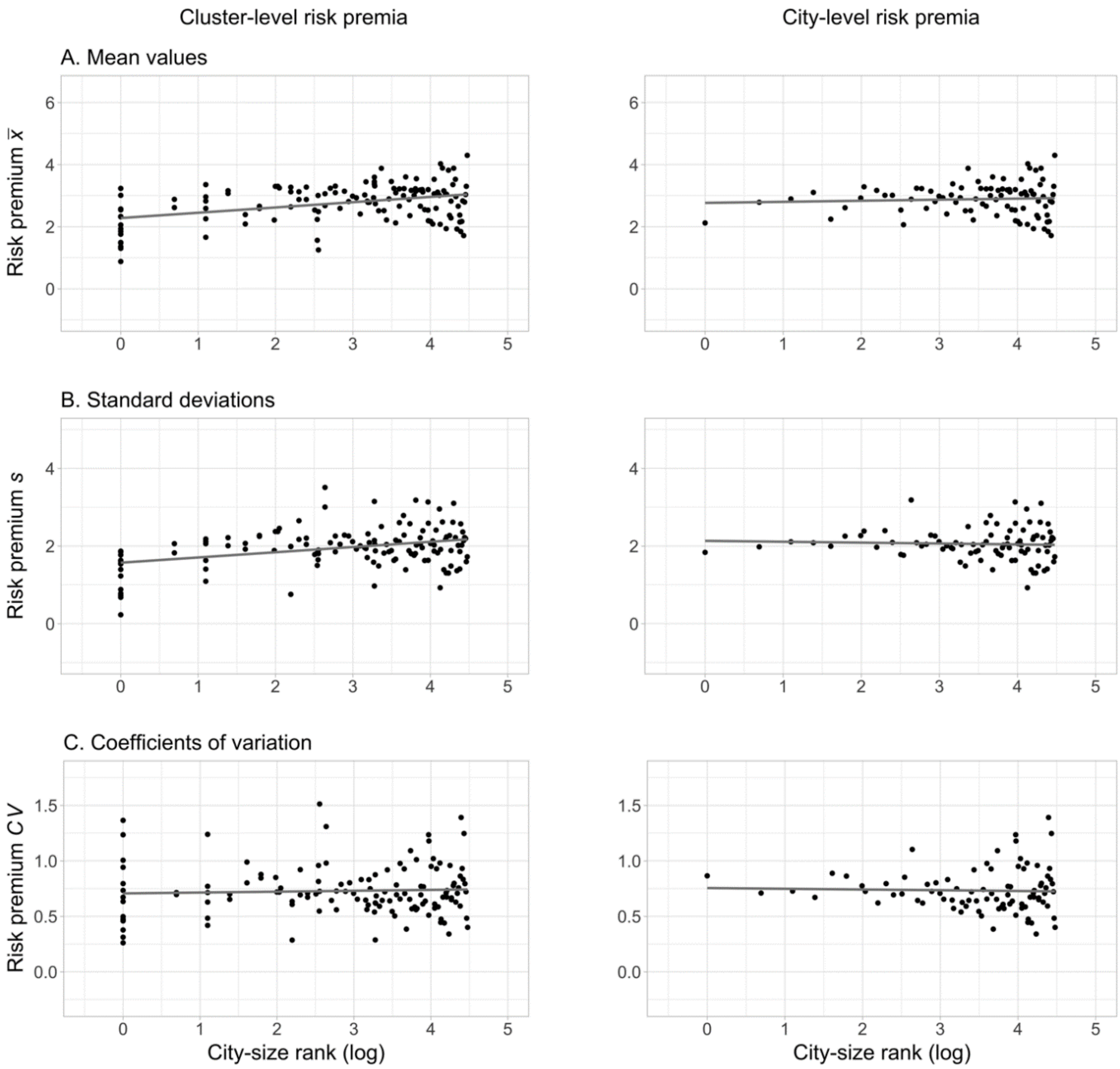
Figure 4. The Cluster Beta Values.



Given our data we can also now examine how the structure of the UK urban economic system relates to the risk related features of the investment markets. According to Zipf's Law, the growth rates of a city should be independent of the size of the city (Gabaix 1999a,b). The yield values provide an index of expected returns, so by examining the UK-wide relationship between the observed risk premia, reflecting the spreads of yields over the expected returns on treasuries, and the log of the city-size rank, we are able to assess the extent to which the financial markets price assets in a manner which is broadly consistent with Zipf's Law. In the left-hand side panel of Figure 5 we do this at the level of individual clusters, and in the right-hand side panel we do this also at the level of cities, which can be considered as being clusters-of-clusters. In Figure 5a we plot the mean risk premia, while in Figures 5b and 5c we plot the standard deviations and coefficients of variation of these values.

What we see in Figure 5a is that the slope of the relationship between the risk premia and the log of the size, aside from London at the very left of the distribution, is indeed very close to zero for both clusters and cities. Furthermore, the standard deviation and coefficients of variation are relatively flat for clusters, and slightly downward sloping for cities which suggests somewhat lower dispersion around the mean risk premium values for smaller cities.

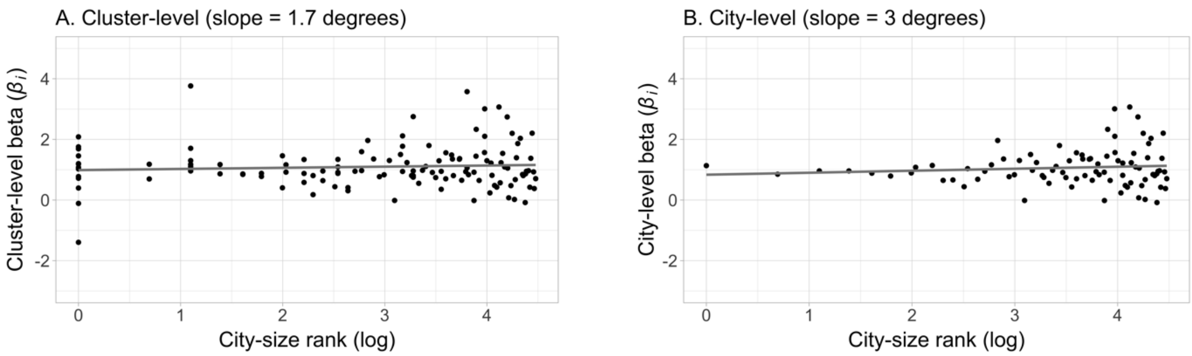
Figure 5. All 2003-2015 Risk Premia Values Aggregated to the Cluster- and City-Level.



We can also repeat this same exercise, but now in Figure 6 we plot the beta values with respect to the log of the size of the respective clusters and cities. As we see from Figure 6 left-hand side panel, the slope of the beta value with respect to the log of the size of the individual cluster is almost precisely zero, whereas it is somewhat upward-sloping when measured at the level of cities. We will return to the salience of this point shortly.

Importantly, however, at this point we can be confident that these various distributions depicted in Figures 5 and 6 tell us that the size of a commercial or industrial cluster, or a city, per se, is not a risk-related feature of the UK market which cannot be correctly priced on all dimensions by the capital markets into investment portfolio allocations (Chervachidze and Wheaton 2013; Wheaton and Nechayev 2005). In terms of location-specific investment pricing, Zipf's Law holds.

Figure 6. Cluster- and City-Level 2003-2015 Beta Values by City Size-Rank.

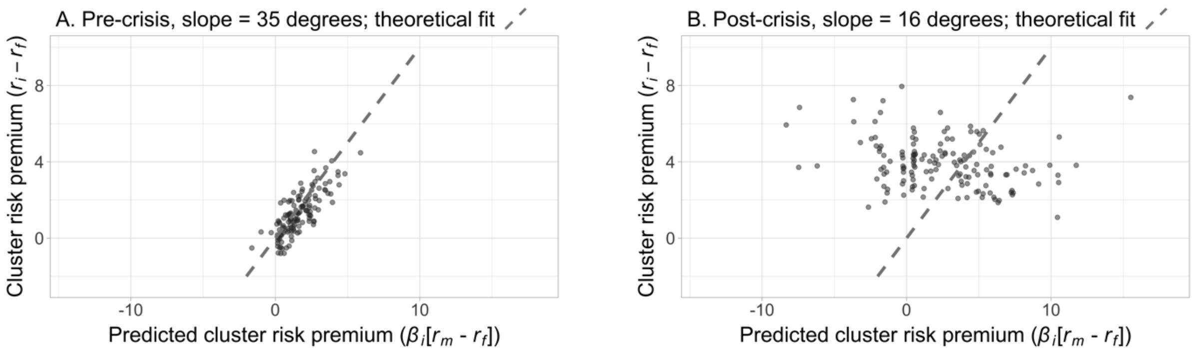


Taken together, the evidence from Figures 3, 4, 5 and 6 tells us that the UK-wide data we have at our disposal displays characteristics typical of both a textbook investment pricing system and also a textbook urban economic system.

4. The Capital Shocks on UK Clusters and Cities due to the Global Financial Crisis

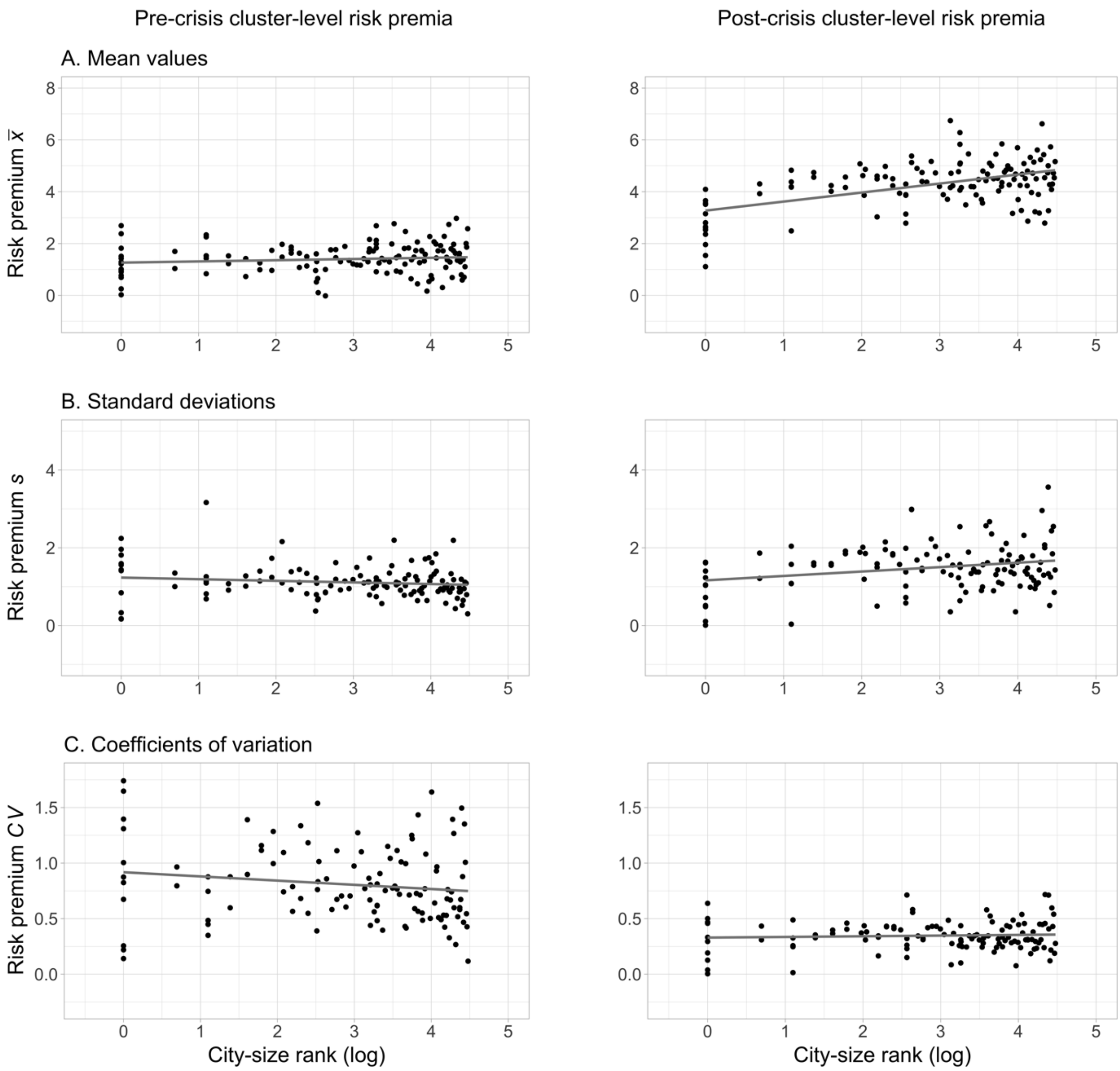
We are now in a position to begin to use our UK-wide data, set within a CAPM framework, to explore the impacts of the 2008 Global Financial Crisis on the performance of UK regions and cities. To do this, we can first examine how the 2008 crisis affected the ability of investors to 'correctly' price investment across places. In figure 7, on the y-axis we plot the left-hand side of the CAPM model against the right-hand side of the CAPM model on the *x*-axis, whereby R_m is the UK-level sector-specific yield and R_f is the UK 10-year sovereign yield for a given year.

Figure 7. Pre-Crisis and Post-Crisis CAPM Relationships in Commercial Centres.



As we see from the left-hand side panel of Figure 7, at the cluster-level, the pre-crisis relationships corresponded to the textbook type CAPM model, with dispersion around the predicted values. However, in the post-crisis period, the observed dispersion is not only dramatically increased, but it becomes almost orthogonal to the expected values. This strongly suggests that investors were no longer able to correctly price investments, even approximately (neither at the level of cities, as shown in Appendix A.4). The 2008 global financial crisis led to a sudden and profound shift from a regime of risk, where the characteristics of investments and their likely returns are quantifiable, to a regime of fundamental and radical uncertainty (Kay and King 2020), whereby standard risk-related pricing models become largely ineffective.

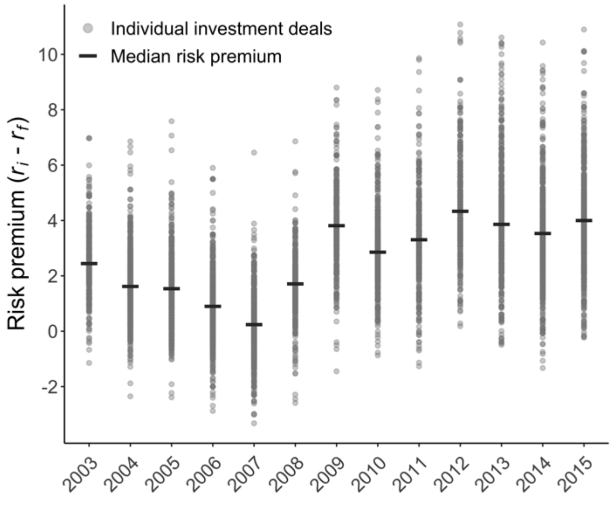
Figure 8. Pre- and Post-Crisis Cluster-Scale Relationships.



As we see in Figure 8, a response to this uncertainty is that whereas in the pre-crisis period investment risk premia at the cluster level were exactly zero with respect to cluster scale, in the post-crisis era not only do the average risk premia increase markedly, but also the risk premia increase with respect to the log of the rank of the cluster size. In other words, in the post-crisis period, clusters which are smaller become perceived by investors as being systematically more risky, whereas pre-crisis there was no difference whatsoever. This sudden 2008-09 regime shift from risk to uncertainty is also evident in the distribution of risk premia across clusters and across time periods. In the right-hand side panel of Figure 8a, the extreme left-hand side clusters of rank zero are the major city centre clusters within London. These now appear to be differently priced to the rest of the UK urban system, such that the UK-wide relationships between risk and scale were fundamentally changed by the 2008 crisis in a manner which also reshaped how investors perceived places.

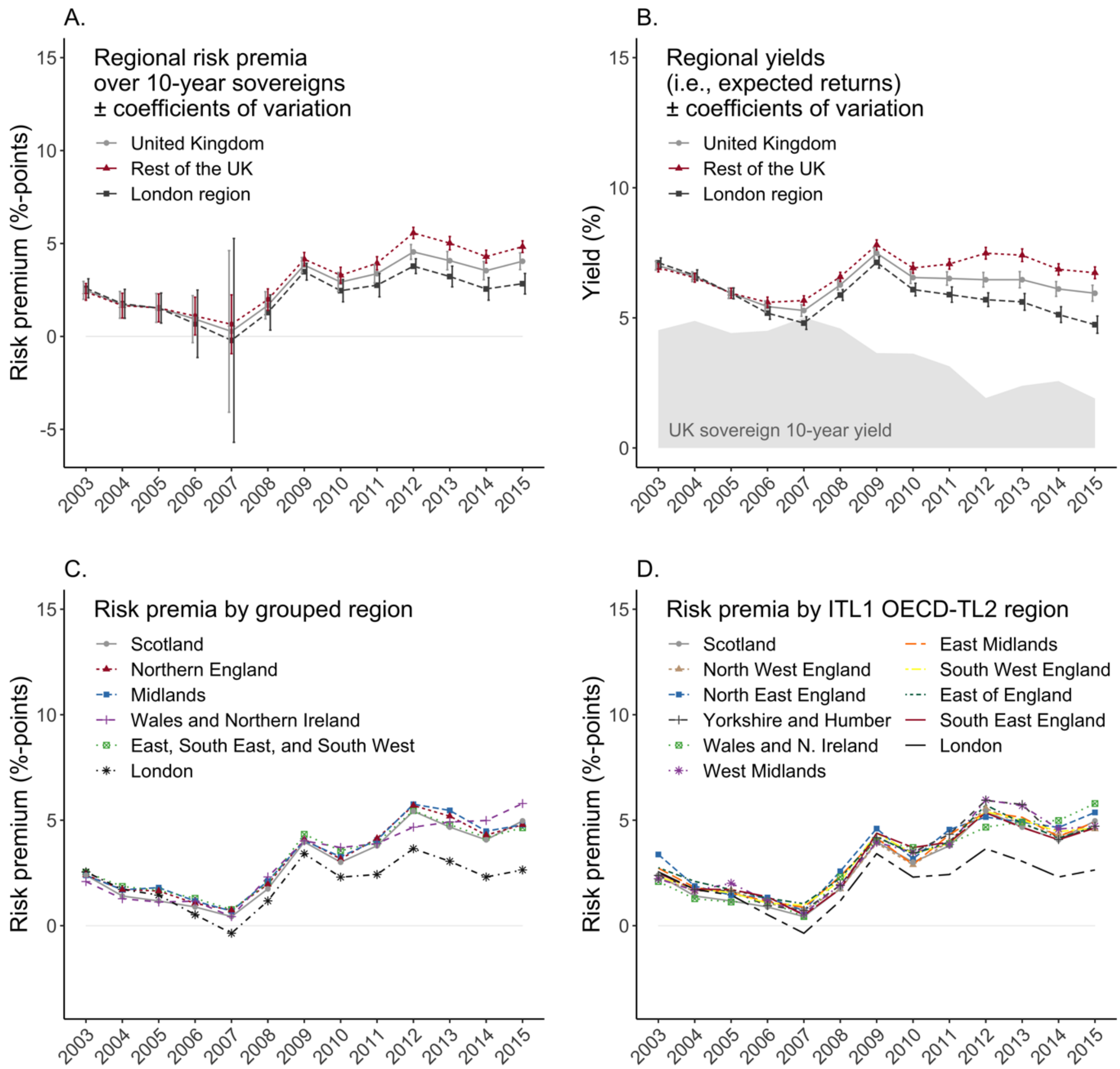
To explore this issue in more detail, for the UK-wide data, Figure 9 plots the risk premia associated with individual property-level investments for the period 2003-2015, along with the median values for each year. As we see in Figure 9, during the pre-crisis period when UK productivity growth was strong while both inflation and interest rates were relatively low and steady by historical levels, UK-wide investment risk premia values were falling slowly. This broadly reflects economy-wide market perceptions of a low risk and high confidence business environment. However, with the onset of the 2008 global financial crisis, UK-wide risk premia suddenly spike, subsequently drifting downward very slowly over the following post-crisis years, even though this was a time of record-low interest rates due to quantitative easing. By 2015, average real estate commercial yield values were still higher than they were a decade earlier, even though Bank of England base rates had fallen 4.5% to 0.5%, or by 88%, during this period. Importantly, the dispersion of risk premia increased dramatically by almost 50% between the pre-crisis and post-crisis periods, implying diverging growth and development expectations between places.

Figure 9. Pre-Crisis and Post-Crisis UK-Wide Risk Pricing.



In Figure 10b we group the individual investments according to their location in either London or in the rest of the UK. As we see, in the period prior to the 2008 crisis, the downward drift in investment risk premia is slightly more pronounced in London, with the minimum average risk premium in London in 2006 being at 5.2%, whereas outside of London they are slightly above 5.5%. The sudden spike in risk premia in the wake of the 2008 crisis is evident in the regions both outside of London and also within London, although in London the average yield peaks at 7% in 2009 whereas it is 8% outside of London. However, the major difference between the London economy and the rest of the country becomes evident in the post crisis period, in that in London commercial yields again drift downwards akin to the pre-crisis trends, by 2015 reaching the same lowest levels as were evident in 2006. In risk pricing terms, this implies that by 2015, the effects of the global financial crisis had largely disappeared in London. In contrast, in other parts of the UK commercial real estate yields and risk premia remained consistently high, and still at levels higher than had been the case at any time since 2003. In risk pricing terms, the effects of the 2008 crisis were still clearly evident in 2015 in regions outside of the London economy, but no longer within London itself.

Figure 10. UK Regional Risk Pricing Trends 2003-2015.



These capital market hysteresis effects can be most clearly seen by grouping the individual investments according to their regional locations at the ONS ITL1 and OECD-TL2 levels. Figure 10a reports the trends in average annual regional risk premia calculated as the left-hand side of the CAPM model for the period 2003-2015, while Figure 10b reports the average annual regional yield value for each year of the same period relative to the 10-year UK sovereign yield, clarifying the yield gaps which define the risk premia in Figure 10a. For ease of exposition, Figure 10c and 10d repeat exactly the same exercises as in Figure 10a, but after grouping the regions, such that Wales and Northern Ireland are grouped together; as are South East, East and South West; North West, North East and Yorkshire and Humber; and East Midlands and West Midlands.

At the top of the trend lines in Figure 10a-10d are the regions of the North East, Wales and Northern Ireland, with the rest of the regions in the north and midlands closely concentrated together. Over time the Scottish economy trend line has gone from being in a relatively low positioning to a higher positioning alongside the northern and midlands regions. The southern and eastern regions are the lowest positioned trend lines outside of the London economy. The combination of the regional trend line positioning, which reflects the perceived regional risk levels, plus the slope of the regional trend line, which reflects the changes in risk perceptions, together tell us how the financial markets perceive the viability of investments across UK regions at different time periods.

The most obvious feature of the four diagrams depicted in Figures 10a-10d is the markedly different capital market experience of the London economy in the years following the 2008 global financial crisis. The trends for the risk premia and required investment yields in London are not only broadly downward-sloping since 2009, but they are also positioned far lower than all of the other regional trend lines, none of which are downward sloping during the post-crisis era. In the years prior to the 2008 crisis, the UK regional variations in risk premia and requisite investment yields were much less than 1%, and in many cases were very close to zero. However, by the end of 2015, the London risk premia and required investment yields were on average more than 200 basis points below the rest of the UK, with yields once again at their lowest pre-crisis levels. In contrast, the other southern and eastern regions along with Scotland displayed regional risk premia and required investment yields which were some 200 basis points above London, while the regions in the midlands, north and the other Celtic regions displayed risk premia and required investment yields of the order of 250-300 basis points above London. In the immediate aftermath of the 2008 crisis the post-crisis yield values for the UK's economically weaker regions shifted rapidly into junk bond territory and still remained there some seven years after the crisis. The scale of the risk spreads generated by these diverging capital market trends can be understood by the fact that at the end of 2015, the differences in the risk premia between London and the UK's economically weaker regions were equivalent to the 10-year sovereign spreads between the UK[3] and Romania[4] and Chile[5]. Similarly, the spreads across UK cities were as large as the city-spreads across the whole of the EU and the USA (Daams et al. 2023). As such, the quantitative easing introduced by the Bank of England in the immediate aftermath of the 2008 crisis appears to have had no beneficial risk-reduction or yield-reduction effects on the non-London regions during the post-crisis era. In marked contrast, the beneficial effects of quantitative easing on the London economy have been very marked, with London yields closely tracking the falls in 10-year sovereign rates. By 2015 the required investment yields in the London economy were again akin to their lowest pre-crisis levels.

The result of this sudden and profound shift of investor sentiment and risk-pricing favouring London were dramatic changes in the scales and patterns of capital inflows into UK regions. These place-specific changes in market shares took place under a prolonged contraction of the UK real estate investment market. By 2015, the UK as a whole had still not recovered beyond the 2004-05 levels of investment, with investment levels at only 74.5% of the levels immediately prior to the 2008 crisis. London had already once again reached 2003-04 levels by 2010. Indeed, by 2015 London had recovered to the investment inflow levels of 2006, at 81% of the levels immediately prior to the onset of the 2008 crisis. In contrast, by 2015 the rest of the UK had only reached the investment levels of 2003-04, at only

[3] https://tradingeconomics.com/united-kingdom/government-bond-yield
[4] https://sdw.ecb.europa.eu/quickview.do;jsessionid=922AF7CBD6730E09075FFB8CCE8CF8DA?SERIES_KEY=229.IRS.M.RO.L.L40.CI.0000.RON.N.Z
[5] https://fred.stlouisfed.org/series/IRLTLT01CLQ156N

64.2% of the levels immediately prior to the 2008 crisis. The result of these shifts in capital flows is that London increased its share of national investment flows from 53.2% in 2003 to 66.7% by 2015.

The reason for this profound shift in investor sentiment between UK regions which favoured London over all other regions, appears to be related a to 'flight to safety' phenomenon in the immediate aftermath of the 2008 global financial crisis. Similar dramatic geographical shifts in capital pricing are also evident in the USA (Daams et al. 2023) and across Europe, whereby investors scrambled to find arenas to invest capital in order to avoid or mitigate potential losses in an environment where they are unable to price-in risk. For example, late 2008 and early 2009 saw an enormous surge of capital inflows into Japanese government bonds, even though at that time Japan had not grown for more than fifteen years, and such flows can only be understood in terms of a 'flight to safety' phenomenon. The sudden surges of capital into certain regions and cities also appear to reflect this 'flight to safety' behaviour, with investors looking for particular types of regional and city locations to invest capital in for a safer long-run prospectus. In turn, this reshaping of regional capital flows appears to have led to a longer and more permanent reshaping of regional investment trajectories, something which in the case of the UK, has potentially profound consequences for the whole Levelling Up debate. The next issue we therefore need to examine, are the characteristics of those places that benefited from these favourable capital pricing effects, and consequently, increased capital inflows in comparison to those places that experienced adverse capital pricing effects and consequently, falling capital flows.

5. Two-Stage Empirical Methodology and Results

To examine these issues in more detail, we adopt a two-stage procedure estimation approach following Combes et al. (2011), that allows for self-selection and sorting processes. They examined the relationships between individual human capital movements into cities and the resulting economic performance of those cities, while we examine individual financial capital investments into cities and the resulting economic performance of those cities.

The estimation of the regression takes two stages. Firstly, we estimate:

$$E(R_{ict}) - R_{ft} = \eta_{c(it)t} + \sum_{a=1}^{A} \delta_a \mathbf{X}_{icta} + \varepsilon_{ic(it)t} \quad (5)$$

where $(E(R_{ict}) - R_{ft})$ is the risk premium observed for the *i*th real estate asset in city *c* at time *t*; $\eta_{c(it)t}$ denotes the year-by-city fixed effects of interest; $\mathbf{X}_{icta}$ is a vector of property-specific characteristics; and $\varepsilon_{ic(it)t}$ denotes standard errors that are clustered at the city-level; followed by:

$$\widehat{\eta_{ct}} = \gamma \mathbf{U}_{ct} + \varepsilon_{2ct} \quad (6)$$

where $\widehat{\eta_{ct}}$ is the first stage estimate of $\eta_{c(it)t}$; and $\mathbf{U}_{ct}$ is a vector of the features of city c and also includes time dummies.[6]

In the model for equation (5), property-specific variables (vector $\mathbf{X}_{icta}$) include standard real estate characteristics such as the floor space in square feet, whether a property is located in a CBD cluster or in a sub-urban cluster, and property type fixed effects. By controlling for these real estate characteristics,

[6] The model does not contain a constant. This is consistent with the CAPM we employ (the simple model assumes no alpha) as well as Combes et al. (2011).

we obtain the estimates for year-by-city risk premium coefficients. In the model for equation (6), these fixed effect coefficient estimates from equation (5) are then regressed against year dummies[7] and the city-level independent explanatory variables, including the log of the rank of the population size of the city, the GDP per capita of the city, the quality of sub-nation governance in that locality, and the share of local land which is undevelopable due to natural topography or to land-use planning constraints. The results for equation (5) are reported in Table 1 and for equation (6) in Table 2. Table 1 reports the estimated risk premia in levels for each city estimated on the basis of the whole period and for all of the UK.

The risk associated with individual investments is higher for large floorspace investments. Yet, what is most immediately apparent is that individual deal-level risk premia for investments in CBD central business district commercial clusters are almost 80 basis points below those in other locations. The year-by-city risk premia estimated in the model described by equation (5) follow a normal distribution. The scatterplot of the distribution of these city-level risk premia, with the reference category being London in 2003, is given in Figure A.3 in Appendix A.3, and Figure A.4 in Appendix A.3 depicts the yearly trends in the year-by-city risk premia.

Table 1. First-Stage Estimation of Year-by-City Premia from Deal-Level Risk Premia.

	Full-period
Square feet (log)	0.192*** (0.017)
CBD cluster	-0.795*** (0.040)
Constant	0.155 (0.322)
Property type controls	Yes
Year-by-city fixed effects	Yes
Observations	6,836
Adjusted R^2	0.614

Notes: Dependent variable is deal-level risk premium in levels for individual properties. City-level clustered standard errors are in parentheses. *, **, *** Significance at 10%, 5%, and 1%, respectively.

In the second stage of the regression model, following equation (6), the estimated year-by-city risk premia from equation (5) are then regressed against city characteristics. The results for the whole of the UK are reported in Table 2.

[7] Note that in equation (2) city-level fixed effects are allowed to vary by year. This accounts for the possibility that, over time, unobserved city characteristics might drive changes in the observed economic characteristics of cities. While such a notion is common when regarding the economics of urban growth processes (Combes et al. 2011), this is not obvious in the case of real estate analysis. For instance, if within a given year an unobserved process reduces or increases a city's level of productivity (the urban economics argument for endogeneity), the structural characteristics of the buildings that host any associated commercial activities are typically not immediately affected. Nevertheless, a change in the characteristics of real estate assets may occur over time, albeit slowly. Indeed, processes such as obtaining building permits and (re)developing real estate are time consuming, and even so, the new supply of real estate is typically a very modest flow as compared to the size of the existing stock. Thus, in the short-term setting of our model, asset-level real estate effects and city effects can be separated.

Table 2. Second-Stage Regressions of Year-by-City Premia on City Characteristics.

	Full-Period	Crisis Shock	
		Pre-Crisis	Post-Crisis
	(1)	(2)	(3)
Rank (log)	-0.015 (0.075)	-0.007 (0.045)	-0.018 (0.075)
GDP per capita (log)	-0.581*** (0.298)	-0.004 (0.184)	-1.055*** (0.298)
Sectoral specialization	-0.044 (0.107)	0.013 (0.051)	-0.113 (0.107)
Sectoral diversity	-0.003 (0.012)	-0.004 (0.010)	-0.003 (0.012)
Governance score (EQI)	0.253 (0.364)	0.164 (0.212)	0.325 (0.364)
Undevelopable land (%)	0.003 (0.004)	0.004* (0.002)	0.003 (0.004)
Year fixed effects	Yes	Yes	Yes
Observations	507	242	265
Adjusted R^2	0.809	0.846	0.797

Notes: Dependent variable is estimated year-by-city risk premium in levels. City size rank and GDP per capita are sourced from the OECD Metropolitan Database; sectoral indices are based on OECD employment data for TL3 regions and follow Duranton and Puga (2000); TL3-level EQI governance scores follow Charron, Dijkstra, and Lapuente (2014); and regional shares of undevelopable land are obtained following Saiz (2010), see Appendix A.1. Regressions exclude small or medium-sized cities, which cover 10% of the original yields sample. The pre-crisis period is 2003 to 2008, and the post-crisis period is defined as 2009-2015. City-level clustered standard errors are in parentheses. *, **, *** Significance at 10%, 5%, and 1%, respectively.

In the pre-crisis period, year-by-city risk premia appear to be unaffected by any of the major characteristics of the city, except for tentative evidence that the local shares undevelopable land may increase risk premia. Most obviously, there is no scale-related effect, an observation consistent with the earlier observations and discussion, and nor is there any effect of sectoral structure, as is consistent with other growth-related findings (Martin et al. 2018; McCann 2016). In contrast, in the post-crisis period, the economic prosperity of the city, as measured by GDP per capita, appears to be the single most important, and also the only real, explanator of lower year-by-city risk premia. Rather than any scale-related impacts, in the UK the apparent sudden 'flight to safety' of capital appears to be almost entirely to places that are already more prosperous, irrespective of size.

In order to assess whether this prosperity effect is in reality a London effect, we repeat exactly the same two-stage exercise, but this time after excluding all London investments.

The first- and second-stage regression results for investments outside of London are almost identical to those for the whole sample including London. From Table 4 we see that after excluding London, the drivers of year-by-city risk premia remain almost exactly the same as when London was included in the sample, with almost all of the explanatory power other than that of annual market-wide risks being related to the prosperity, the GDP per capita of the city. One difference is that the risk premia associated with being located in a CBD commercial cluster is now some 50 basis points below a non-CBD location, rather than 80 basis points lower, as was the case when London was included in the sample[8]. However, the one real notable change here is that the estimated coefficient for the post-crisis effect of GDP per capita in lowering risk premia falls by 30% when London is excluded from the sample.

[8] As with the case above when London was included in the sample, when London is excluded from the sample, the city-level risk premia from equation (5) follow a normal distribution. Appendix Figure A.4 depicts reports the scatterplot annual distribution of the estimated year-by-city risk premia after excluding London, and Figure A.5 depicts the trends in year-by-city risk premia after excluding London. Comparing Figures A.4 with Figure A.2 we see that the distribution of year-by-city effects remains largely unchanged after excluding London. Meanwhile, comparing Figure A.5 with Figure A.3 shows that the trend in year-by-city effects also remains largely unchanged, except for the fact that the levels are somewhat higher after excluding London.

Table 3. First-Stage Estimation (Excluding London).

	Full-period
Square feet (log)	0.083*** (0.027)
CBD cluster	-0.478*** (0.059)
Constant	0.735 (0.523)
Property type controls	Yes
Year-by-city fixed effects	Yes
Observations	3,734
Adjusted R^2	0.683

Notes: Dependent variable is deal-level risk premium in levels for individual properties. City-level clustered standard errors are in parentheses. *, **, *** Significance at 10%, 5%, and 1%, respectively.

Table 4. Second-Stage Regressions (Excluding London).

	Full-Period	Crisis Shock	
		Pre-Crisis	Post-Crisis
	(1)	(2)	(3)
Rank (log)	-0.016 (0.084)	0.021 (0.051)	-0.042 (0.084)
GDP per capita (log)	-0.445** (0.337)	-0.047 (0.206)	-0.769** (0.337)
Sectoral specialization	-0.006 (0.109)	0.028 (0.052)	-0.047 (0.109)
Sectoral diversity	-0.005 (0.012)	-0.008 (0.010)	-0.004 (0.012)
Governance score (EQI)	-0.028 (0.396)	0.064 (0.231)	-0.114 (0.396)
Undevelopable land (%)	0.004* (0.004)	0.004* (0.002)	0.004 (0.004)
Year fixed effects	Yes	Yes	Yes
Observations	497	237	260
Adjusted R^2	0.839	0.742	0.856

Notes: Dependent variable is estimated year-by-city risk premium in levels. City-level clustered standard errors are in parentheses. *, **, *** Significance at 10%, 5%, and 1%, respectively.

To now examine the role of different types of places from a perspective that more closely aligns with how investors tend to examine very specific localities as well as their performance relative to how the market moves as a whole, we now turn to Table 5.

Table 5 reports the model estimations for beta from the full period, and these indicate that the full period beta is not systematically related to any of the key explanatory variables or city characteristics. However, we are able to use the estimated beta for the full period to understand the pre-crisis to post-crisis shift in investor sentiment regarding different types of places by examining the observed CAPM residuals after inserting the estimated full-period beta back into the CAPM equation.

Tables 6 and 7 report the estimations of the CAPM risk residuals, for the pre-crisis and post-crisis periods, respectively. These residuals reflect the differences between the observed CAPM risk premia and what would be expected on the basis of the CAPM equation as calculated with the estimated beta values inserted. This then captures risks that are unique to particular places. We break these risks down according to types of places in which investment takes place, namely city centre CBDs, any other scattered or less clustered locations within cities, and for cities as a whole.

Table 5. Regressions of Full-Period CAPM Beta Values.

	Within-City Localities		Cities
	CBD Clusters	Rest of the City	
	(1)	(2)	(3)
Rank (log)	0.264 (0.203)	0.121 (0.077)	0.076 (0.069)
GDP per capita (log)	0.059 (0.625)	-0.321 (0.322)	-0.446 (0.287)
Sectoral specialization	0.239 (0.380)	0.038 (0.100)	0.042 (0.089)
Sectoral diversity	0.047 (0.082)	-0.016 (0.018)	-0.016 (0.016)
Governance score (EQI)	-0.740 (1.229)	-0.246 (0.391)	-0.377 (0.349)
Undevelopable land (%)	-0.014 (0.015)	-0.004 (0.004)	-0.002 (0.004)
Constant	0.210 (6.755)	4.341 (3.376)	5.866* (3.013)
Observations	40	44	44
Adjusted R^2	-0.048	-0.027	0.024

Notes: Dependent variable is full-period beta. *, **, *** Significance at 10%, 5%, and 1%, respectively.

Table 6. Regressions of Pre-Crisis CAPM Residuals.

	Within-City Localities		Cities
	CBD Clusters	Rest of the City	
	(1)	(2)	(3)
Rank (log)	0.212* (0.060)	-0.145** (0.064)	-0.027 (0.060)
GDP per capita (log)	0.023 (0.256)	0.484* (0.273)	0.506** (0.256)
Sectoral specialization	-0.016 (0.067)	-0.025 (0.071)	-0.033 (0.067)
Sectoral diversity	0.028 (0.014)	-0.001 (0.015)	0.009 (0.014)
Governance score (EQI)	-0.761 (0.305)	0.369 (0.325)	0.415 (0.305)
Undevelopable land (%)	-0.006 (0.003)	0.008** (0.004)	0.004 (0.003)
Constant	-0.724 (2.674)	-4.974* (2.853)	-5.636** (2.674)
Year fixed effects	Yes	Yes	Yes
Observations	155	249	249
Adjusted R^2	-0.003	0.057	0.038

Notes: Dependent variable is the year-specific CAPM residual at the locality- or city-level as observed within the 2003-2008 time-window. *, **, *** Significance at 10%, 5%, and 1%, respectively.

Table 7. Regressions of Post-Crisis CAPM Residuals.

	Within-City Localities		Cities
	CBD Clusters	Rest of the City	
	(1)	(2)	(3)
Rank (log)	0.120 (0.108)	-0.289** (0.117)	-0.042 (0.108)
GDP per capita (log)	-1.953** (0.441)	0.102 (0.484)	0.372 (0.441)
Sectoral specialization	-0.172 (0.137)	-0.079 (0.150)	-0.103 (0.137)
Sectoral diversity	-0.035 (0.018)	-0.006 (0.020)	0.003 (0.018)
Governance score (EQI)	0.066 (0.566)	0.332 (0.620)	0.956* (0.566)
Undevelopable land (%)	0.009 (0.006)	0.012* (0.007)	0.003 (0.006)
Constant	20.604** (4.605)	0.015 (5.045)	-4.010 (4.605)
Year fixed effects	Yes	Yes	Yes
Observations	169	272	275
Adjusted R^2	0.009	0.021	0.014

Notes: Dependent variable is the year-specific CAPM residual at the locality- or city-level as observed within the 2009-2015 time-window. *, **, *** Significance at 10%, 5%, and 1%, respectively.

If we compare Tables 6 and 7, what we see is that the most marked implication of the sudden shift in investor sentiment between the pre-crisis and the post-crisis periods was in favour of the central business districts of the already-prosperous cities, as reflected in the large and statistically significant negative risk premium with respect to the city GDP per capita. The 'flight to safety' of capital appears to be in search of city centre investment locations in prosperous cities, independent of their size.

In order to check whether the very marked post-crisis falls in the CAPM risk premium in favour of CBD commercial clusters is primarily or solely a London-specific effect, we repeat exactly the same exercise as reported in Tables 5, 6 and 7, but this time after excluding London. The results are reported in Tables 8, 9 and 10. Table 8 confirms again that outside of London, there is no systematic relationship between the beta value and the characteristics of a city. Moreover, Tables 9 and 10 also demonstrate that outside of London, in the aftermath of the 2008 crisis, there was no change in the relationships between CAPM risk premia and different types of places. In other words, all of the UK-wide risk premia changes highlighted in Tables 6 and 7 are associated with falling risk premia in London.

Table 8. Regressions of Full-Period CAPM Beta Values (Excluding London).

	Within-City Localities		Cities
	CBD Clusters	Rest of the City	
	(1)	(2)	(3)
Rank (log)	-0.077 (0.377)	0.180^{**} (0.086)	0.133^{*} (0.076)
GDP per capita (log)	1.585 (1.561)	-0.530 (0.348)	-0.646^{**} (0.309)
Sectoral specialization	0.040 (0.414)	0.030 (0.099)	0.034 (0.088)
Sectoral diversity	0.103 (0.096)	-0.015 (0.018)	-0.016 (0.016)
Governance score (EQI)	-1.172 (1.260)	-0.107 (0.397)	-0.244 (0.353)
Undevelopable land (%)	-0.008 (0.015)	-0.005 (0.004)	-0.002 (0.004)
Constant	-14.925 (15.696)	6.263^{*} (3.580)	7.703^{**} (3.181)
Observations	28	43	43
Adjusted R^2	-0.094	0.025	0.080

Notes: Dependent variable is full-period beta. *, **, *** Significance at 10%, 5%, and 1%, respectively.

Table 9. Regressions of Pre-Crisis CAPM Residuals (Excluding London).

	Within-City Localities		Cities
	CBD Clusters	Rest of the City	
	(1)	(2)	(3)
Rank (log)	0.442^{**} (0.069)	-0.245^{***} (0.073)	-0.119^{*} (0.069)
GDP per capita (log)	-0.981 (0.283)	0.846^{***} (0.302)	0.843^{***} (0.283)
Sectoral specialization	0.049 (0.067)	-0.013 (0.071)	-0.022 (0.067)
Sectoral diversity	0.009 (0.014)	0.000 (0.015)	0.010 (0.014)
Governance score (EQI)	-0.407 (0.313)	0.139 (0.334)	0.200 (0.313)
Undevelopable land (%)	-0.009 (0.003)	0.009^{**} (0.004)	0.005 (0.003)
Constant	9.045 (2.889)	-8.320^{***} (3.085)	-8.760^{***} (2.889)
Year fixed effects	Yes	Yes	Yes
Observations	117	243	243
Adjusted R^2	0.028	0.086	0.062

Notes: Dependent variable is the year-specific CAPM residual at the locality- or city-level as observed within the 2003-2008 time-window. *, **, *** Significance at 10%, 5%, and 1%, respectively.

Table 10. Regressions of Post-Crisis CAPM Residuals (Excluding London).

	Within-City Localities		Cities
	CBD Clusters	Rest of the City	
	(1)	(2)	(3)
Rank (log)	0.196 (0.119)	-0.586*** (0.132)	-0.354*** (0.119)
GDP per capita (log)	-2.272 (0.475)	1.193** (0.529)	1.496*** (0.475)
Sectoral specialization	-0.139 (0.132)	-0.090 (0.146)	-0.115 (0.132)
Sectoral diversity	-0.038 (0.017)	-0.008 (0.019)	0.002 (0.017)
Governance score (EQI)	0.239 (0.563)	-0.417 (0.626)	0.189 (0.563)
Undevelopable land (%)	0.009 (0.006)	0.016** (0.006)	0.007 (0.006)
Constant	23.486 (4.844)	-9.984* (5.384)	-14.314*** (4.844)
Year fixed effects	Yes	Yes	Yes
Observations	124	265	268
Adjusted R^2	-0.060	0.077	0.064

Notes: Dependent variable is the year-specific CAPM residual at the locality- or city-level as observed within the 2009-2015 time-window. *, **, *** Significance at 10%, 5%, and 1%, respectively.

As a final check on our data and results we also estimate a differences-in-differences model, observing in particular the CBD treatment effects. The results for the whole UK sample are given in the Appendix in Table A.1 and the results for the rest of the UK after excluding London are given in Table A.2. The trends of the CBD treatment effects for the whole of the UK and also for outside of London after excluding London from the data, are given in the Appendix A.4 in Figures A.6a and A.6b, respectively.

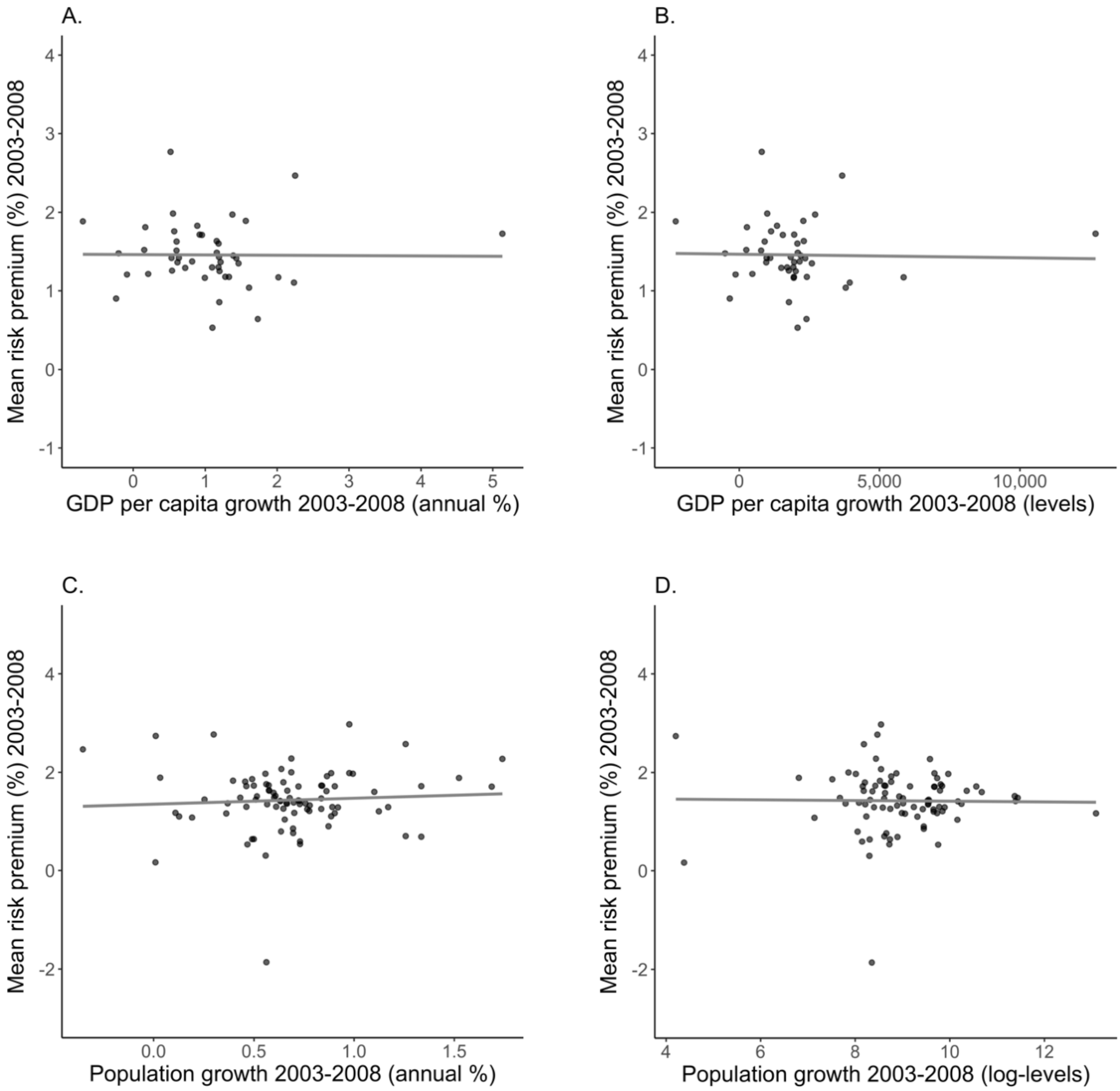
Again, the differences-in-differences approach confirms that the risk premia associated with CBD locations fall dramatically in the wake of the 2008 crisis, this effect is almost entirely a London-specific phenomenon. For the rest of the UK, there is no systematical fall in the perceived investment risk of city centre locations. Indeed, if anything, the risks of CBD locations outside of London have increased post-crisis. Allied with the fact that, outside of London, there are also no scale-related effects or structure-related effects on risk premia, our results suggest that there are no UK-wide risk-reduction features of agglomeration economies. This may well be the financial analogue of the fact that outside of London, there are also no UK scale-productivity effects (McCann and Yuan 2022) or structure-productivity effects (Martin et al. 2018, McCann 2016) of agglomeration.

6. Discussion

In order to succinctly synthesise and summarise all of our findings, the best way to depict the insights arising from this exercise is to consider Figures 11(a) to (d) and 12(a) to (d). Figure 11 plots the pre-crisis relationships between the local mean risk premia and the local regional productivity and population growth rates. Figure 12 plots the relationships between the pre-crisis and post-crisis change in mean risk premia across UK cities and functional urban areas and the consequent productivity and population growth rates in the post-crisis period.

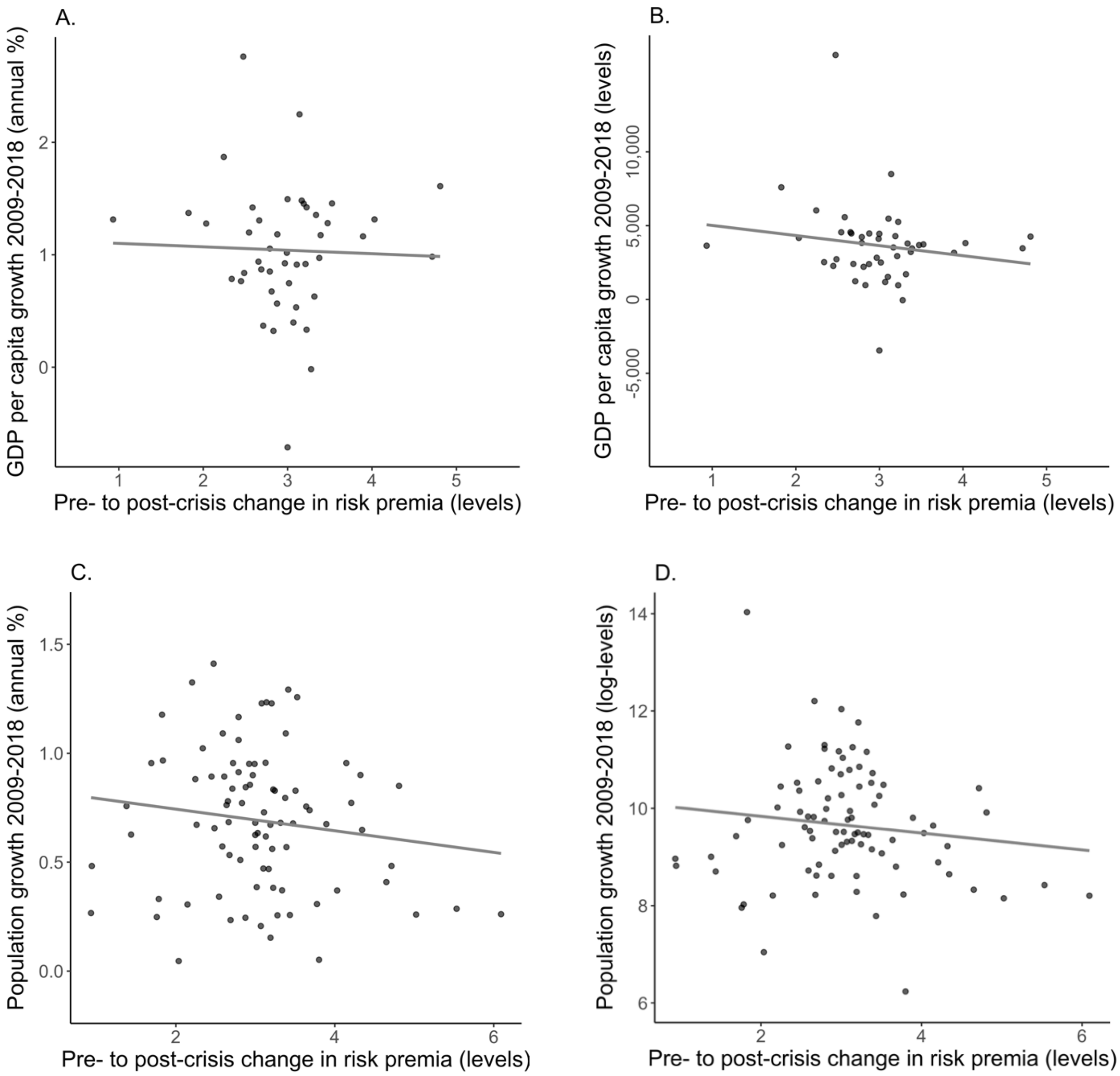
As we see in Figure 11, during the pre-crisis period 2003-2008, there was no more than the mildest relationship between the mean risk premia and annual regional productivity growth, either in annualised growth rates or in levels. Nor was there any real relationship between mean risk premia and regional population growth rates in levels, although there was a slight positive relationship with annualised population growth rates. This pre-crisis period saw the population resurgence of many economically weaker regions (McCann 2016), especially larger cities, a period also characterised by yield compression between the weakest and strongest localities, as observed in Figures 9 and 10 as well as Figures A.3, A.4 and A.9 in the Appendix.

Figure 11. Pre-Crisis City-Level Relationships Between Risk Premia and GPD Per Capita Growth as well as Population Growth.



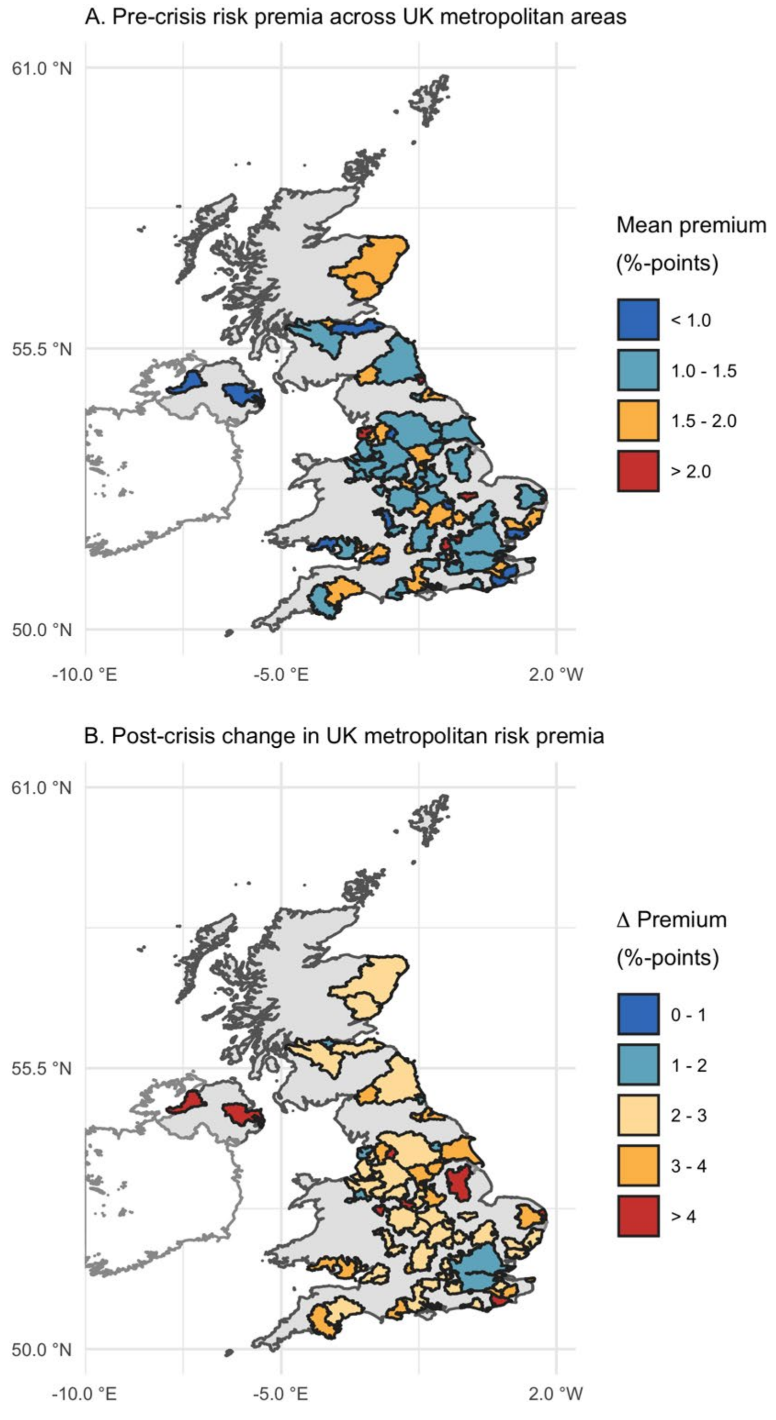
As we see in Figure 12, however, during the post-crisis period 2009-2015, the cities and functional urban areas that experienced the largest increases in mean risk premia between the pre-crisis and the post-crisis eras also experienced slower post-crisis productivity growth and population growth. This is the case irrespective of whether growth is calculated in terms of annualised rates or in levels.

Figure 12. Post-Crisis City-Level Relationships Between Risk Premia and GPD Per Capita Growth as well as Population Growth.



Higher local risk premia and lower credit inflows in economically weaker regions are also associated with weaker local collateral positions. Each of these features adversely affects local and regional investment trajectories. Meanwhile, lower regional risk premia and increased capital inflows imply that credit availability and credit pricing in London becomes more favourable relative to other regions. The collateral positions of real estate owners in London also consequently improve (Advani et al. 2020; D'Arcy 2018; *The Times* 2022). This is important because real estate also serves as collateral to secure other types of business and investment loans. Through this 'collateral channel', the value of real estate is closely intertwined with broader levels of firm investment, and also entrepreneurship and new firm formation (Black et al. 1996) as well as bank balance sheets and lending (Minsky 1964; Gan 2007; Chaney, Sraer, and Thesmar 2012; Liu, Wang, and Zha 2013). These changes in regional risk premia impact directly on local investment flows and consequently also on local and regional economic growth. Importantly for our purposes, these adverse capital shocks displayed a very clear core-periphery geographical logic to them. The actual spatial distribution of these patterns is depicted in Figures 13.

Figure 13. Maps of UK Regional Mean Risk Premia and their Pre- to Post-Crisis Change.



From Figure 13a we see that during the pre-crisis period of the 2000s, there was only a mild core-periphery structure of risk premia across UK regions with respect to London. London exhibited the lowest risk premia, followed by parts of the South East and East along with different parts of the Midlands, the North and Scotland. However, the picture across the UK was something a patchwork with no discernible features. In marked contrast, however, during the post-crisis period, as we see in Figure 13b, the change in risk premia heavily favoured London over all other regions. This led to a core-periphery capital market partitioning across the UK's economic geography whereby the rest of the UK regions face more adverse capital pricing regimes than London. In particular, the more remote regions tend to exhibit the greatest increases in risk premia. As such, the post-crisis core-periphery capital market partitioning overlaid and then amplified the pre-existing core-periphery regional productivity patterns.

These observations reflect relative shifts in what Bernanke (2022) calls the 'external finance premium', namely the differences in perceived risk in different contexts, over and above official discount rates. The analysis and explanation put forward here therefore offers the possibility for a deeper understanding of how macroeconomic policy, and in particular, monetary policy decisions, impact on regions. The post-crisis era was a period of unprecedented quantitative easing and low interest rates, but our analysis suggests that this gained little, if any, real traction in the UK's economically weaker regions.

7. Conclusions

The findings in this paper provide a new explanation as to why the UK regional productivity gaps have accelerated in recent years. Our argument is that the capital shocks wrought by the 2008 global financial crisis, of which a 'flight to safety' in central London was a key feature, have altered the relative investment attractiveness of different places in a manner which is systematically unfavourable to the economically weaker regions. The sudden and dramatic regime change in capital markets associated with the 2008 global financial markets profoundly altered investors' sentiments from viewing all UK regions pre-crisis as being little different from each other in terms of their investment attractiveness, to a post-crisis reality where London was perceived of as providing a fundamentally different financial and investment offering to the rest of the UK. The factors that shape the 'external finance premium' (Bernanke 2022), which in this case reflects the differences in perceived risk in different UK regions, over and above official discount rates, are likely to include the UK's monocentric economic geography, its asymmetric regional responses to globalisation, and the UK's over-centralised governance, institutional (McCann 2016) and financial system (Mayer et al. 2021). All of these aspects combine in the minds of investors to provide confidence that whatever the circumstances, the performance of the London's economy will be prioritised and protected by the UK state (McCann 2023). However, in terms of interregional divergence, when taken together, the increased post-crisis local capital availability and lower local capital costs identified in this paper, along with the improved local collateral positions, all appear to have combined to spur the wider London economy post-crisis relative to other UK regions. In contrast, the post-crisis local capital withdrawal and higher local capital pricing in other UK regions observed in this paper, allied with the weaker local collateral positions, all serve to have weakened the other regional economies. In more recent years, the effects of Brexit, the formation of the city-region mayoral combined authorities, and the Covid-19 lockdown are all likely to have reshaped risk-perceptions, and these are areas for further research. However, on the basis of our evidence here, it is clear that the UK core-periphery regional divide in recent years is a result of profound and asymmetric regional capital shocks, which operated over and above any other forces (McCann 2016) driving regional divergence during the post-crisis years.

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Appendices

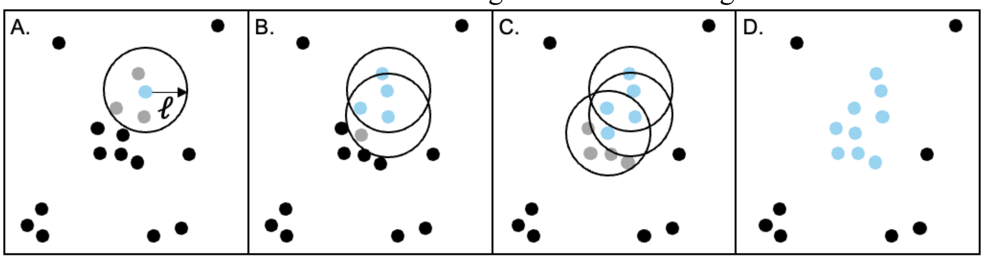
Appendix A.1 – Clustering Algorithm

Our definition of local commercial or industrial clusters is based on the leading established density-based algorithm (Ester et al. 1996) in terms of its ability to detect spatial patterns of any shape and size (Rozenfeld et al. 2011; Wiwie, Baumbach and Röttger 2015). Clustering outcomes for the locations of real estate investments are obtained from varied parameter values and validated using the silhouette metric, which regards cluster compaction and spatial separation (Rousseeuw 1987). This allows for relatively dense clusters to be obtained across cities whose growth has been shaped differently by centripetal and centrifugal forces. The algorithm is discriminative, in that not all observed real estate assets are partitioned into clusters. Those assets that are isolated in space are recognized accordingly, such that clusters representing Central Business Districts (CBDs) or central sub-centers can be clearly discerned.

The algorithm for defining local clusters uses an iterative process. Within an observed city, a first cluster is initiated in the point-location for a randomly selected real estate asset in our investment data which meets the threshold criterion for cluster assignment. The criterion is that the number of investments surrounding the observed asset's address-location, within a circle of radius ℓ, equals or exceeds a threshold cluster size θ (in absence of theoretical guidance, following Esther et al. 1996 initially $\theta = 4$ as per convention for two-dimensional data such as our coordinate-based data). After the first cluster-point has been obtained, the algorithm expands the cluster by including those observations which are within the circle surrounding the starting observation. This process is then iterated for the observations that were added to the cluster, until at the cluster's outer observations no other observations are found within radius ℓ. Once an individual cluster is obtained in full, the algorithm repeats the same process for the remainder of the real estate investments in the observed city to obtain any further clusters.

These steps in the clustering process are illustrated in Figure A1. After in a given city, all clusters within have been defined, remaining investments that are relatively isolated in space are classified as 'non-clustered', instead of forcing also these observations into clusters as conventional clustering algorithms would do. This implies that areas which investors might evaluate but where investment activity is low may be lesser captured by cluster boundaries, whereas local industrial concentrations such as CBDs and sub-centers within broader CBD area are reflected more elegantly. Given these properties of the algorithm the final number of resultant clusters in a city needs not be estimated a priori but follows from local investment densities and parameter values in the clustering algorithm.

Figure A.1 Schematic Visualization of the Algorithm for Defining Local Industrial Clusters.



In Panel (a), a random investment asset's point location, which necessarily meets the criterion that the number of assets within radius ℓ equals or exceeds the threshold cluster size θ, is selected to initiate a cluster. Subsequently, the cluster is iteratively expanded as to include any further 'density-connected' assets (Panels b-c) and so obtain the cluster in full (Panel d).

In applying the clustering algorithm to our data on real estate investment locations, we consider that cities may have been shaped differently by centripetal and centrifugal forces or any mix thereof, as may originate from market forces, policy-making in different jurisdictions, or physical land cover, as related to the spatial allocation and density of land use or land use mix. As such, the shape and size of what constitutes a cluster may vary by city. To account for this at the city-level, for each city, we obtain separate sets of clusters based on clustering radii ℓ that vary between 100 and 1,000 meters, at 50-meter increments. The initial minimum cluster size, in turn, is allowed to vary with the expected number of investments to be observed within a given radius ℓ if all investments were not clustered at all, that is, if they were distributed across space evenly within the spatial extent of the city's real estate market. From the resultant sets of clusters for each city, the set to be observed in the main analysis is selected by cluster validation.

Cluster validation here is based on the silhouette score metric, which considers cluster compaction and coherence and performs well in the presence of non-clustered observations (Wiwie, Baumbach, and Röttger 2015), which is a natural feature of urban real estate markets. The silhouette score for individual investment observation i can be written as (Rousseeuw 1987):

$$s(i) = \frac{b(i) - a(i)}{\max\{a(i),\ b(i)\}} \tag{A.1}$$

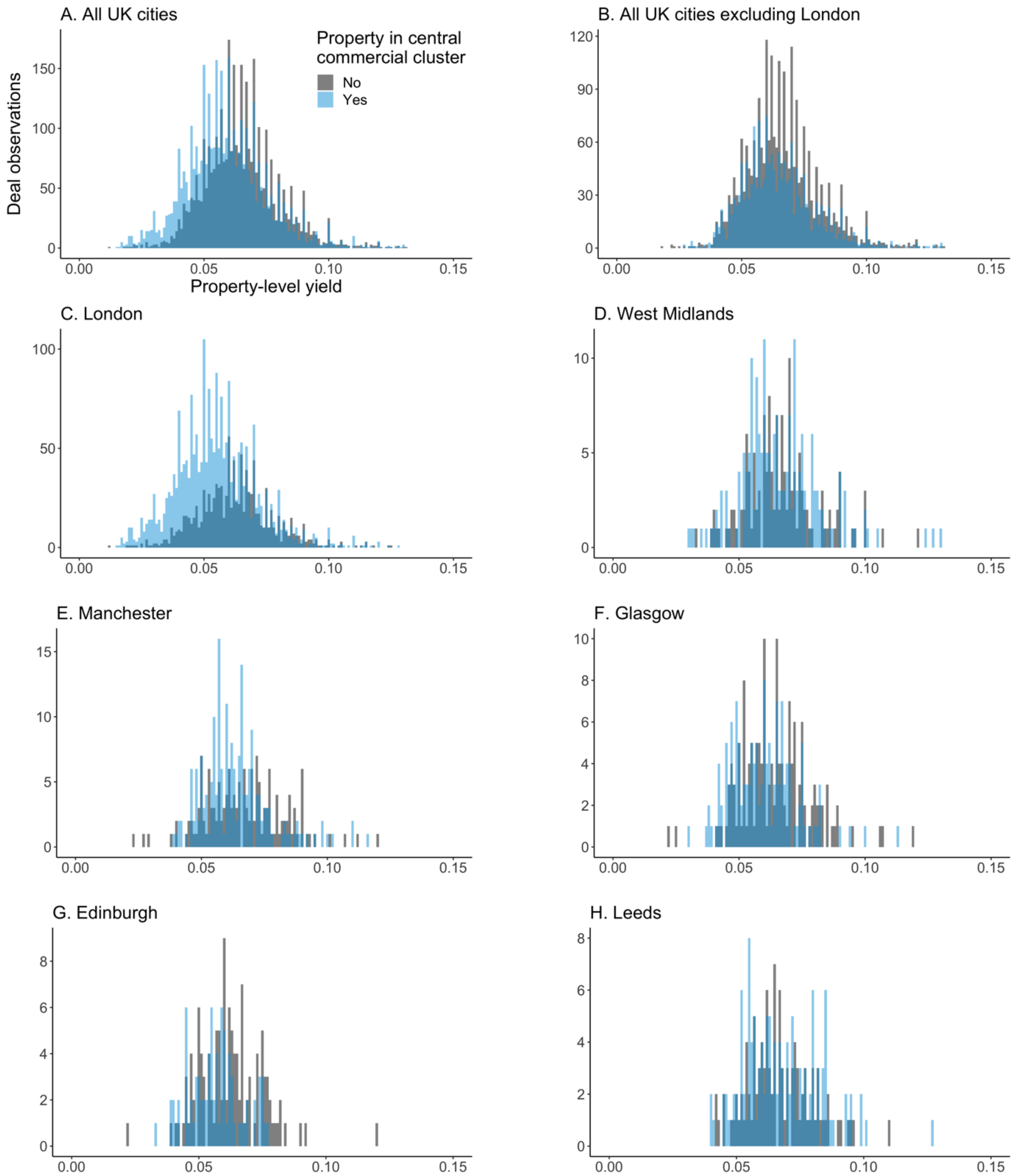
where $a(i)$ denotes the average distance of investment i to the other investments in the same cluster and $b(i)$ gives the average distance of investment i to the nearest cluster. Following the suggestion by Rousseeuw (1987), silhouette scores for non-clustered investments are set to zero as this is most neutral value in our type of clustering approach. We then select the set of clusters that maximizes the silhouette scores, as calculated per equation (A.1), after averaging these at the city-level.

To further account for city geography, separately from the clusters which already implicitly pick up underlying land-use structures at the below-city scale, we follow Saiz (2010) in calculating the share of undevelopable land at the city-level. First, we define the population-weighted centroid of each FUA using 2015 gridded information about population in 1x1 km^2 grid cells as captured by the European Commission's Global Human Settlement Layer. Subsequently, surrounding each city's centre we generate a buffer with a 50-kilometer radius. For each buffer, the area covered by sea is calculated.

Appendix A.2 –UK City Yields Distributions Inside and Outside of Local Commercial Clusters

Figures A.2, Panels A to T, show yield distributions for all cities, as well as all cities excluding London and subsequently individual cities, that have CBD clusters.

Figure A.2 Yield distributions inside and outside local commercial clusters in UK cities.



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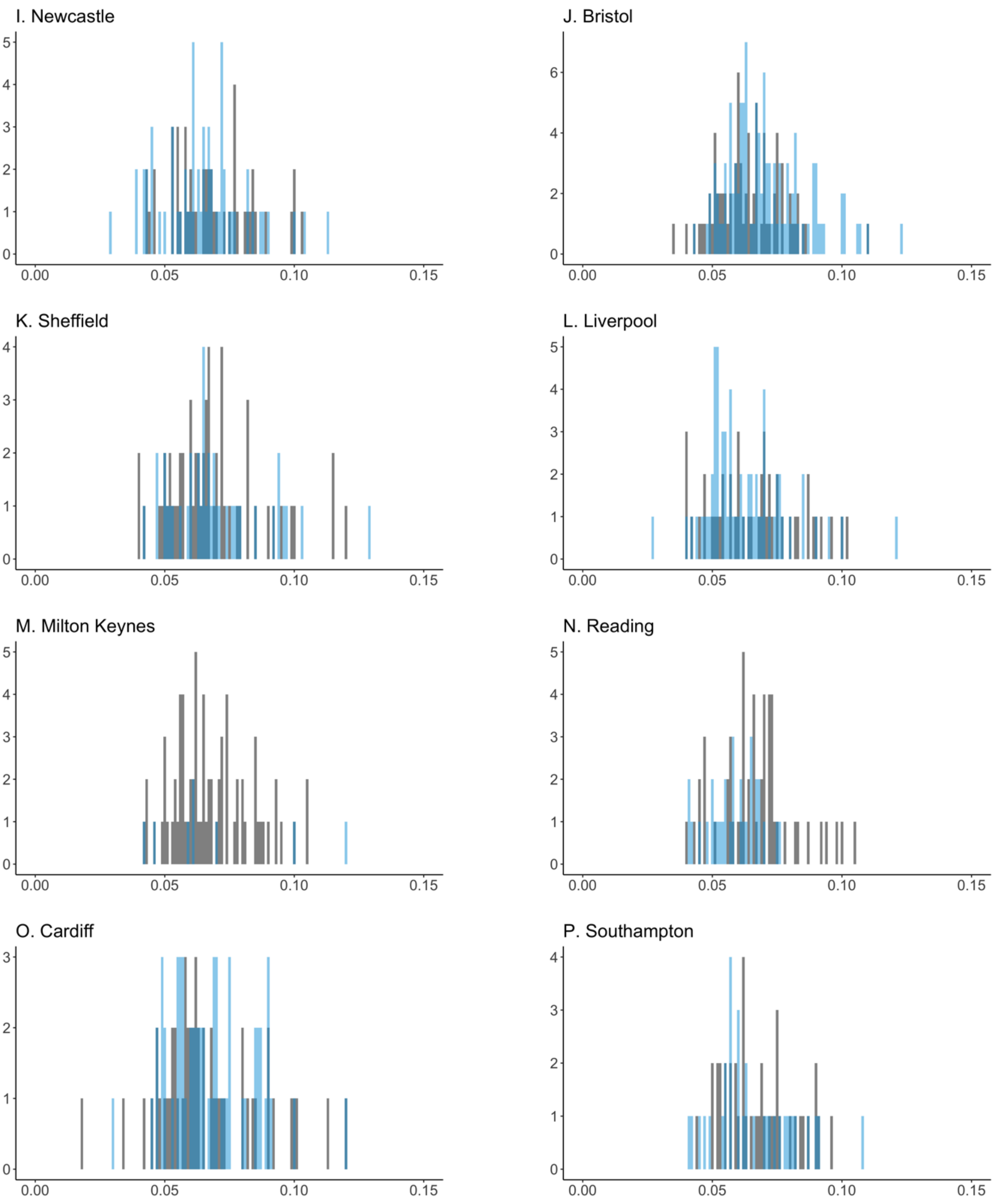

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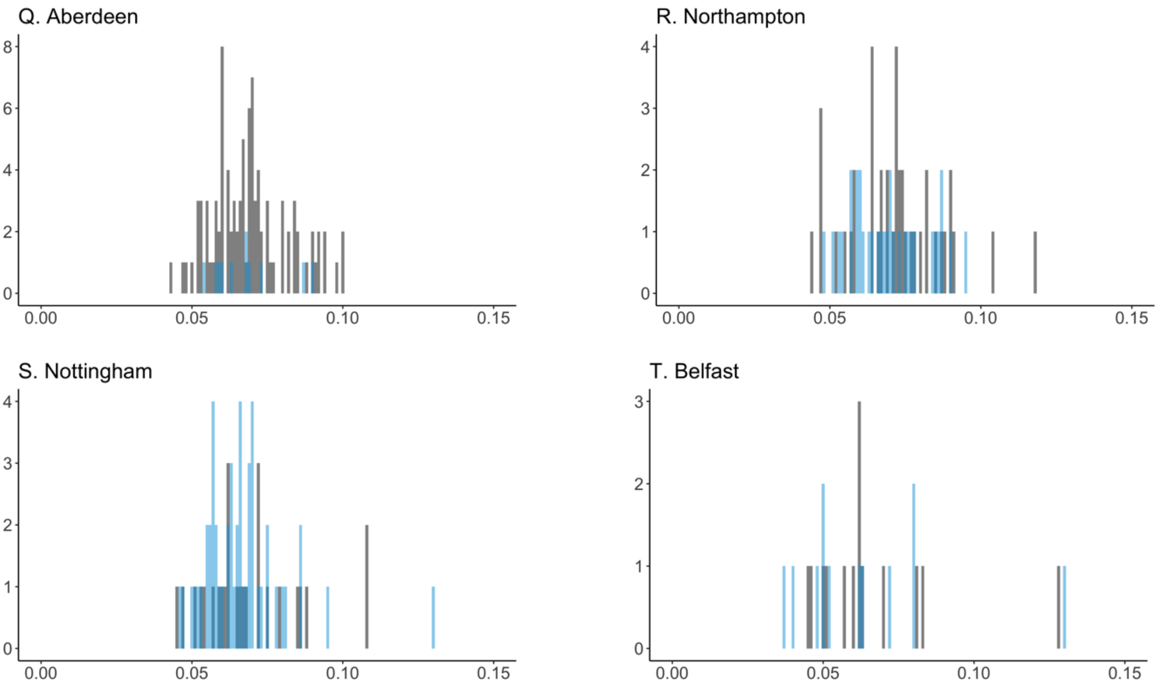
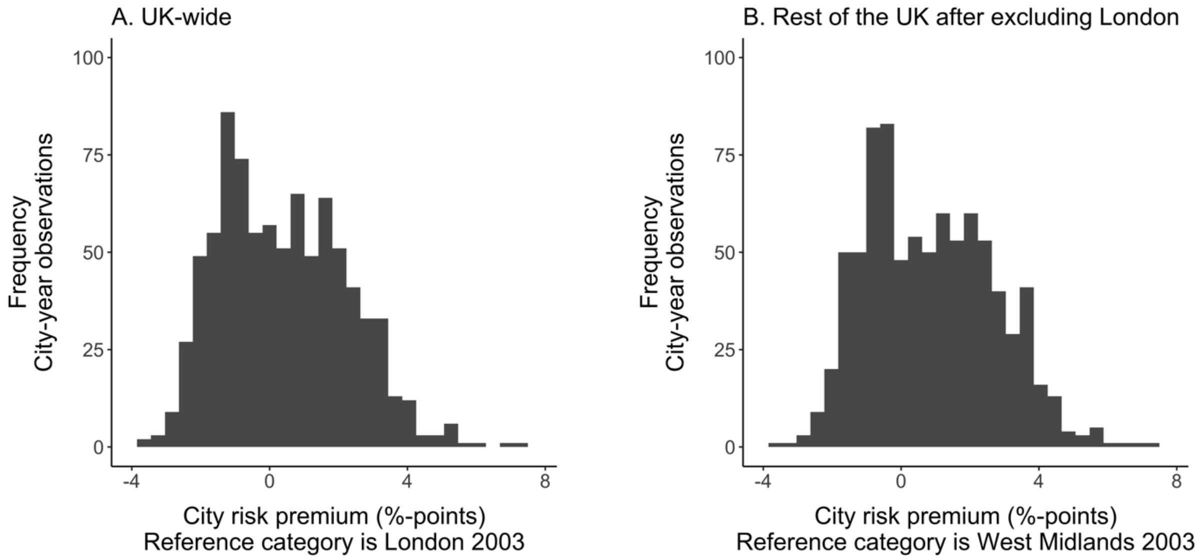


Appendix A.3 – Year-by-City Risk Premia for the Two-Stage Estimation

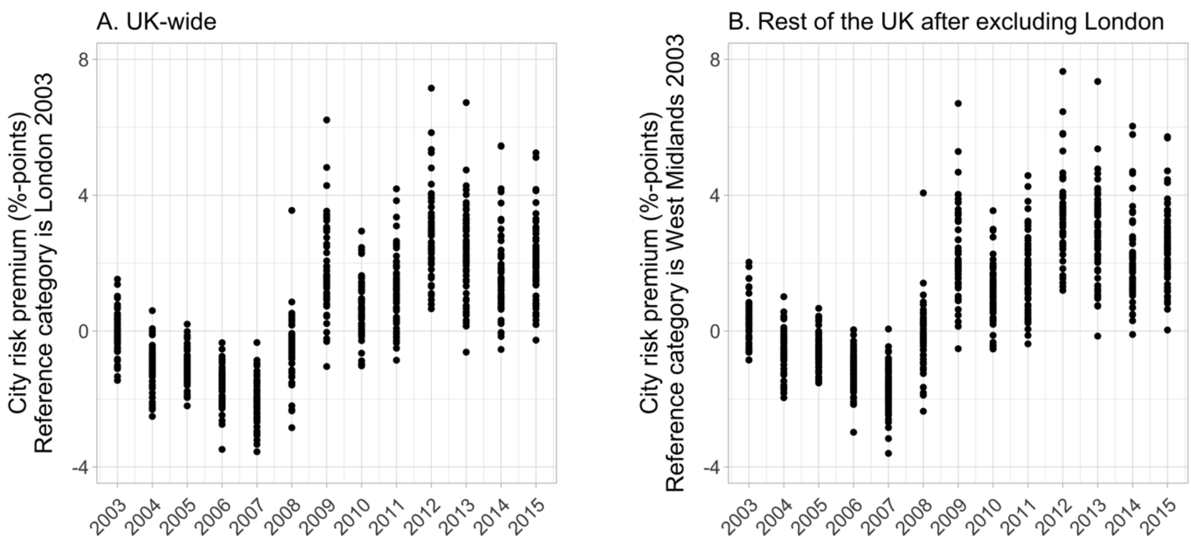
Figure A.3 depicts the scatterplot distributions of the year-by-city risk premia from Equation (5) for the whole UK sample, in Panel A, and for the sample of the rest of the UK after excluding London in Panel B.

Figure A.3. The Estimated Year-By-City Risk Premia.



The sudden and persistent shock in UK city risk premia over time is clearly evident in Figure A.4, Panels A and B, as is the widening of the dispersion of the year-by-city risk premia during the post-crisis years.

Figure A.4. Trends in the Estimated Year-By-City Risk Premia.



Appendix A.4 – City-Level CAPM and Scale Relationships

Figures A.5 and A.6 depict CAPM and risk-scale relationships, respectively, at the city-level.

Figure A.5. Pre-Crisis and Post-Crisis CAPM Relationships in Cities.

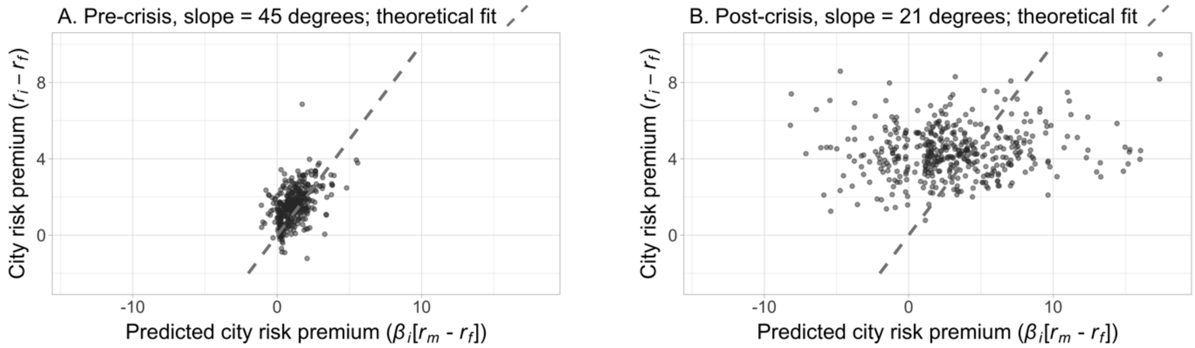
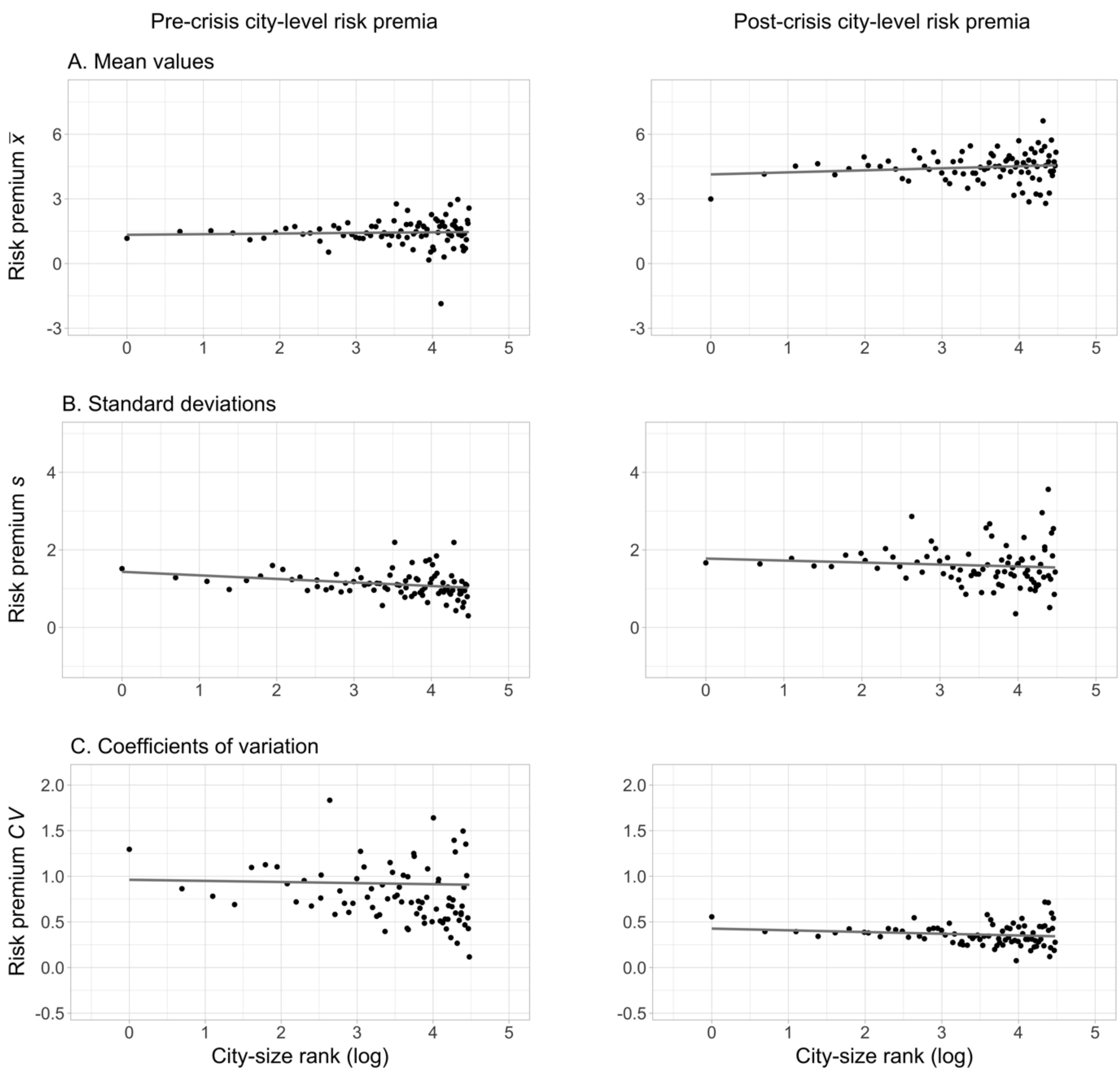


Figure A.6. Pre- and Post-Crisis City-Scale Relationships.



Appendix A.5 –Scale Relationships Excluding the London Clusters and Metropolitan Area

Figures A.7 and A.8 show cluster-level and city-level scale relationships with mean risk premia for the pre-crisis and post-crisis periods while excluding all investments into London. This means that the Manchester clusters are now shown at the top (most left) of the city-size rank order depicted in Figure A.7, and that Manchester is the first city shown in Figure A.8.

Outside of London's CBD clusters, the shock is mostly a levels effect of about 250-300 basis points (Figure A.7). There is some very subtle rotation of the curvature as well, suggesting slightly higher investment risks down the urban hierarchy. This slight curvature persists when omitting the clusters in, incrementally, each of the top-10 largest UK cities.

Figure A.7. Cluster-Scale Relationships, Pre- and Post-Crisis while Excluding London.

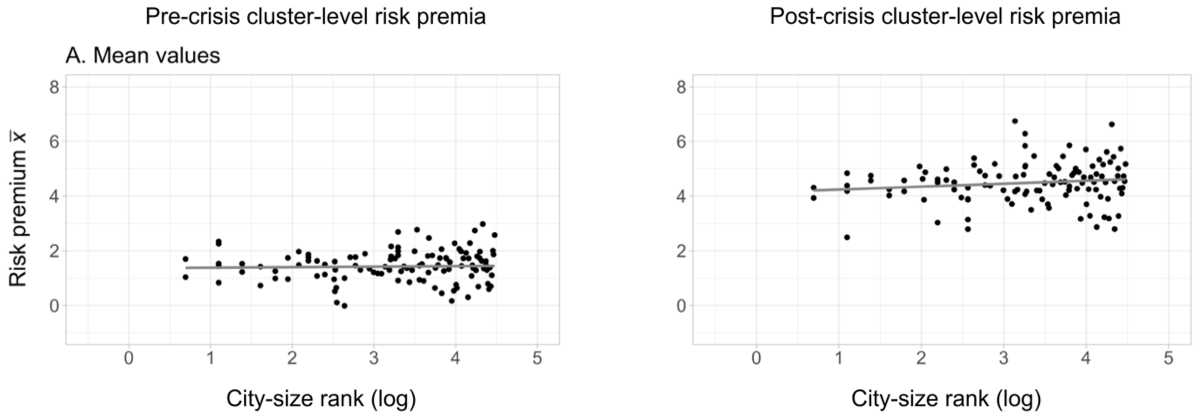
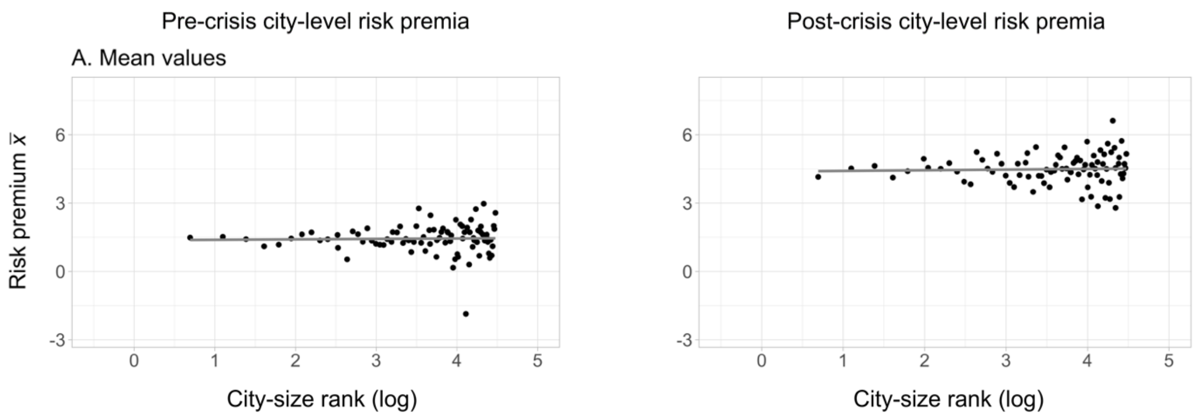


Figure A.8, which is city-level, and so also reflects the risk pricing of investments outside of city centres, more purely shows a levels effect of approximately 300 basis points. The risk premium of the UK's second city, Manchester, may be noted to have fallen very subtly by a few basis points relative to the rest of the cities in the top of the urban size hierarchy, which mostly remain in similar positions relative to each other. This is likely to reflect the early stages of the city-region combined authority programme which began in 2011, which was intended to build confidence with potential investors by designing and delivering policies at scale and with long time-horizons. The real progress of the city-region combined authority programme was from 2017 onwards, with the election of Mayor. The mayoral-led model has now become the blueprint for many other areas.

Figure A.8. City-Scale Relationships, Pre- and Post-Crisis while Excluding London.



Appendix A.6 – Differences-In-Differences Estimation

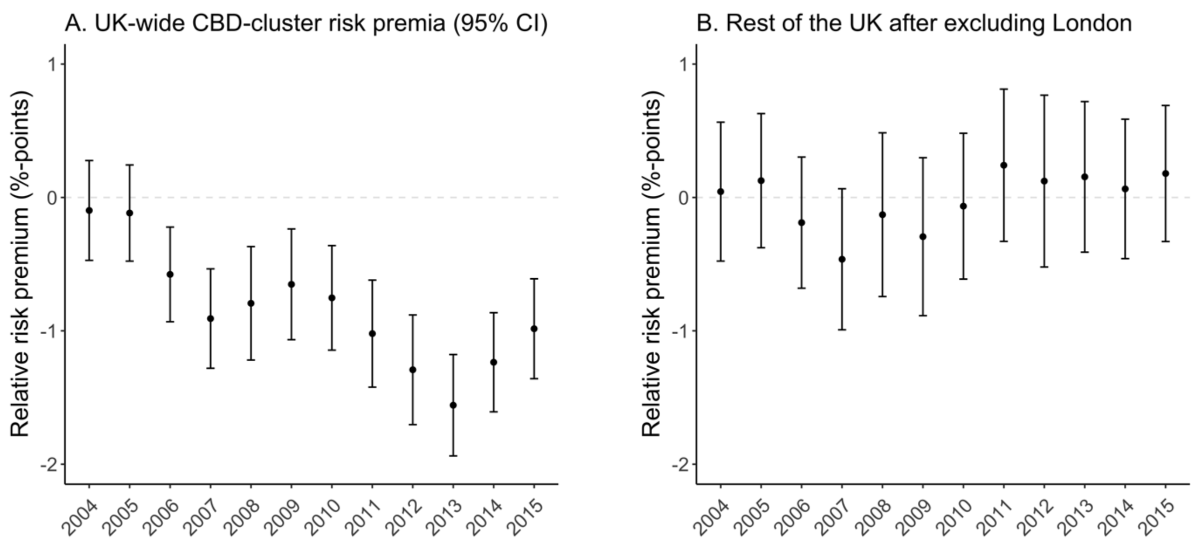
As a final check on our data and results we estimate a differences-in-differences model using a CBD treatment. The baseline model can be written as:

$$E(R_{it}) - R_{ft} = CBD_{it} + PostCrisis_{it} + \underbrace{CBD_{it} x\ PostCrisis_{it}}_{CBD\ Shock_{it}} + \delta_t + \varepsilon_{it} \quad \text{(A.1)}$$

where $E(R_{it}) - R_{ft}$ denotes the risk premium for the *i*th individual investment in year *t*; CBD_{it} captures whether the location of investment is within a CBD; $PostCrisis_{it}$ indicates transaction during the post-crisis period; $CBD_{it} x\ PostCrisis_{it}$ is the difference-in-differences indicator that captures the post-crisis CBD shock; and δ_t is a vector of dummies for year of transaction.

The results for the whole UK sample are given in Table A.1, Panel A, and the results for the rest of the UK after excluding London are given in Table A.1, Panel B.

Figure A.9. Estimated CBD-cluster treatment effects on risk premia broken down by year derived from Differences-in-Differences models as estimated following Equation A.1.



For the whole UK-wide sample, as we see in Figure A.9a, there is a strong pro-CBD effects in the aftermath of the 2008 global financial crisis, whereby relative risk premia for CBD locations fall dramatically. However, this effect is almost entirely a London-specific phenomenon. For the rest of the UK, after removing London from the data, as we see in Figure A.9b, there is no systematical fall in the perceived investment risk of city centre locations. Indeed, if anything, the risks of CBD locations outside of London have increased post-crisis.

Table A.1 Results for Difference-in-Differences regression models of property-level risk premia.

	Baseline	Property Controls	City Features	City Features *x* Post	City Features *x* CBD Shock
	(1)	(2)	(3)	(4)	(5)
A. All UK regions					
CBD Shock	-0.681*** (0.072)	-0.666*** (0.067)	-0.669*** (0.068)	-0.293*** (0.076)	12.146** (5.216)
CBD Shock *x* log(Rank)	-	-	-	-	0.468*** (0.136)
CBD Shock *x* log(GDP per capita)	-	-	-	-	-1.193*** (0.459)
CBD Shock *x* Sectoral specialization	-	-	-	-	0.393*** (0.151)
CBD Shock *x* Sectoral diversity	-	-	-	-	-0.070 (0.045)
CBD Shock *x* EQI governance score	-	-	-	-	-0.225 (0.506)
CBD Shock *x* Undevelopable land (%)	-	-	-	-	-0.015 (0.009)
Constant	2.695*** (0.073)	-1.128*** (0.324)	8.985*** (1.049)	1.535 (1.428)	-2.432 (2.296)
Observations	6,836	6,836	6,160	6,160	6,160
Adjusted R^2	0.484	0.550	0.574	0.592	0.609
B. All UK regions excluding London					
CBD Shock	0.167 (0.103)	0.186** (0.094)	0.157 (0.098)	0.126 (0.107)	-2.003 (9.657)
CBD Shock *x* log(Rank)	-	-	-	-	0.169 (0.197)
CBD Shock *x* log(GDP per capita)	-	-	-	-	0.333 (0.953)
CBD Shock *x* Sectoral specialization	-	-	-	-	-0.778 (0.561)
CBD Shock *x* Sectoral diversity	-	-	-	-	-0.086* (0.049)
CBD Shock *x* EQI governance score	-	-	-	-	-0.042 (0.655)
CBD Shock *x* Undevelopable land (%)	-	-	-	-	-0.005 (0.011)
Constant	2.528*** (0.087)	0.213 (0.426)	2.639 (1.604)	0.159 (2.183)	-2.483 (2.707)
Observations	3,734	3,734	3,064	3,064	3,064
Adjusted R^2	0.598	0.661	0.660	0.661	0.665

Notes: Dependent variable is property-level risk premium. Specifications are based on and extend Equation A.1. Models (2) to (5) include controls for property characteristics and types, and all models account for year fixed effects. Estimates of *CBD Shock* are additional to time-invariant CBD effects similar to those in Tables 1 and 3. CBD Shock estimates in columns (1) to (3) are for a between-city setting but are robust to city as well as city *x* post-crisis period fixed effects.
*, **, *** Significance at 10%, 5%, and 1%, respectively.